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ASRC News

QUARTERLY NEWSLETTER OF THE AVIATION SERVICES RESEACH CENTRE

In this big issue

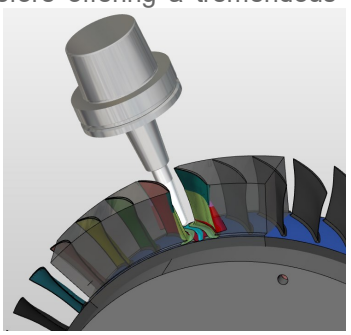
Message from the Editor
Mr Tony Mannion, ASRC

We have being putting out this newsletter for almost two years now and what a tumultuous period it has been. Hong Kong experienced months of civil unrest followed by the impact of the global COVID 19 pandemic. These have affected every area of life and the aviation industry has experienced the impact of the pandemic in particular with greater consequences than most.
The drop in passenger travel has meant the reduction in the number of aircraft in service and consequently the number of aircraft requiring overhaul and maintenance. Our members have faced challenges as have all MRO and aviation concerns. The ASRC itself has continued with periods of 'work from home' and with staff stranded overseas, unable to return to Hong Kong. Now, with the roll out of the vaccines and the uptake in inoculations, we expect that there is some light at the end of the tunnel.

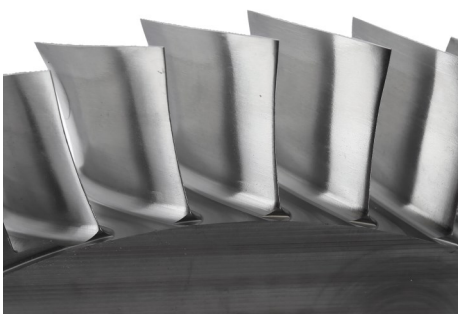
We hope that this newsletter gives members, customers, clients, competitors and friends an idea as to the working of the ASRC and how we can help local and multinational industries with projects and services. As our funding and administration model is scheduled to change in the near future, it's a good chance to reflect on our achievements.

Blisk Manufacture

One of the most intriguing developments in recent years is the introduction of 'blisks' (bladed-disks) into aero engine design, consisting of a rotor disk and multiple blades in a single part, therefore offering a tremendous saving in weight but significantly increasing the complexity of manufacture as they are machined from a solid piece of material. Due to this, they are ideally balanced for optimum performance.


Machining Strategy for a Blisk

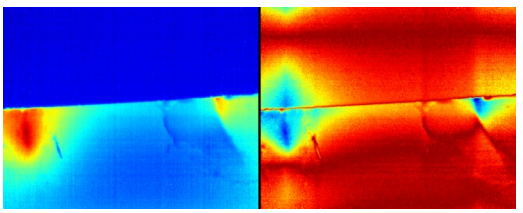
The ASRC are developing blisk manufacturing capability to help support future blisk repair solutions. Repair is necessary when a blisk becomes physically damaged in service or due to routine wear. Blisk repair often starts by building up the airfoil surface at the tip and leading edge via direct energy deposition or completely replacing individual airfoil sections via electron-beam welding. In either case, the added material must be contoured to bring the airfoil surface back to its original shape.


Stainless Steel Blisk machined at ASRC

Using adaptive machining, operations such as chord restoration, leading-edge profiling, airfoil surface machining as well as blending back to original can be performed automatically. The additive repair and adaptive machining of blisks is a very challenging and interesting area of R&D for ASRC and its members.

NDI of Fuel Tank Fasteners

This 2-year ITC funded project, initiated by BOEING was completed in June. During the past 24 months the project team of accomplished researchers developed a set of technologies improving the inspection task to detect nearly invisible cracks inside aircraft fuel tanks. Many technical challenges were overcome to make the invisible visible.
A small size, advanced induction thermography system was developed and tested to detect any crack longer than 5mm. The cracks are automatically reported in 2D with their dimensions, hence helping engineers to make an informed repair decision.


With Induction Thermography cracks become obvious

As the area is usually covered by sealant, sealant removal techniques were researched as well. Less sealant means more accurate inspection results. For this, both dry-ice blasting and mechanical removal via polymeric cutting tools were investigated and these gave good results.

The final project report with details on research elements, results and conclusions will be provided to the ASRC partners in July 2021.

Technology Corner

Structured Light Cameras

Structured Light Cameras have revolutionized the world of engineering, architecture and the recording of ancient artifacts. Lets see how they work.

The Structured Light Camera has revolutionized the recording of surfaces and objects. This technique allows technicians to create a full 3D point cloud of a surface or a 3D object by rotation of the object. The basic principle of the operation is contour following based on the old technique of fringe projection. A series of bright lines are projected onto a surface and viewed with either one or two cameras.

The actual 3D shape of the object can be obtained from the path the lines take and their deviation from normal. Deeper information can be obtained by the broadening of the lines which is akin to the differential of the surface or the instantaneous slope. Stripe frequency and phase deliver similar cues to the depth and can be analyzed by a Fourier transform of the pattern.

In general the pattern of straight lines is varied in spatial frequency to provide a higher degree of accuracy of the reconstruction. Blue light is preferred as it has the shortest wavelength and detectors are highly responsive to the wavelength.

Structure light cameras are becoming more and more common and applications abound. Here at the ASRC we are using them to create full volumetric object copies of engine components and blades in addition to surface profile construction and reconstruction to assess deviations from nominal profiles. It is a joy to be working in this field at the moment as developments are happening all the time.

Dr. Anita Xin is team leader of the Data, Materials and Instrumentation Stream of the ASRC.

Project Descriptions

ITC funded Open source projects underway in the ASRC

Machining Distortion Minimisation

In the process of manufacturing aero structures, a considerable amount of material is removed from the blank material to create a monolithic structure. This of course requires substantial machining on a multi axis machining centre. One drawback in the production of these monolithic structures is that the machining process can leave behind some stresses which manifest as distortion in the part.

This project aims to develop a machining strategy for both three and five axis machines that will minimise the remaining distortion. The parts will be measured 'on-machine' for strain during final cuts and the data from the machine will be added to this to create a model of the process. This can be run in a digital twin to make predictions on the changes resulting from modification of the machining parameters such as feed, speed and depth of cut (among others). The residual stresses in the final part will be measured by incremental hole drilling through strain gauge rosettes and this information will also be used to verify the model. We shall endeavour to make use of the local (Guangdong) China Spallation Neutron Source to do neutron diffraction measurements and get a value of the stress in the core of the blank or even the finished structure. The ASRC are uniquely positioned to carry out this project as we have the use of a high speed machine and a high torque machine in the centre.

Radome Assessment and Transmission Test System

The Radome is a critical, yet passive, component on the airframe. It protects the weather radar and is optimized to have an aerodynamic profile. The transmission at the radar frequency of 9.5 GHz through the radome should be over 90% as this is the standard for Doppler radar which is fast becoming the norm on aircraft and is used to detect wind shear and clear air turbulence.
Should the Radome become damaged and due to its location this is rather common, the radome is scarf repaired and tested to ensure that the transmission is at the same level as before. The two options for this are to use a large anechoic chamber and test the radome with a weather radar and a radar signal some 50 metres or more away. The second method which is not the same as certification is to measure the decibel loss on a point to point basis.
We will use a pitch and catch method to test the radome at each point and produce a map of the decibel loss over the entire radome. This will be overlaid on a map of the subsurface health of the radome obtained by flash thermography using a 8 to 12 micron thermal camera translated over the entire component.

Cold Metal Spray Deposition

Firing metallic, ceramic or composite alloyed powders in the supersonic speed regime of 600 - 1200 m/s as a depositional repair process may sound like science fiction, but cold spraying is very much science fact that will bring benefits to aviation component repair in spraying application.
The dynamic work-hardening process involved enables large areas to be bonded rapidly with purely mechanical clean adhesion; heat produced from the powder and substrate (work-piece) collision to plastic deformation is retained in the zone where it is created, resulting in negligible residual stress with initial physical and chemical material properties retained.
The challenge however remains in maximizing the utilization of heat generated upon the impact of powder governed by the physics of adiabatic shear instability.
R&D work at the Centre will be carried out to identify the critical particle velocity tolerance window for successful repairs on selected components in relation to spray particles of interest.

At present due to the global heath pandemic the cold spray system has not been installed. Everything is in place for the system to be set up but there is a requirement for the Japanese OEM to supervise the setup and certify the safety of the system. The ASRC had pressed the Japanese OEM and eventually installation began on the 1st of June 2021. Installation was supervised remotely by three cameras using MS Teams. At present the sound proof booth has been erected and the equipment placed in situ. We now await a decision on how to perform the final commissioning of the gas gun.

PolyU Foundation (a charitable wing of the PolyU) visit the ASRC

Aviation Classics — de Havilland DH86

DH 86 at Kai Tak, first mail flight into HK

Commercial air travel began rather quickly straight after the first flight by the Wright brothers. One of the driving features of commercial flight wasn't to transport people around the globe but to move information in much the same way as we do today on the internet. Only in 1936 moving information by air mail wasn't quite so quick. The first scheduled flight to arrive in Hong Kong was on an Imperial Airways de Havilland DH86 named "RMA Dorado". The mail took 8 days to come in from London with 20 stops mostly on flying boats. The final stop before Hong Kong was in Vietnam in what is now Da Nang and after a 6 hour flight the aircraft was escorted into Kai Tak by 9 Royal Air Force aircraft from the aircraft carrier HMS Hermes in the harbor, where, on landing, it was met by the Governor and a crowd of 200 people. (*Reminds me of my first landing in Hong Kong*)

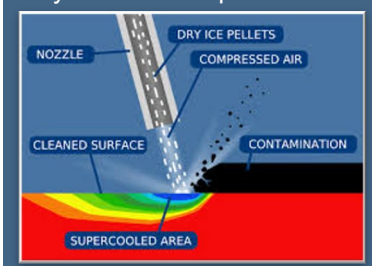
DH86 of Qantas Empire Airways

The DH 86 was a four engine biplane manufactured by de Havilland. It was a very popular aircraft at the time and was the backbone of the recently formed Qantas Empire airline. In addition to mail sacks it could carry up to 16 passengers. The aircraft which was the first into Hong Kong only had one passenger and 16 bags of airmail. In military service in WWII it served as an air ambulance for the ANZAC forces in the pacific theatre.

ASRC Equipment — Dry Ice Blasting

The ASRC have a Cold-Jet Dry Ice blasting machine that was used on a project for sealant removal on aircraft components.

The blasting machine fires small pellets of dry ice (solid CO_2) at high pressure from a aerodynamic accelerating nozzle at around Mach 1. The dry ice sublimates into a gas on contact with the surface and the energy is transferred to the layer on the substrate of the material. In this way contamination, paint and polymeric sealant can be removed with ease. The Equipment is portable and only needs compressed air and single phase power.



Enhanced material removal can be obtained by using an additional sand blasting attachment, which combines with the dry ice impact to remove materials with an even higher efficiency.

Applications:

* Cleaning of oil and grease
* Coating removal (paint, primer)
* Sealant removal
* Glue removal, e.g. Epoxy
* Treatment of corrosion

Membership Benefits of the ASRC

Companies who join the ASRC as members should have a primary involvement in Aircraft Maintenance, Repair and Overhaul or should benefit from involvement and investment in technologies which may spin off from this field of research and development.

If you feel you are in one of these categories and would like more information on benefits and details on how to join, have a look at the website at www.asrc.hk or contact our CEO, Prof. Stephen O'Brien. (Stephen.Obrien@polyu.edu.hk)

In principle there are different levels of membership with different levels of access to research in the ASRC. Almost certainly there is a membership level that is a good match for your company.

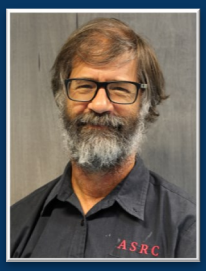
Asian Airlines Profiles

Garuda Indonesia

Garuda Indonesia is the flag carrier of Indonesia and is based in the capital, Jakarta. It started out as Royal Dutch Indies Airways, this being dissolved and taken over by KLM in 1947. By 1949 and with independence the name was changed to Garuda and with a DC -3 aircraft (RI-001) as it's first flight the new airline came into being.

The airline suffered in the Asian financial crisis and with two fatal crashes on the ground it's reputation was damaged. Further damage in 2004 from an on board assassination of an activist led to a ban on flights to Europe.

2009 onwards saw a rehabilitation and a plan to double the size of the fleet and return to European flights. It still had PR issues throughout the decade and is now suffering under the COVID crisis.



Staff Profile:

Glenn Cooke

Glenn has held a number of positions over the years, indeed a more eclectic confluence of occupations would be hard to emulate in any number of lifetimes. From organic farming to hotel management, from merchant banking to motorbike mechanics, from Marine Engineering to Computer Aided Design — safe to say there is very little to which Glenn has not turned his hand.

In keeping with the tradition of many young New Zealanders, Glenn took some time out of his native country to work in Europe or Asia for a few years. In Glenn's case it was about 45 years, taking him to Scotland as a movie extra in 'Highlander' and Belize as a hotel manager. Returning to his now Native Australia he met his future wife and married, finding himself in Hong Kong shortly thereafter.

Following on from a long stint as a Yacht captain, mechanic, composite material repairer and welder, Glenn took up the position of technician in the then recently formed ASRC.

Here he could at last apply all that he had learned over the years to help in Aviation MRO research. The ASRC are very lucky to have access to the wealth of experience, boundless enthusiasm and talents of our hard working technician. Glenn is indeed a valuable member of this team.

Activities

08 APR — Demo of HoloLens capability

28 APR — Visit to ASRC by HAECO Director AFS, Mr William Ginns

04 MAY — Cold Spray progress meeting with Boeing

05 MAY — Visit to the Centre by the CEO of Seaplane Hong Kong, Mr Steven Cheung

14 MAY— Visit by Prof Raymond Leung and Mr Simon Szeto, Aurora and SBI China Capital respectively

18, 26 MAY Cold spray installation meeting

27 MAY— Visit by PolyU Foundation

1 JUN — Cold spray installation begins with remote supervision from Japanese OEM

4 JUN — Visit from Ir Dr SW LUI, former VP PolyU

10 JUN— Visit by PolyU Foundation

18 JUN— Visit by Eddie Leung Tin -fu, Shine Tak Foundation

'HoloLens' Demonstration

William Ginns and HAECO team visit ASRC

Mr Steven Cheung, CEO of Seaplane Hong Kong

The ASRC on Social Media

ASRC maintains three active social media accounts, namely 'Facebook', 'LinkedIn' and 'YouTube'. These are updated from time to time after visits and special events in the centre. Needless to say this has been less frequent over the past couple of years. Despite this we try to keep information flowing on these platforms to allow followers to keep up with our activities.

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