ISSUE #11
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ASRC News

QUARTERLY NEWSLETTER OF THE AVIATION SERVICES RESEACH CENTRE

Visit to the Marine Police to discuss potential projects

In this big issue

Working Together: Ally LIU and ASRC

Ally is the R&D manager in Boeing Research & Technology – China in Beijing and has been involved with the ASRC for over 4 years. She talked with us over a phone call.

ASRC: What is the benefit of the ASRC to BR&T-China?
Ally: BR&T-China has been prioritizing applied R&D in aviation services for over 10 years. This aims to accelerate the local MROs' technologies for better operational efficiency and sustainable aviation industry growth. The expertise of automation and inspection within ASRC is a good match. Our aluminium recycling research area also benefits from ASRC's machining and laser ablation capabilities and the funding support from Hong Kong government. This industry-university-research consortium faced many challenges during the past two years, we then focused more on delivering immediate value, which actually triggered more opportunities and possibilities for the centre's future.

ASRC: What's the best aspect of the ASRC?
Ally: I view the best aspect of ASRC is their talents. Many of them used to work in aviation MRO and manufacturing companies. When we work together with them, we are impressed by their rich industrial experience, excellent project management skills, and professionalism.

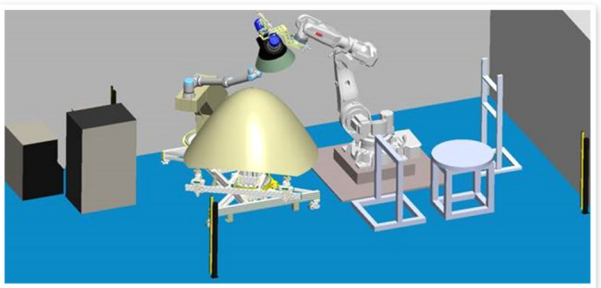
ASRC: Are there any ways the centre could further help BRT?
Ally: ASRC has a 1,500 square metres facility with over US$4.5M new equipment for metals processing and treatment. We'll explore more work packages to better utilize these lab facilities.
Due to the pandemic, we haven't done the regular face to face meeting for more than two years. Establishing a better communication and information sharing mechanism under the new normalcy could help ASRC align their good work better with BR&T and other consortium members' business priorities.

Radome Technology

A Radome, or Nose Radome to be correct, is an aerodynamic structure placed at the front of an aircraft to protect the weather radar and glide path antenna from wind pressure and FOD.

To achieve this, the Nose Radome must be tough, resilient, aerodynamic shaped and transparent to the radar wavelength of 9.5GHz in the X-Band. Invariably the solution is to make the radome out of GFRP shell with a honeycomb interior. This makes it durable and light whilst being transparent to Radar frequencies.

At present the ASRC, with ITC funding, are fabricating a test rig that can automatically measure the radar transparency of such a component, off wing, post repair to confirm that the transmissions are up



to the standard required by the radome type. We will measure the attenuation loss and map this to a synthetic thermal image of the component produced by flash thermography which is stitched together on a CAD model of the component.

Virtual Open Day

On November the 18th, the ASRC held three separate virtual open day sessions; 7:00 am, 9:00 am and 9:00 pm, (UTC+8).

Staff from the three member companies were able to join the ASRC via WebEx and enjoy a tour of, and explanation of the projects and facilities in the ASRC, both in X block (offices, labs and workshop) and W Core (Titanium facility). Timing was set to enable members from every corner of the known world to attend at least one of the sessions and indeed we had staff in attendance from both coasts of the USA, from China, Europe and India. Feedback on the event has been universally positive and we anticipate this being an annual event. Were it not for the global pandemic and the surge in live streaming many people would not have had the chance to see the ASRC in action. Truly, every cloud has a silver lining.

Technology Corner - The LASER

When first demonstrated, Lasers were considered a solution with no problem, today their use is ubiquitous.

Light Amplification by the Stimulated Emission of Radiation was first demonstrated in 1960 with the pulsed ruby laser, developed by T H Maiman. He used a large flash-lamp and elliptical reflector to pump energy into the ruby rod.

Lasers produce light which is (a) coherent (in phase), (b) monochromatic (single wavelength), (c) directional and (d) intense. These properties add up to make the laser a useful device in manufacturing, metrology and research.

The principle of operation of the laser is explained in its own acronym. A population inversion of electrons in the bulk of the lasing medium is created by pumping energy into a 'metastable' material, and this results in spontaneous emission of a photon. This photon will cause Stimulated Emission of the Radiation. Because of the large number of photons, some will travel parallel to the lasing medium. Due to resonance they will all have the same phase, wavelength and direction. Mirrors (one of which is almost 100% reflective and one around 95%) reflect the stimulated stream of photons back along their path, stimulating further emission of photons. This cavity filled with Light Amplification allows the light to escape from the lower reflection mirror (Output coupler) and the laser light is created. The flatness or curvature of the mirrors and length of the cavity dictate the purity and coherence of the laser beam.

The medium can be solid, liquid or gas and the pump mechanism to create the population inversion can be electrical, optical or even chemical. Extremely high powers are possible with some lasers.

Today, solid state lasers on chips make use of the same principles to produce intense beams with wavelengths dependent on the band gap energies. Due to their small size the beams are rather distorted and require compensation optics. Applications of lasers use different energies, wavelengths and output modes but wherever they are used the laser have become a versatile and useful light source.

Mr. Mannion is Lead 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 micrometre 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.

Visit to the *Royal* Hong Kong Yacht Club (Sub-surface scanning tests)

Aviation Classics — SE210 Caravelle

In the days before the dominance of Boeing and Airbus a number of companies vied for market share with occasional success. The large French venture 'Sud Aviation' produced an aircraft inspired by the UK Comet aircraft called the Caravelle.

This was a twin engine swept wing medium size jet and was the first to operate successfully in the medium range city to city model. The aircraft had no competitors as it was the only jet aircraft operating in that range. Around 280 were produced in a number of variants with a good number going into military service as well.

An Air France Caravelle and its old friend in the background

The iconic triangular windows of the Caravelle remained in all variants

It suffered from a number of accidents much like its predecessor the Comet but continued to find a solid market and success around the world.

The entire design team were switched in the late 60s to work on a supersonic successor to the Caravelle, the super-Caravelle which ultimately was merged with the work in the British Aircraft Corporation to become the famous Concorde aircraft.

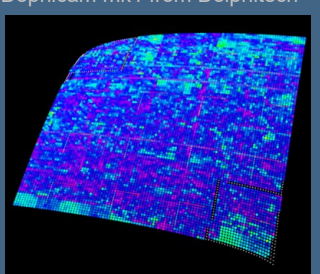
ASRC Equipment — The 'Dolphicam' Ultrasound imaging

Ultrasound is used in a wide range of applications from medicine to aerospace. In many cases the use of the ultrasound probe is a technicians art and requires many years of training to correctly interpret the signals that we see as flickering lights on the screen.

The Dophicam instrument takes the traditional depth reflections (A-scan) and sweeps them twofold to produce a volume image (C-scan) and does this instantaneously using pulse echo methods. It has a rectangular array of overlapping linear transducers that switch from transmit to receive in order to maximize efficiency and resolution. The overlapping linear transducers form an array of 1024 elements that switch from Transmit to receive sensors giving the array C-Scan in real time.

The device was developed for Carbon Fibre composite materials and was used widely on the B787. It has been superseded by a Mk2 which can be used with a range of other composite, polymeric and metallic materials. ASRC have made use of this on two projects already and are always on the lookout for another application.

Dophicam mk1 from Dolphitech



Stitched images from a Dolphicam

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 Airline Profile

JAPAN AIRLINES

JAL

Japan Airlines are the flag carrier for Japan and were established in 1951 with a DC-3 aircraft. The first international flights were to San Francisco with a DC-6A, still coded as flights 1 and 2. By the late 60s the airline was flying to most global cities with DC-8 aircraft. It invested heavily in 747s and was one of the largest operators. Following financial trouble in the 1990s as the Japanese economy slowed, it went into bankruptcy. After emerging from this, it merged with other Japanese airlines and operated a scaled back service.

The J-Bird MD-11 was a common sight over Kowloon city in the 90s

Staff Profile:

Ms Ziwei Moey

One of the great things about the set up of the ASRC is that we can recruit Intern researchers to work with us on a specific project. This gives us access to young enthusiastic graduates (usually from PolyU) and gives the graduates a good opportunity to see how industry works whilst still being in a familiar academic environment. An example of this is our researcher, Ms Ziwei Moey. Ziwei graduated from Mechanical Engineering in the PolyU in June of 2019 and joined the ASRC as researcher in the Automatic Blade Balancing project under Dr HP Tang. In this project she worked on the Blade balancing software and the robotic marking of weight on the blade itself. She assisted in the coding for the robotic movements and investigated the weighing methodologies.

With the completion of the project she successfully transferred to the Radome testing project and is currently working on the automation and synchronization of the twin robots for radar transmission.

In her evenings she continues with her studies and is reading a Master's degree in Aeronautical Engineering at the University of Science and Technology.

Ziwei has used her interest in graphic design to assist the communications staff in layout and fonts for documents and publications.

Recently she accepted a full time job with Cathay Pacific in Cathay City. We are sorry to see you go but good luck and farewell Ziwei!

Activities

04 OCT - Visit by Apex Carbon

07 OCT - Visit to Royal Hong Kong Yacht Club

18 OCT - Visit by Marine Police

22 OCT - Visit by Chinese Manufacturers Association

29 OCT - Visit by HK Express

08 NOV - Visit by Mr Andrew TUNG

12 NOV - Visit to Marine Police base in Tai Lam

18 NOV - Virtual Open Day

18 NOV - EDB with Teachers visit

26 NOV - EDB with Teachers visit

09 DEC - Visit by Mr Leo KUNG

Subsurface scanning at the RHKYC

EDB and secondary teachers visit the Centre

Marine Police visit the Centre

Chinese Manufacturers Association of Hong Kong

Mr Leo KUNG visits the Centre

The ASRC on Social Media

ASRC maintains four active social media accounts, namely 'Facebook', 'LinkedIn', 'YouTube' and 'Instagram'. 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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