ISSUE
#10
July – September 2021

ASRC News

QUARTERLY NEWSLETTER OF THE AVIATION SERVICES RESEACH CENTRE

Aviation at the Edge of Space

In this big issue

Message from Prof Stephen O'Brien, CEO, ASRC.

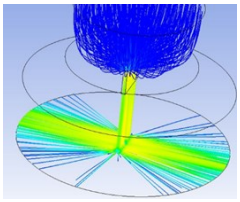
Recent changes in the organisation of Research Units in the HK PolyU have resulted in the reorganization of Integrated Research in the University. As a consequence the ASRC will now operate independently, reporting to the University through the Dean of Engineering.

We welcome this change and look forward to a new era of co-operation and collaboration with other units in the PolyU as we take the ASRC forward, embracing new opportunities, new members, and new paradigms to better serve the aviation MRO and the wider Hong Kong Community.

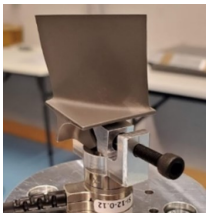
The ASRC will eventually merge with the Innovative Manufacturing Research Consortium (IMRC) to be formed in due course and as such will actively welcome new members from outside the aviation field whilst still focusing primarily on the core membership that have been so loyal and collegial over the past 8 years or more. The governance of the ASRC will not change in the medium term with the Board of Governors overseeing and guiding the direction but with a greater representation from the senior management of the PolyU. The ASRC will continue to operate in the way it has so successfully for the past years and we look forward for more to come.

Dynamic Blade Balancing

A turbine blade's aerodynamic properties and its shape and surface properties are critical for the efficiency of a turbofan jet engine. Satisfactory surface roughness allows smooth airflow. Hence their airfoils are currently polished with a process called "vibro-polishing". This process uses a polishing medium to smooth irregularities and achieve a fine surface finish after several hours. The performance of jet polishing on blade materials was studied in our latest ITC project. A high pressure jet of slurry was employed to polish blade surfaces. The significant factors influencing the polishing process were identified. Various slurry and blade material combinations were tested. Furthermore, computer simulations (CFD) were performed to evaluate the effectiveness of different jet nozzle openings.



Before the blades are installed to engines, they must be balanced accurately. Any imbalance force will cause the rotor to vibrate inducing higher wear and fuel consumption. The current balancing procedure is labour intensive as every blade is weighed, temporarily marked and installed individually. During this procedure, data is entered manually into an OEM software, which gives a blade order within acceptable balance limits. Blade sets are mounted on a testbench afterwards, and the operator often must swap a few pairs of blades. An automatic blade weight system was developed in this project. Blades' weights and centres of gravity are automatically measured and be transferred to the OEM software. In addition, the blades can be sorted into any installation order. Finally, an AI system based on reinforcement learning techniques was developed. It could search the orders that produced lower imbalance forces.



Seaplane Hong Kong

The ASRC are happy to report that an MOU was signed with the Seaplane Hong Kong Company on the 16th of September 2021. They intend to run a project with the IMRC in the near future.

The Company plans to operate a fleet of seaplanes to fly to and from bespoke destinations in the GBA and South China Sea. Their destinations will be designer resorts affordable to all.

Seaplane will have their headquarters in Hong Kong and fly from suitable locations such as the perimeter of Victoria Harbour.

In time they intend to introduce eVTOL aircraft to function as air taxis and to facilitate rapid transportation across Hong Kong.

The ASRC with the IMRC and the PolyU are planning to run projects looking at the feasibility of Urban Air Mobility (UAM) and Hydrogen fuel cells.

Technology Corner - Deep Learning and Artificial Intelligence

Software combined with powerful GPUs now enables us to perform tasks on observations and data that were inconceivable only a few years ago, now read on...

Recently, AI and ML are being applied in aviation industry. It is anticipated that using AI/ML can increase performances of complex systems in aircraft. Boeing mentioned that ML would be able to find patterns, reveal information, and even make recommendations from enormous amount of data generated in their manufacturing processes. Applying ML can be very beneficial to in some areas like design, supply chain, factory, service, etc. In addition, some repetitive and skillful tasks involve specified trainings and experience. ML is able to capture tasks' skills and provides the possibility of automating them. In another example, ML helps companies to analyze flight restrictions and air traffic fluctuations during COVID-19 pandemic and make important decisions. Although ML showed its tremendous potential, people sometimes find difficulty in understanding its operations and puzzle about its outcome. Consequently, we have an underlying fear to hand over our control to an AI system and worry that the system goes haywire someday.

Another approach "augmented intelligence" also referred as intelligence augmentation (IA) emerges. Unlike AI, augmented intelligence's aim is not to replace human workers but empower them to work better and smarter. Applications of augmented intelligence include big data analytics, aircraft/drone autopilot, preventive maintenance, etc.

IEEE: "The key difference between AI and augmented intelligence is one of autonomy. AI is intended to operate without human assistance. Such AI generally operates within very narrow criteria and is often intended to take mundane tasks off human hands …. as augmented intelligence's machine learning does not have to take part in any decision-making process. Instead, augmented intelligence analyzes data, sees patterns, and reports those patterns to users, allowing human intelligence to take over…"

In typical augmented intelligence applications, data from different sources are gathered and converted to deeper and more revealing information. Therefore, a human operator is better informed and can make smarter decisions. Moreover, IA can handle immense amount of data that usually overwhelm any human capability and remove human factors such as bias, fatigue, emotion, etc. Augmented intelligence seems to be a sensible alternative because it involves people and machines working together, playing to their own strengths to achieve greater business value.

Dr. HP TANG is team leader of the Robotics and Automation Stream

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.

Project Descriptions

ITC funded Open source projects underway in the ASRC

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.

Senior Officers of the HK Police Force at the ASRC

Aviation Classics — Martin M 130 Flying Boat

M130 in the USA

Not all classic aircraft made use of airfields and runways for operations, many early commercial flight routes used seaplanes AKA flying boats. The iconic 'China Clipper' was built for Pan-Am by the Glen L Martin Company in 1935 and ran the San Francisco to Hong Kong route taking ten days to get to Kowloon Bay via Hawaii, Midway, Wake Island, Guam, Manila and Macau. Only three such planes were built for Pan Am and all ran on Pacific routes, the sister ships were the Philippine Clipper and the Hawaii Clipper. All three had eventually crashed by1945 in accidents that were unrelated to WW2. The China Clipper was eventually replaced in 1938 by the equally iconic Boeing 314, the 'Yankee Clipper'

Interestingly much of the terminology around modern aircraft originated with seaplanes; captain, first officer, ramp, fore and aft, port, starboard, nautical miles and of course the naval styling of the pilots' and stewards' uniforms.

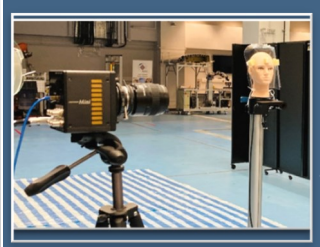
Painting of M130 in Hong Kong

The name 'China Clipper' lives on in the China Clipper lounge of the Peninsula Hotel which is kitted out in the art deco interior style of the original flying boat.

We wonder if we will ever see flying boats in Hong Kong again.

ASRC Equipment — High Speed Camera

The ASRC recently took delivery of a high speed camera from the Photron Company in Japan. The camera (in good lighting conditions) can take up to 80,000 frames per second albeit at only 256x32 pixels. A more useful 512x512 image gives us 8,000 fps and 2048x1440 gives us 5 seconds at 1,500 fps.
These ranges all depend on the file transfer rate and the memory size which is 32Gb. The critical technology in these cameras is the transfer rate of data from the CCD to the memory chip. We envisage a number of uses for the camera in the areas of laser paint ablation, laser marking and other high speed processes such as shot peening. At present the camera is deployed in the measurement of Respiratory Pathogen Emission Dynamics (sneezing) and the assessment of face masks developed by the PolyU.



High speed cameras have been around since the invention of movie film. Clearly the speed was limited by mechanical considerations. Today the speed of the film is limited by the transfer rate of data to the solid state memory and the electronic shutter rate. Our "Fastcam Mini" can have a shutter speed of 2.7 microseconds.

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 Profile

Vietnam Airlines

Vietnam airlines were founded in 1956 and became an State controlled company in 1989. It the years after the second Indo-China war the country was isolated and obtained only older aircraft from the Soviet Union. With the normalization of relations with the USA the company started to expand. It began to operate Airbus and Boeing single isle aircraft for use internally and in the region. It experienced a big expansion from 2007 onwards and added A350s and B787 aircraft to its fleet.
It is currently one of the biggest airline operators in Asia with routes to Europe and America in addition to many routes within the South East Asian region.

Staff Profile:

Mr. A J P Mannion

Mr. Mannion Graduated in Physics from Paisley College of Technology (Now UWS) and took up a position in Ferranti Optical Components Group in Dundee working on Optical Test, Diamond Turning and Vacuum Coating. He worked on a number of projects including neutron guide installation and optical test of the IRAS satellite optics in addition to setting up polygon mirror fabrication for the diamond turning section.
Upon the closure of the Ferranti factory he accepted a position with a two year contract as a Senior Lecturer in the VTC in Hong Kong as a course leader for optical courses in Lee Wai Lee. Some 28 years later he resigned the post and came to work with the ASRC.
Mr. Mannion is lead of the Materials, Data and Instrumentation stream and current Project lead of the Radome Test project. He has successfully established a residual stress test setup in the centre based on incremental hole drilling and delivered a project on Aircraft Damage Assessment. His interests remain primarily in Optics and Optical technology but have extended into all manner of NDT and inspection, particularly in relation to the assessment of composite materials.

Activities

09 JUL — Visit by Hong Kong Police Force Senior Staff
15 JUL — Visit by Y. Elite Foundation
5 AUG — Visit by MTR Fleet Performance staff
19 AUG — Visit by Hong Kong Aerospace Technology Group
16 SEP — MOU signed between Seaplane Hong Kong and PolyU
25 SEP — Seminar on AI for HAESCO in ASRC
24,28 SEP - Investors in Seaplane Visit to Centre

Prof Man, Prof O'Brien, Dr Xin, Mr Mannion and the HKPF

Dr HPTang with the Y.Elites Foundation

MTR Development staff with Ms Yandy MA

Steven Cheung with HC Man - MOU signing ceremony

HK Aerospace Technology Group with Prof HC MAN

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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