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VIRUS EDITION

ASRC News

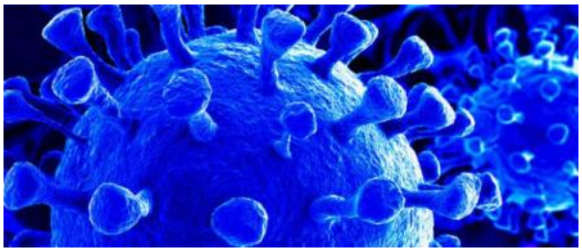
QUARTERLY NEWSLETTER OF THE AVIATION SERVICES RESEACH CENTRE

In this big issue

Singapore Air Show, FEB 2020 — RMAF SU-30

Visits and 'Other Events'

Over the period to March a number of events, visits and activities were planned including board meetings, overseas fact finding trips and on site meetings. However, due to the spread of the COVID-19 virus and the ensuing pandemic, the bulk of these had to be cancelled. Only the visit to the Singapore Air Show



A Corona (crown) type virus

went ahead as planned and even then, most of the conferences and meetings were cancelled.

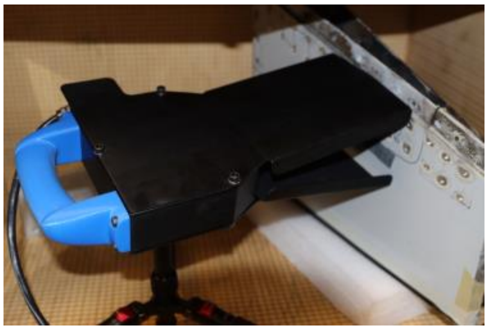
The advice from the university management was to work from home where possible. ASRC staff based in the mainland continued to work on documents and software from home whilst some staff, of their own accord chose to go into the labs to continue to work for three or more days per week. This enabled projects to progress and meetings to be organized as required via the WebX, MS teams and Skype platforms.

From 2nd March the government and the university management instigated a return to work process. Staff continued to work from home on certain days but everyone who could come in, was in the office at least three days per week. Travel to overseas locations and visits to mainland China had to be curtailed due to self quarantine procedures.

Even visits to customers in Hong Kong such as HAECO and HAESL were cut back as many of the senior staff were working from home and the university recommended minimizing contact with other staff.

Delivery of the cold spray equipment from Japan and China has been left on hold as once again quarantine and virus threats have left the installation in difficulty.

Other projects have continued and we are now working hard on the submission of two new and exciting projects for HAECO and HAESL on the areas of robotic welding and automated radome test equipment.



A new 3D scanner under development

Message from Mr Arnie Lewis (Technical Fellow, Boeing)

Boeing and the Aviation Services Research Centre (ASRC) have a very important relationship for improving in-service processes and procedures. I have been working with the ASRC for over six years and witnessed the centre grow from an empty work room to several full functioning research areas. The capabilities for developing machining, robotic assisted processes, material knowledge and data processing have grown and we are seeing the benefits through the research.

The ASRC is one of several research centres we engage with and the ASRC has a unique focus on creating technology and implementing technology in real world scenarios. Having consortium partners such as HAECO and HASEL help balance out the focus on "real" world problems. Because of the great start six years ago, I see a great future for the ASRC being successful solving in-service maintenance process issues.

I have been working with the ASRC for over six years now and have helped them with a number of successful projects.

Here at Boeing, we are always on the lookout for novel methods of test, manufacture, repair and design, and for this reason we have a number of research centres around the world looking afresh at old and new problems in the aviation industry.

ASRC is one of three such centres in China and the only one focused on MRO issues. This is in part due to the influence of HAECO in the HKSAR. The ASRC have done a terrific job of taking university research and industrial know how and experience and mixing it with a dash of inspiration to try to solve the real-world problems in the MRO world. With the guidance and assistance of Boeing I can see them performing great things well into the next decade and I wish them all the best for the future.

Technology Corner
Focus on Optics IV

Optical Technology is an all pervasive enabling technology with wide applicability in a vast and disparate range of applications, yet it is often perceived as something of a 'black art' outside the realms of the main practitioners. Here, Mr. Tony Mannion looks at the basic principles that make optical technology so ubiquitous.

Quantum Optics:- Light is a particle!

Last edition we discussed how light could be modelled as a wave and this explains precisely how light transmits and spreads out in space. It also adds to reflection and refraction the three other wave properties; diffraction, interference and polarization. This evidence was enough to replace Newton's particle theory of light back in the 18th Century. However, in the early 20th Century the tables were turned, and Einstein deduced that we must think of light as a particle, but only when it interacts with matter. The birth of the Quantum theory of light.
The emission or absorption of light is when we treat light as a particle. The consequence of this is quite profound. It is responsible for our development of the laser, photoelectric cells, solar power, semiconducting devices, LEDs CCDs and a deeper understanding of nature.
The particle of light is called the photon and its energy increases with decreasing wavelength. The photon 'particle' has no mass, but we can ascribe a momentum to it to help with calculations. When we take a picture or turn on a light, we are dealing with photons in a quantum world.

Mr Mannion is a Principal Research Fellow in the Materials, Data and Instrumentation stream of the ASRC.

NDI of fuel tank fasteners

Within the wing fuel tanks there are a large number of fasteners which are covered with an organic sealant. This sealant prevents leakages but must be removed every 6 years to check if the structure underneath is damaged. This project proposes to automatically remove the sealant and to use advanced non-destructive inspection (NDI). The effectors will be conveyed inside the fuel tanks using a robot arm small enough to go through the manhole and to reach the areas to be processed. The delivered system shall alleviate the need for fuel tank entry by an operator, thus avoiding many dangers.
The sealant removal technologies investigated by the ASRC include dry-ice blasting and mechanical removal via polymeric cutting tools. The applied research aims to determine the most appropriate method for surface preparation. The focus will be set on achieving the highest possible sealant removal rate. The dry-ice blasting has shown to be very promising as it is a contact-free method leaving virtually no residues. Depending on the pellet size and the applied air pressure, the abrasion can be either gentle or strong.
As for NDI, the developed technology must detect cracks as small as 5mm. The use of a coil to induce heat into the area to inspect along with a thermal camera (infrared) is currently the preferred method. The objective is to use temperature variations to reveal crack tips.

Automated Surface Preparation and Inspection

Paint removal of aircraft components prior to inspection, repair or repainting is usually a time consuming and messy process involving unhealthy chemicals or manual sanding methods and is conducted either in the hangar or in a specialized workshop environment at a great expense of floor space. The aim is to use laser ablation to remove paint and other coatings with an integrated real time inspection system to avoid damage to the substrate material. An autonomous vehicle will also be developed to de-paint and clean seat tracks in the cabin using a portable laser system with onboard power supply and extraction.
The ability to remove aircraft coatings by an automated feedback laser ablation system would have the following advantages for the local MRO industries: aircraft turnaround time will be significantly reduced, MRO capacity will be increased, aircraft weight saving resulting in better fuel economy (approx. 0.25 tonnes per livery), reduced damage to the composite skin through the preservation of the primer coat and Improved working environment with less use of harmful chemicals and the associated waste.

These factors would greatly increase the commercial advantage of the local MRO companies over their competitors.

Project Descriptions

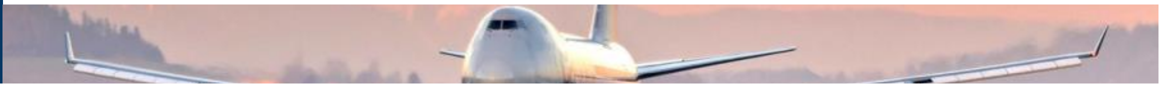
ITC funded Open source projects underway in the ASRC

Advanced Blade Dynamics

Correct surface finishing of the blades and vanes in a jet engine is critical to the efficient running of the engine over its service life. Furthermore the components, on return to the engine body, must be balanced correctly to minimize or nullify vibration and wear.
The Centre will devise a method to balance the blades with relation to their mass and the second moment of area. This is a step change in the way that the finished blades are processed and adds a degree of complexity resulting in an astronomical number of permutations. It is a grate challenge to find the solution to this type of problem.
In addition we will be looking at novel surface finishing methods to improve surface roughness in a deterministic method. We are fortunate to have available the services of the Advanced Optics Manufacturing Centre in the University who will assist us in devising a non contact method of fine surface finishing of the blades with no impact on surface geometry.

Cold Metal Spray Deposition

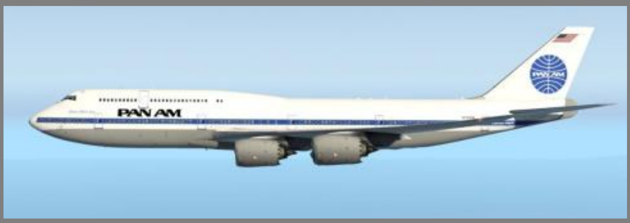
Firing metallic, ceramic or composite alloyed powders in the supersonic speed regime of 600 - 1200 m/s as a depositional repair process may sound like science fiction, but cold spraying is very much science fact that will bring benefits to aviation component repair in spraying application. The dynamic 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.



Embraer's E195-E2 at the Singapore Air Show

Aviation Classics — The Boeing 747 — Jumbo Jet

747 in flight



When it first took to flight in February 1969 the Boeing 747, AKA the 'Jumbo Jet' was easily the largest passenger aircraft the word had ever seen. Lauded by engineers, artist and architects it became a star in its own right featuring in movies and novels for many decades often as the principal character. Today as engine and aircraft design have advanced and commercial considerations change, we find that the 747 is largely used as a freighter aircraft, however it is rightfully remembered as a design classic in addition to an aviation icon.

"The 747 is the commuter train of the global village" - Hendrik Tennekes

The final version of the 747 had a vertical stabilizer taller than a six story building and was over 76 m (250 ft) long. The view from the cockpit was the same as that from the third floor of a building. Over 1,500 747s were manufactured in 8 commercial viable variants and a large number are still in service in some capacity including the VC-25 (typically air force one) and a number of luxurious private versions.

The jumbo jet may be fading from service but it will live on as the most iconic Boeing aircraft.

ASRC Equipment — The Surface Optics Hyperspectral Camera

Features of the Hyperspectral Camera

The Hyperspectral camera is used to give a spectral cube of a field of view. Each pixel is essentially a scan of the wavelength range of the spectrometer in the camera. The z axis of the cube being wavelength. A normal camera combines three colours to give a picture of the field, whereas the Hyperspectral camera records 128 wavelengths (colours)

- Spectral Coverage : 400-1000 nanometres
- Spectral Resolution : 4.6875 nanometres
- Bands : 128
- Dynamic Range : 12-bit
- Pixels per line : 696
- Speed : 30 spatial lines per second 23.2 seconds / cube (696 by 520 cube)
- Weight : 2.95 Kg (6.5 lbs)
- Power : 12-VDC / 100-240VAC (50-60Hz)
- Dimensions : (HWL) 9.5 x 16.8 x 22 cm

The SOC710 Hyperspectal Camera in the field

Applications:-
Web and surface inspection, Chemical analysis, Agricultural inspection, Crop health, Target Discrimination, Microscopy, Biological analysis, Plant Sciences, Material Sciences, Oceanography, Remote Sensing, Ground truth, Material Mapping and many more

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 develeopement.
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 Director, Dr. 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.

Member Company Profile

HAESL

Hong Kong Aero Engine Services Ltd (HAESL) is a joint venture company between Rolls-Royce plc (50%) and Hong Kong Aircraft Engineering Company Limited (HAECO) (50%). Combining the strength of Rolls-Royce as an Original Equipment Manufacturer (OEM) and HAECO's experience of more than 35 years repair and overhaul expertise on Rolls-Royce engines, HAESL has become one of the world's most respected engineering names offering the highest quality and most comprehensive engine repair and overhaul service to our customers. Their established strong long-term customer and supplier relationships are based on trust and integrity – the hallmark of all successful business partnerships.

Staff Profile: Dr HP TANG

Dr. Tang Hon-ping got his Masters degree in industrial Robotics from Imperial College, London University in 1989, his Doctoral degree in Industrial System Control from The University of Hong Kong in 2005 and a Masters degree in Mathematics and Statistics from the Hong Kong University of Science and Technology. Since 1992 he has worked in the tertiary institutes such as the Institute of Vocational Education and City University of Hong Kong. He also worked as an engineer in ASM Assembly Automation Co. and TDK Manufacturing Co.
Dr. Tang joined the ASRC in early 2015 and is a senior engineer and project lead. His main research interests include robotics, industrial automation, image processing, artificial intelligence and deep learning.
Dr. Tang won the gold medal award at the International Exhibitions of Inventions, Geneva in 2018 and continues to innovate in a number of ITC funded research projects. We are all grateful for the continuing efforts of Dr. Tang.

Activities

11 to 14 FEB – Visit to Singapore Air-show and meetings with a number of aircraft OEMs

Early MAR - Visits to HAECO for laser paint removal and robotic spray painting tests

Sid HO explains why we don't catch bugs on a commercial jet — It's the Environmental Control System (ECS)

The ECS of an aircraft controls the cabin pressurization at various altitudes, the air distribution, temperature control (including cooling of electronic and electrical equipment), ozone conversion, moisture and air contaminant control.
The ECS receives compressed air at around two atmospheres and hot bleed-air (over 200°C) from the intermediate or high-pressure compressor stages of the turbo fan-jet engine. The switch between the intermediate and high stages is automatic according to the state of engine and prevailing atmosphere or altitude. The bleed-air is regulated to 2 atm to power and supply the Air Cycle Machine (ACM), and partly to the designed cabin altitude pressure (0.74-0.80 atm).
The ACM consists of a cooler stage prior to a compressor and turbine pair, with another cooler in between the pair. It works according to the reversed Brayton (Joule) cycle, in other words pumping heat from the aircraft interior overboard. The turbo-pair is a necessity for adiabatic compression and expansion. The bleed-air itself serves as the refringent; the engine fan and the ram air-intake (in flight)/interior fan (on ground) provide air-cooling to the coolers. The cooled air is dehumidified before mixing with the uncooled air to an appropriate temperature for the cabin.
Air within the cabin is nominally on a 50:50 (new air : recirculated air) mix. Recirculating air passes through a HEPA filter and a contaminant control before re-entry to the cabin. A complete cabin air change is about 24 times per hour (that of a building is at most 2.5 times per hour). High temperature as a result of the heat of compressed bleed-air is beyond the survivability of any known germs from outside the aircraft. Air ventilation system is of ceiling to floor and localised downdraft design - the chance in sensing one's own odour is next to nil, likewise airborne cross-contamination from neighbouring passengers is unlikely.

Meeting with ex-colleague Dr River GUO in Singapore. It's clearly hard to forget the ASRC!

Robotic painting at HAECO

Honda Private Jet - Singapore air show

Laser Paint removal at HAECO

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