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ASRC News

QUARTERLY NEWSLETTER OF THE AVIATION SERVICES RESEARCH CENTRE

The Stratolaunch — Alternative for orbital launch or perhaps for heavy lift

In this big issue

Cold Spray Gun Installed

After a wait of almost three years due to the onset of the pandemic, the Engineers from Plasma-Giken arrived in Hong Kong, survived quarantine and with the assistance of ASRC staff installed, set up and commissioned the PCS-100 high pressure Cold Spray system in our titanium processing facility in W core.

The equipment was installed on an ABB robot in the previously constructed sound proof booth and commissioned at full pressure N_2 gas at 70MPa and 1000 degrees Centigrade for 15 Mins.

Thereafter we used N_2 for warm up and cool down and Helium gas for spraying the Titanium alloy material.

Results so far are largely positive and much was learnt in the relatively short period in which the gun was operated. The consumption of gas is quite extreme but the high quality surfaces that were produced tend to make the process an acceptable one from the financial standpoint.

We will now complete the ITC project and start to apply for funding for our PhD research into Hydrogen embrittlement of Cold Sprayed Titanium. Other areas of research will include additive repair of engine components and airframe parts. We will initially focus on rotationally symmetric parts that are currently repaired using the high temperature plasma spray process.

Testing of the samples produced is now underway following the ASTM standard tests that we have been preparing for. Onward and upwards for our additive manufacturing!

Meeting the Partners

In the month of September, the ASRC CEO visited a number of countries to re-engage with collaborators and partners across Asia and Europe.

In addition our Engineer, Fu Peng-fei began a trip to mainland China to reconnect with the assorted HAECO concerns with whom we have ongoing projects.

Robert Voyle, CEO, started with a visit to the Asia Pacific MRO conference in Singapore and combined this with a visit to the Nanyang Polytechnic to discuss additive manufacture. He then rotated to Europe and met with SIEMENS Additive Manufacturing Centre to hold discussions on the digital twin that will be used in future models of the manufacturing machines. With the Covid pandemic gradually becoming a seasonal endemic condition and vaccination making good for those unluckily infected, it may be possible to return to normal travel in the not too distant future and engage with our partners once more on a regular basis.

Green Corner -
Bio fuel for Aviation

As human activity threatens to destroy civilization with the runaway greenhouse effect and mass migration precipitated by related crop failure further exacerbates the issue, we look, in this column at measures that we could take and will perhaps one day actually take. - Bio-fuel in Aviation

An **aviation biofuel** or bio-jet-fuel or bio-aviation fuel (BAF) is a biofuel used to power aircraft and is said to be a sustainable aviation fuel (SAF). The International Air Transport Association (IATA) considers it a key element to reducing the carbon footprint within the environmental impact of aviation. Aviation biofuel could help decarbonize medium- and long-haul air travel which generate most emissions, and could extend the life of older aircraft types by lowering their carbon footprint. Biofuels are biomass-derived fuels, from plants or waste; depending on which type of biomass is used, they could lower CO_2 emissions by 20–98% compared to conventional jet fuel. The first test flight using blended biofuel was in 2008, and in 2011 blended fuels with 50% biofuels were allowed in commercial flights. In 2019, the IATA was aiming for a 2% penetration by 2025. Aviation biofuel can be produced from plant sources like Jatropha, algae, tallows, waste oils palm oil, Babassu and Camelina (bio-SPK); from solid biomass using pyrolysis processed with a Fischer–Tropsch process (FT-SPK); with an alcohol-to-jet (ATJ) process from waste fermentation; or from synthetic biology through a solar reactor. Small piston engines can be modified to burn ethanol.

Sustainable biofuels do not compete with food crops, prime agricultural land, natural forest or fresh water. They are an alternative to electro-fuels.

Mr. Mannion is Lead of the Data, Materials and Instrumentation Stream of the ASRC

Machining Distortion Minimisation

Stress and distortion in aerostructure parts costs the aviation industry approx. US$1bn per annum due to corrective action, scrap parts, or later delivery of parts. Therefore, any reduction in this area can give huge benefits to the OEM and its supply chain. This project is now in its final phase, where it is becoming very apparent that distortion can be predicted, and therefore prevented. Over 200 parts from 5 different material suppliers have been machined on high-speed and high-performance machining centres during the project, with residual stress analysis undertaken pre and post machining to determine the levels of stress in the material. Where FEM analysis of machining methodology has been undertaken to simulate the machining strategies and predict stress fields and distortion. In-process monitoring including displacement sensors, vibration sensors, strain gauges, temperature monitoring, spindle monitoring, in process probing, and coolant monitoring have been conducted and managed within a Digital Twin. With CMM inspection of all machined components for geometric verification at the end of the process plus ultrasonic thickness gauging, and conductivity tests. All data collected is analysed and fed into the internally developed AI system (machAI) to support distortion prediction and machining method analysis. With data correlation and regression testing ongoing to help support an industrial standard solution.

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 95% 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.

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 at 800˚C in an open environment as a depositional repair process may sound like science fiction, but cold spray is very much science fact, that will bring benefits to aviation component repair applications.
The dynamic work-hardening process involved enables large areas to be bonded rapidly with purely mechanical clean adhesion; heat produced from the powder and workpiece during collision ensures 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 continues to be carried out to identify the critical particle velocity tolerance window and angle of attack for successful repairs on selected components in relation to spray particles of interest. Testing on representative specimens for aero engine, landing gear, and structure repair is currently being conducted following a series of ASTM/ISO standards to ensure the results meet recognised global standards, enabling successful fruition of the project, and the industrialisation of a Cold Spray repair solution for aircraft components for the ASRC Members.
With the gun now installed in W core, we are investigating the samples produced whilst applying for further finding to carry out downstream research into material properties and stability of the process.

The ASRC at the weekly Flag Raising Ceremony with University President Prof Jin-guang Teng

Aviation Classics, SOFIA - flying IR observatory

The Converted United airlines short body 747 called SOFIA (Stratospheric Observatory for Infra-red Astronomy) was equipped with a reflecting Cassegrain telescope for NASA by arrangement with a German research consortium. It was not the first airborne observatory but was the most ambitious.

SOFIA in flight

This was a novel solution to get a telescope up above the zones where water absorption blocked all the wavelengths of interest to the astronomers who studied the infra-red wavelength range. This required flights at up to 45,000 feet- above 99% of atmospheric water vapour. First light was in May 2010 and it is now retiring after 921 overnight 10 hour science flights

Cassegrain Telescope supplied by German Consortium

Other telescopes in satellites competed with this, the IRAS being launched in 1983 , ISO in 1995 , Hubble and then the Spitzer telescope and of course this year the JWST. These complex satellites have eclipsed the flying observatory but the contributions made by this and the genius technology to stabilize a 2.7 meter telescope in the side of a jumbo jet is quite remarkable. The telescope will likely continue in operation at a terrestrial observatory at some suitable wavelength.

ASRC Equipment - Terahertz imaging

The Terahertz frequency range is becoming more and more useful for investigation of materials, diagnostics in medical science and in metrology. The ASRC have taken ownership of a terahertz source and imaging camera to investigate the use of this frequency in determining composite materials.

The source and imaging sensor come from North America from an industrial supplier of terahertz equipment. We will be using the kit to investigate the condition of the two radomes that we currently have on loan from our friends at HAECO in addition to the many composite samples that we have in the ASRC. Terahertz wavelengths (around the millimeter range) are non ionizing with energies of about 0.5meV. They can penetrate most materials but are blocked by excessive thickness. In reflection they can be thought of as an equivalent to X -rays but without the health issues. Reports on the progress will be added in future editions of the newsletter.

Terasense camera

Membership Benefits of the ASRC

Companies who join the ASRC as members should have a primary involvement in Aircraft MRO or aerospace manufacture or should benefit from involvement in technologies which may spin off from these fields 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, Mr Robert Voyle (robert.voyle@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

Air India is the flag carrier of India and changed to private ownership (Tata) in 2022.
The airline was founded by J. R. D. Tata as Tata Airlines in 1932; Tata himself flew its first single-engine de Havilland Puss Moth, carrying air mail from Karachi's Drigh Road Aerodrome to Bombay's Juhu aerodrome. After World War II, it became a public limited company and was renamed as *Air India*. On 21 February 1960, it took delivery of its first Boeing 707 named *Gauri Shankar* and became the first Asian airline to induct a jet aircraft in its fleet. In 2000–01, attempts were made to privatise Air India and from 2006 onwards, it suffered losses after its merger with Indian Airlines. Another privatisation attempt was launched in 2017, which concluded with ownership of the airline and associated properties reverting to Tata in 2022.

Staff Profile: Jeffrey Smith

Mr Jeff Smith is a PRF in the Design and Manufacturing Technology stream of the ASRC

Jeff joined the ASRC in the spring of 2019 from SAAB A/B aerospace in Linköping. Jeff had previously worked in aerospace manufacture companies such as Kale Aerospace, Istanbul, ASCO Aerospace, Vancouver, Canada, Stork Fokker, The Netherlands, Midcast Engineering Ltd, Wales, Israel Aircraft Industries, Tel Aviv, Renishaw, Westland Helicopters and Airbus, UK, Filton.

Jeff studied Mechanical and Production Engineering before moving onto CAD design and technology with 3D modeling. This enabled him to move into the field of CAD programming and specialize in the manufacture of aerostructures. This has taken him all over the world and gives the ASRC access to many years of hands on experience with advanced CAD programming and operation of multi-axis machining centres. Jeff is another fine addition to the ASRC team.

Activities

12 JUL Visit by Hong Kong Federation of Industries

22 JUL Visit by China Aircraft Services Limited

27 JUL Visit by Chinese Manufacturers Association of Hong Kong

5 SEP ASRC staff attend GBA Innovation summit

19 SEP Visit by HK Express

SEP Visits to Nanyang Polytechnic, MRO conference in Singapore and visits to the Aerospace Validation Centre, Additive Manufacturing Experience Centre, Technology and Applications Centre, and Digital Industries Department

ASRC Staff at the GBA Innovation Summit

HK Express Airways visit the ASRC

ASRC CEO at Nanyang Polytechnic and the AP-MRO Conference

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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