



Message from Ir. Professor H C MAN, Dean of the Faculty of Engineering.

I have been directly and indirectly involved with the ASRC since Professor O'Brien initiated the idea back in 2012. The ASRC concept was a new one for the University and we were most enthusiastic to see how this direct interface with industry would help the applied research of the University. The Centre has turned out to be highly successful and has helped boost the status of the PolyU in the wider academic community. I am pleased to see how a mixture of expatriates and locals, lecturers, technicians, engineers and scientists have come together to run projects that have directly benefited the local MRO community and the wider Engineering field in the South China region. They have secured a considerable amount of government funding in addition to substantial industrial sponsorship and have delivered their projects on time and to the satisfaction of the ITC and the member companies. It goes without saying that to have the Boeing company associated with the University is a great privilege. I wish the ASRC many more years of success as together, we move the University forward.



PolyU Council and President Visit the ASRC

## Checking the Chocks

Polyurethane material is used in the manufacture of triangular 'chocks' for bracing aircraft whilst stationary on the airport field over long periods. These chocks are subject to environmental factors and a number of unusual loading conditions when in contact with the aircraft.

Responding to a request to investigate the performance of these chocks, the ASRC quickly assembled a team to look

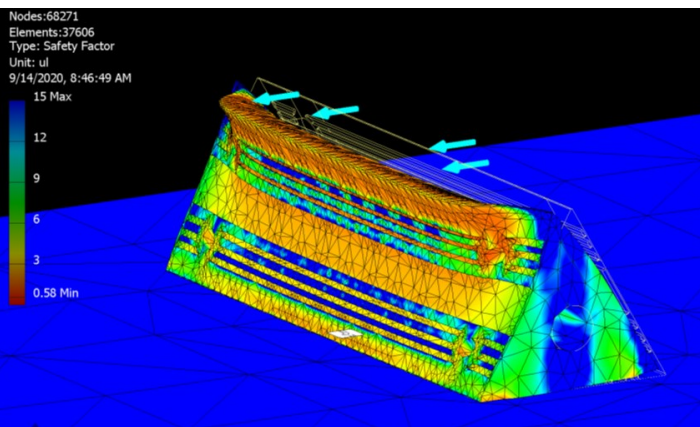


into the capabilities with computer simulations and mechanical testing of the components.

The team quickly chalked up a victory as they produced a finite element model of the components and supplied it with values of moduli obtained from real world measurements of the tensile strength and the Poisson ratio.

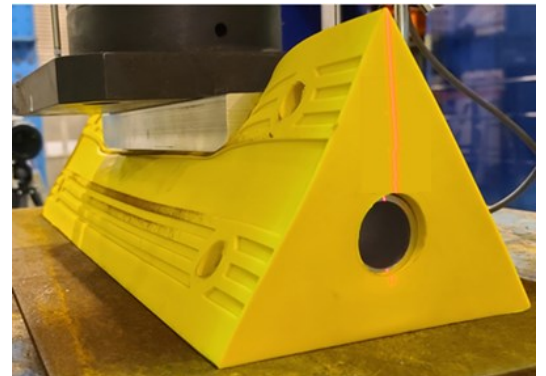
The behavior of the components was then tested on an electrohydraulic press with the assistance of colleagues in the Civil and Environmental Engineering Department of the Faculty of Engineering. We are most grateful to Prof KF Chung and his team for their help.

It was 'chocks away' when the team took the components over to the CEE workshop and loaded them up with several tons of force to simulate a wide number of scenarios.



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Tensile tests were conducted with the assistance of our colleagues in the Industrial Centre, again to whom we are most grateful.

Analysis of the performance of the chocks under a wide variety of loading conditions was carried out through Finite Element Analysis and the results supplied to the client. An extensive literature search was also carried out to establish agreed values of the physical constants of the material that we used in the computer simulation.

Several tests of the material in compression and in tension were conducted and a statistically significant number of tensile tests were conducted with a variety of thickness of material. This was a good example of the ASRC quickly putting together a mixed team of engineers and technicians and matching theory and practice to obtain a useful result for a client.

## Technology Corner Robotics

Are robots a threat to the worker of tomorrow or will they provide a massive assistance to production processes?

"Cobots, or collaborative robots, are robots intended for direct human robot interaction within a shared space, or where humans and robots are in close proximity. Cobot applications contrast with traditional industrial robot applications in which robots are isolated from human contact." In recent years, all major players of industrial robot manufacturer launch their collaborative robots. For example, ABB's Yumi robot and Kuka's LDR iiwa are cobots. Another cobot is the UR series from Universal Robots and it has been a very popular choice in many applications. These collaborative robots are designed to work side-by-side with human workers. They are equipped with safety facilities such as force sensors, limited speed and force, and even soft casing to protect nearby workers. Unlike conventional industrial robots, collaborative robot does not need safety fences or cages and they usually have smaller physical footprint. Most cobots provide lead-through programming capability that enables novice operator to develop robot program on the fly. Consequently, cobots can be easily deployed to shop-floor for many jobs. Their typical jobs are material handling, machine tending, and small components assembly. Some of them could be the intelligent assistants of human worker due to powerful capabilities. In an ABB's demonstration, a human worker was teamed up with a Yumi robot to assemble electrical buttons. Human fed button's parts to Yumi and Yumi's camera recognized individual parts and assembled those parts with its twin dexterous arms. Despite its strength, cobot still cannot become mainstream industrial robots. As mentioned, current cobot has low force and speed and is not suitable for heavy-duty applications. The cobot with the highest payload 35 kg namely "CR35iA" from Fanuc and it is designed for material handling. Other cobots' payloads seldom exceed 15 kg. Furthermore, robot manufacturers have their individual definitions of collaborative robot. Industry may need more guidelines for choosing cobot. Until recently, ISO/TS 15066:2016 "Robots and robotic devices -- Collaborative robots" was published which covered the requirements of cobot and their applications. It is anticipated more cobot related standards will emerge and manufacturers will have more guidance for designing their upcoming cobots. We will see more and more collaborative robots applied in different areas. They will become more intelligent and fit well into our working environments. Finally, I believe that MRO industry, which heavily relies on labour power, can leverage this technology to increase its productivity in future.



Dr. Tang is a Principal Research Fellow in the Robotics Stream of 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 is in a unique position to carry out this project as we have the use of a high speed machine and a high torque machine in the centre.

### 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.

## 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.





L to R; Council Vice Chairman, The University President, Secretary for Innovation and the Permanent Secretary for the ITC at the ASRC

## 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](http://www.asrc.hk) or contact our Director, Prof. Stephen O'Brien. ([Stephen.O'Brien@polyu.edu.hk](mailto:Stephen.O'Brien@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.

## Aviation Classics — The Boeing 707 “Stratoliner”

Boeing ‘Stratoliner’ in service with Pan Am in the 60s



The Comet may have been the aircraft that launched the Jet Age but the iconic 707 ‘Stratoliner’ was the workhorse that made the jet age a commercial viability. After the design changes that were necessitated by the experience with the Comet aircraft, the stage was set for Boeing and Bill Allan, the visionary CEO, to bring the jet age into fruition with the introduction of the first in its ‘7’ series of aircraft the ‘Stratoliner’. The preceding aircraft, the ‘Stratocruiser’ was in fact a modified B-29 ‘Superfortress’. Boeing basically ‘bet’ the company’s worth on this project. The 707 was the first true high capacity jet aircraft which could cross the Atlantic. It was mostly deployed on the New York to London route (Usually stopping in Shannon to refuel and grab and Irish Coffee). It was the first plane to be used for US presidential transport (Air Force 1) and took President Eisenhower on a whistle-stop tour of Europe and Asia in the late 50s. The 707-320 version was the most common and it was the first aircraft fitted with Rolls Royce medium bypass turbofan engines. Famously the Boeing test pilot Alvin ‘Tex’ Johnston demonstrated the aircraft at an airshow by flying the aircraft into a barrel roll over lake Washington.



Boeing 707 first flight in vintage Boeing livery

The military variant KC-135 continues to serve today as a refueling tanker with a number of countries.

## Asian Airline Profiles



Philippine Airlines (PAL) is the flag carrier of the Republic of the Philippines and the oldest commercial airline company in Asia. It started service in 1935 as Philippine Aerial Taxi Company and became PAL in 1941 with businessman Andrés Soriano of San Miguel brewery fame at the helm.

The airline grew rapidly but went through a period of operating low profit routes to Europe at the time it was modernizing its fleet. This coupled with the Asian financial crisis in the late 90s hit the airline badly and it was dramatically reduced in size following a government bail out. Today it is recovering slowly and operates routes to America and Europe under code share agreements. It has always been a popular and friendly way to fly in Asia.

## ASRC Equipment — The ABB YuMi Co-operative Robot

### Co-operative Robots

ABB of Japan manufacture a range of cooperative robots that have found applications in a wide area of manufacturing. The ‘YuMi’ is a portmanteau of ‘You and me’ and they allow operators to have an extra pair of hands and eyes to help in an assembly or measurement task



The YuMi® was an Innovative human - friendly dual arm robot with breakthrough functionality designed to unlock vast global additional automation potential in industry. YuMi® is designed for a new era of automation, for example in small parts assembly, where people and robots work side-by-side on the same tasks. Safety is built into the functionality of the robot itself. YuMi® removes the barriers to collaboration by making fencing and cages a thing of the past.

Applications:- The ASRC has deployed these robots on a number of inspection and assembly tasks. They can be programmed in a number of ways and integrated with other sensors and systems to perform repetitive tasks that would be a strain for human operators.





## Staff Profile:

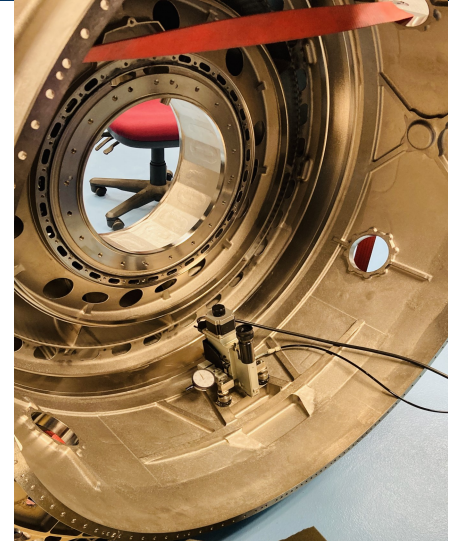
### Mr. Andrew Gridley

Andrew recently announced that he would be retiring from the ASRC to spend time with his family and return to the UK; we all wish him the best in his future endeavors and pursuits.

Andrew joined the team working on the negotiations with Boeing to establish an Aviation Services Research Centre in Hong Kong in 2012. Prior to that he had worked for many years in aerospace manufacturing at BAE Systems in the UK. A significant part of that role was working with the founding Boeing Research Centre (the Advanced Manufacturing Research Centre) in Sheffield. Having seen the value that such research centers can provide from the client's perspective first hand, he knew this was the way forward for the MRO field in Hong Kong. During his time in Hong Kong, both he and Prof O'Brien have been extremely busy disseminating the ASRC concept to Academia, Government and Industry with great success despite this completely novel research model. It is only now that it can be seen that Hong Kong institutions and the Hong Kong government are fully embracing the new model as they see the positive effect the ASRC is having on the industrial landscape of southern China.

## Activities

- 6 JUL** — Visit by ITC management and University management
- AUG** — Staff spent August largely working from home with a few staff attending to take care of sudden requests and day to day maintenance of equipment. Meetings were held in real life and online.
- SEP** — Return to office for all staff .
- 7 SEP**— Visit by HAESL engineers to discuss residual stress tests on engine compressor casing and cold spray progress.
- 22 SEP**—Visit by PolyU Chairman and President.



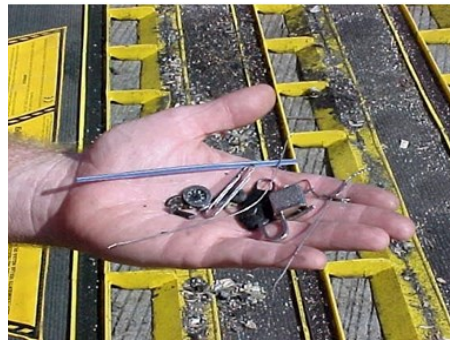
Preparing to test an engine compressor casing

### Avoiding Foreign Object Damage / Foreign Object Debris (FOD).

*Nobody wants to see their expensive tools and clothing sucked into an engine or left behind in the aircraft*

#### The Solution – Tool Tracking from the ASRC.

We at the ASRC can assist your engineers while working in an MRO environment by using a software package which keeps track of all their tools, equipment and kits of parts (TEK). TEK can be micromanaged to prevent loss or misplacement in a dangerous place. Because we know the position of all the TEK at all times we can ensure that FOD is minimised and any TEK used can be replaced or repaired as required. Any specialist tools can be tracked and retrieved rapidly to allow re-use and increase job efficiency.



*If I'm tracking all my parts at all times, what do I do with them when I take a break or finish a job?*

#### Introducing - **Safe Areas**, an ASRC concept!

The Smart Central Stores is the ultimate Safe Area for TEK, but when on plant the tools can be placed in 'smart containers' which will allow them to be tracked back to the central database and any losses or uses noted so that TEK can be tracked, replaced or calibrated as required.

A **Safe Area** can be a smart container or smart toolbox which can be moved to a convenient location on plant to store the TEK and prevent the engineers having to return a possibly long distance to the Central Stores.

A **Safe Area** can be used to store the TEK mid-task so that the engineers can be assured that they are leaving the job in a safe

state if they are taking a break or finishing work mid job.

#### The Cage – The Ultimate **Safe Area**.

The Cage is a set of secure shelves onto which we can place our TEK safely.

It can be tracked throughout the plant so that we know that it is in a safe place and a relevant area for the tasks being performed near it.

The cage is part of a **smart process** which is controlled using AI and keeps a record of what is placed in it, when and by whom.

Because the Cage is a secure environment the TEK within it is protected from being removed or stolen by unauthorised personnel.

Interested? - Ask us about our **TEPU** System today.

ASRC:- Tooling and Equipment at the Point of Use (TEPU)

#### **Safe Areas**

Smart Central Stores

The Cage

Smart Toolbox

Contact : Mr. Robert Voyle [Robert.voyle@polyu.edu.hk](mailto:Robert.voyle@polyu.edu.hk)

