Presentation by Dr Paul Scully-Power to the Australian Institute of Navigation (in company with the Honourable Company of Master Mariners and the Nautical Institute)
Sydney, 13th April 2016

The Australian Institute of Navigation was delighted to host Dr Paul Scully-Power at their most recent dinner/meeting in Sydney on 13th April 2016. The night was a great success with a very large gathering from not only the AIN, but also the Master Mariners and Nautical Institute.

Space Experience

Paul was the first Australian-born astronaut and flew on the Challenger space shuttle in 1984. He provided an outstanding presentation that had everyone enthralled.
The initial part of Paul's presentation followed the highpoints of his selection for astronaut training and then his flight in to space.

In June 1984, he was chosen by NASA to be a Payload Specialist on the 13th Shuttle mission, which would study Earth Sciences. His space flight STS-41-G Challenger (October 5–13, 1984) was launched from and returned to land at the Kennedy Space Center, Florida.STS-41-G was the first mission with a 7-person crew, and the first to demonstrate American orbital fuel transfer.

During the 8-day flight, the crew deployed the Earth Radiation Budget Satellite, conducted scientific observations of the earth with the OSTA-3 pallet and Large Format

Camera, and demonstrated potential satellite refuelling with an EVA and associated hydrazine transfer. At mission conclusion, Scully-Power had travelled over 3.4 million miles in 133 Earth orbits, and logged over 197 hours in space.

Undergoing Training in the 'Vomit Comet'

Prior to his flight he underwent a significant amount of training including acclimatization to zero gravity in specially modified B707 aircraft operated by the NASA Reduced Gravity Research Program. These aircraft give occupants the sensation of weightlessness by climbing initially to reasonably high altitude and then slowly bunting over to zero g for about 25 seconds.

While following this flight path, the aircraft and its payload are effectively in free fall. Weightlessness begins while ascending and lasts all the way "up-and-over the hump", until the craft reaches a downward pitch angle of around 30 degrees ads it loses height from 38000 feet down to about 10000 feet.

At this point, the craft is pointing downward at high speed and must begin to pull back into the nose-up attitude to repeat the manoeuvre. The forces are then roughly twice that of gravity (e.g. 2g) on the way down, at the bottom, and up again. This alternating between zero and 2 g often causes airsickness in the astronauts and hence the name of the aircraft – the Vomit Comet!

Tank Driving Course for Astronauts!

The photo of Paul in a modified army tank was also taken during initial astronaut training. It was meant to provide an emergency way of escaping from the rocket if there was a malfunction on the launch pad. The idea was that if something went wrong and a fire started on the launch pad, then the crew would use a flying fox to escape from the capsule to the ground.

Of course, by this time the launch pad may be awash with fuel on fire, and so a modified Army tank was positioned near the flying fox so that the crew could scramble in to it, and then drive through any flame to escape the fireball. Good in principle…but would have been interesting to see how it worked in practice! Paul made the point that since there was no surety that the escaping crewmembers would include any particular individual that

they all had to undergo tank driving training!

Introducing the Space Shuttle

You can get a good idea of the size of the Space Shuttle in this photo of the Shuttle atop its B747 transporter. Paul was quick to point out that despite its great size, it was quite cramped inside.

The B747 suffered significant fuel and altitude penalties when flying with the Space Shuttle on top. The range was reduced to 1,000 nautical miles (1,850 km), compared to an unladen range of 5500 nautical miles (10,100 km), requiring an SCA to stop several times to refuel on a transcontinental flight.

Without the Orbiter, the SCA needed to carry ballast to balance out its center of gravity. The SCA had an altitude ceiling of 15,000 feet and a maximum cruise speed of Mach 0.6 with the orbiter attached. A crew of 170 took a week to prepare the shuttle and SCA for flight.

Space Suits

By the time that Paul flew in space, the Shuttle crew had gone from wearing partial pressure suits (which could be used with ejection seats in the first few Shuttle flights to provide for an emergency escape system) to just normal blue flight suits and an oxygen helmet for the ascent. The crew also had an escape harness for vacating the Shuttle on the launch pad if necessary. After the crash of the *Challenger*, NASA, in need of an escape system, also required the reintroduction of the wearing of pressure suits during the launch and landing portions of the flight.

Shuttle Launch

Paul said that at launch the Shuttle boosters only just had a slight amount of thrust over weight – and the acceleration was very slow initially. However, the acceleration went for a long time and eventually the speed increases to 17,500 miles per hour. Paul said the “launch

was a bit bumpy but amazing”, and soon gave an incredible view from the windows.

The Space Shuttle during launch and low Earth orbit

The Connecticut coastline north of Long Island, USA

Paul was able to take high quality photographs from the various windows and apertures around the Space Shuttle. The photo above had special meaning, as it is a photo of Long Island, and on the Connecticut coastline just above Long Island is his home where his wife, Fran, and his children were waiting while he flew his mission.

Paul said that it was amazing how clearly one could see the various major cities and geographical features on Earth from the Shuttle.

The Straights of Gibraltar

Paul said that the view of the Earth from space was really fantastic but not something you could really capture on film. The above photo is of the Straights of Gibraltar – the

entrance to the Mediterranean Sea. He noted that in this one shot was all of the areas where civilisation had started.

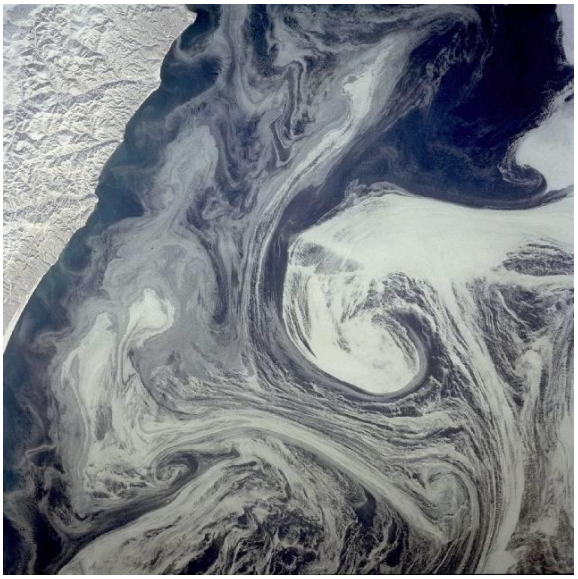
Solitons and Anti-Submarine Warfare

One of Paul's key aims of the space mission was to collect space imagery as evidence of internal ocean waves that did not appear to any large extent on the surface. Such "solitons" typically form on a surface separating two submerged water bodies of different density. The photographs showed the successive solitons at the entrance to the Straights of Gibraltar from two days before and one day before.

Paul managed to take a series of photos of internal waves propagating through the Strait of Gibraltar, which were then compared with those taken by Navy oceanographers in aircraft "underflying" the shuttle. It was suspected, based on earlier observations, that they might orignate at the western entrance to the Gibraltar Strait and flow eastward into the Mediterranean.

Because that sea gains less water from the rivers feeding it than it loses in evaporation, there is a net flow of water into it through the strait from the Atlantic, modulated by semidiurnal tides. Bottom water is diverted upward as it meets the shallow sill at the western entrance to the strait, forming a standing wave across the stretch between Spain and Morocco. This produces an intense "boil" on the water surface. This boil is important as it could affect sound transmissions used to detect submarines; an important consideration during the ‘Cold War’!

Other amazing sights!



Patterns of ice in the artic regions

The sediment patterns around the mouth of the Po River in Italy

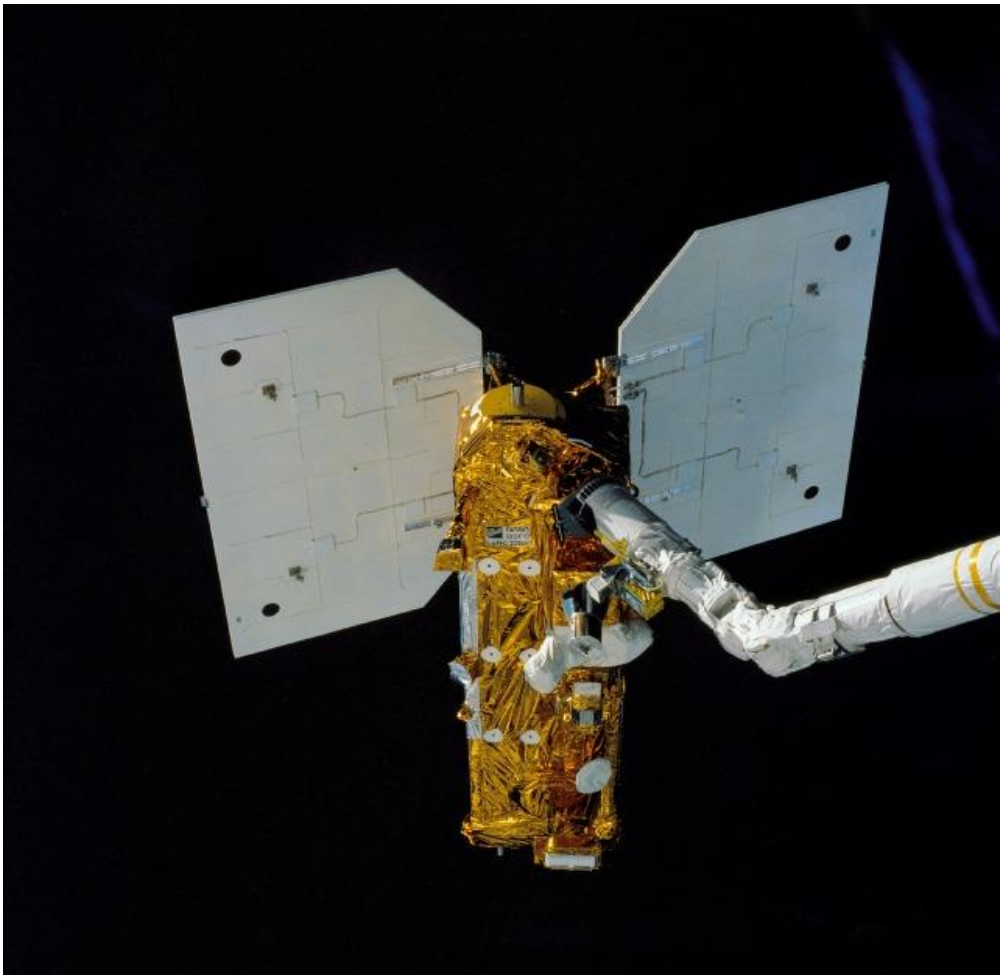
A sandstorm from space

Sydney and environs from space

Perth from space

Uluru (on right) and the Olgas (on the left) from space

The Great Barrier Reef from space



Some of the other activities that the crew were involved in included gently placing a delicate satellite in orbit using a mechanical arm. Also they conducted a refuel of a satellite during the mission.

The day before re-entry to Earth there was an enormous storm (see photo above) blew up over the Challenger's planned landing zone. However, it cleared (see photo below) by the time the Shuttle was ready to return and an uneventful landing took place.

Paul also shared his thoughts about technological advances and Defence. He thinks that the next disruptive technologies for Defence are cyber, nano-technology, big data analytics, and UAVs.

The advantages of (and risks when they are used against us) cyber and UAV technologies are becoming more accepted and well known.

Some examples of nano-technology in defence applications include battle-suits that are remain lightweight, while stopping bullets, protecting against toxins, monitoring vital signs and administering first aid where possible. It can also revolutionise communications, and lead to the development of super-strong but lightweight aerospace structures. Nano-technology coatings can also be corrosion resistant, and they can sense damage or corrosion and automatically initiate repair of some damage. The potential is also there for coatings to change colour when required. This could include adaptive camouflage for tanks moving from jungle to open fields or into urban areas.

Following a brief question time, AVM Kym Osley, Secretary of the AIN thanked Paul for his insightful presentation and presented him with a plaque from the AIN in appreciation.

About Dr Paul Scully-Power AM

In January 1967, after graduating from the University of Sydney, he was approached by the Royal Australian Navy to stand up the first oceanographic group within the Navy. From January 1967 to July 1972 he was a Scientific officer and remained the first permanent head of the oceanographic group. From July 1972 to March 1974 he was Australian Navy Exchange Scientist to the US Navy and worked at the US Naval Underwater Systems Center, New London, Connecticut and the Office of Naval Research, in DC. During this period he was invited to assist the Earth Observations team on the Skylab Project and has worked in space oceanography for each manned spacecraft mission since that time.

From March 1974 to March 1975 he returned to Australia, planned and executed the joint Australia, NZ and US project ANZUS EDDY which was the first combined oceanographic and acoustic measurement of an ocean eddy ever conducted. In 1976, he was appointed a foreign principal investigator for the Heat Capacity Mapping Mission, which was one of a series of satellites launched by NASA to explore the usefulness of remote sensing measurements.
In October 1977, he emigrated to the United States and was offered a position at the Naval Underwater Systems Center. This position is that of a senior scientist and technical specialist on the staff of the Associate Technical Director for Research and Technology with the responsibility to insure the development of a comprehensive and balanced technology base within the Center.

In June 1984, he was chosen by NASA to be a Payload Specialist on the 13th Shuttle mission, which would study Earth Sciences.

Scully-Power has extensive commercial, government and academic experience in Australia, New Zealand, the United Kingdom, and the United States, and is widely recognised in the fields of defence & national security, aviation & aerospace, marine science, communications & systems analysis, and education. Scully-Power has served as a Director of a number of public and private corporate and advisory boards worldwide.

Scully-Power is past Chairman of the Australian Civil Aviation Safety Authority (the federal regulator) and the Federal Government's International Space Advisory Group, a former Chancellor of Bond University (Australia's largest private university), and was the inaugural Chairman of the Queensland Premier's Science and Technology Council. Prior to that he spent over twenty years in the United States where he managed and led many high technology and defence industry programs