INTERVIEW WITH ALBERT J. WILLIAMS III, WOODS HOLE OCEANOGRAPHIC INSTITUTION, USA

Innovator Measuring â€˜Salt Fingersâ€™

Mr Albert J. Williams III was given the IEEE OES Distinguished Technical Achievement Award in 2000; a prestigious prize, as one of the earlier winners was Robert J. Urick. Mr Williams has spent many years at Woods Hole Oceanographic Institution doing research in oceanography and developing instruments for current and for shear measurements. He chairs the IEEE Current Measurement Technology Conference in March 2003 in San Diego. It thus seemed a good moment to ask Mr Williams about his career, developments of today and tomorrow in current measurement equipment, and the Current Measurement Technology Conference.

Please give our readers a short summary of your career and the way in which you arrived at your present position.

I majored in physics through my PhD but I loved boats and thus was interested in oceanography and got an appointment as a Postdoctoral Investigator at Woods Hole Oceanographic Institution in the Instrument Section of the Department of Ocean Engineering. There I applied my knowledge of optics to imaging salt fingers in the ocean. Before my work, these convective mixing structures were only hypothesised. Less organised images, chaotic lines in my shadowgraphs, required me to measure velocity shear as well as temperature and salinity gradients. The search for a sufficiently sensitive velocity sensor led me to develop an acoustic shear meter. This was configured into a 3-D acoustic stress sensor, BASS, for boundary layer stress measurements and MAVS, a modular acoustic velocity sensor for current measurements.

What is the meaning of the addition â€˜3rdâ€™ to your name?

I am the son of a son, all with the same name. That is also why I am called â€˜Sandyâ€™.

Could you inform us regarding your experience in current measurements, in particular any special projects (for instance, deep sea projects east of the USA and Canada) which may be of interest to our readers?

The development of the Benthic Acoustic Stress Sensor, BASS, was driven by questions concerning sediment transport in the deep sea. Our first experiment with BASS was at 4,800 metres depth, off Nova Scotia on the lower rise. Measuring both velocity and Reynolds stress (the correlation of fluctuations in the downstream velocity with that perpendicular to the bed) at six heights, from 35cm to 5 metres above the bottom, we showed that the stress was constant and uniform over 4km horizontal distance. But high turbidity events were generated locally only about 10 per cent of the time. The rest of the time, suspended sediment was advected from somewhere upstream. More recently, BASS has been used on the shelf where the effect of surface waves cannot be ignored. At the present, I am working in shallow water. At the Martha's Vineyard Coastal Observatory, exposed to the Atlantic Ocean to the south and east, I am placing two MAVS current meters on the bottom in 12 metre and 15 metre depth to report 3-D velocity and pressure continuously to shore for directional wave spectral analysis. The attenuation of wave energy crossing 2km of shelf will be studied during storms.

Have you been involved in projects outside USA waters, like in the Middle East, Australasia or Europe? If so, are measurement conditions different there, is every area unique or is current measuring following the same procedures world-wide?

In 1996 and 1997 Fred Thwaites deployed one of my BASS tripods near IJmuiden, in the Netherlands, to measure stress on the bottom of the North Sea under waves and current. The conditions were related to those in sand bottoms on the New England shelf. Jae-Youll Jin, in a related study, has used MAVS current meters of my design in Korea. Here the scientific question was the behaviour of mixed sand and mud under waves and current. In each case, measuring waves, current, and stress in the flow and optical turbidity was the appropriate strategy. I think current measuring is following similar procedures world-wide.

One sees more and more Current Meters and Current Profilers which use Doppler Technology. What do you expect from this type of current meter when compared with the type based on the travel-time principle?

Acoustic Doppler current profilers permit moderate resolution velocity profiles from a single instrument. Acoustic Doppler velocimeters obtain high-resolution velocity measurements from a point or single level if there are enough acoustic scatterers. There are generally

enough of these scatterers in the bottom boundary layer and in the surf zone. But there are often too few in the mid-water and in the blue surface water of the open ocean. Travel-time Acoustic Current Meters (ACMs) don't need scatterers. These sensors average over a modest volume of fluid so they do not need to transmit more than a single ping per measurement to avoid aliasing. So each has its niche, with boundary layer measurements appropriate for either travel-time or Acoustic Velocimeter sensors and mid-water appropriate for either travel-time or current profilers.
Long range and remote sensing favours Doppler measurements, while clear water or highly turbid water favours travel-time measurements.

As probably not all of our readers are familiar with the principle of travel-time, can you give us a brief explanation on this method?

Propagation of sound downstream is faster than upstream. This is because the sound moves at a fixed velocity with respect to the moving water. Total travel-time difference is proportional to the integral of the velocity component along the acoustic path. Since the 1 to 2MHz frequency used in travel-time ACMs is not sensitive to small bubbles or suspended particles, travel-time ACMs work in clear, turbid, and bubbly water equally well. Large bubbles like fish swim bladders or kelp floats stop the sound, but there is almost no dispersive effect from bubbles in breaking waves.

What is the main theme of the IEEE Current Measurement Technology Conference in March 2003? How many attendees do you expect and what will be their level? Is there any striking presentation, advanced or new development?

The main theme of the 7th CMTC is developments and applications of current measurement technology over the last four years. We expect one hundred attendees at the project engineer or project manager level. Most of the talks will present incremental advances but there is a concentration on horizontal variability in current in this year's papers.

Have there been any interesting developments, presented at previous CMTC conferences, which have since resulted in new products or operational methods?

Improved HF radar backscatter techniques, horizontal Doppler profilers, acoustic backscatter signal strength for particle concentration in current profilers, correlation sonar, proliferation of Acoustic Doppler Current Profilers and Acoustic Doppler Velocimeters, and replacement of mechanical sensors by acoustic sensors are developments that were stimulated and reported at previous CMTC Conferences. I like to think that there is cross fertilisation at CMTC meetings that leads to new developments reported at the next CMTC meeting.

Flow in rivers is a new subject for the CMTC. What do you expect, considering the programme of CMTC 2003?

Many papers related to estuaries and rivers (plus dammed lakes) are included in this conference. There is a new interest in 2-D current patterns and the technology to make such measurements. I think this will change our hopes and expectations about resolving such structure.

What are today's developments (including political) at WHOI (Woods Hole Oceanographic Institution)? Has there been an impact from the 11th September 2001 disaster on research policies?

Development of Autonomous Underwater Vehicles (AUVs) and tethered ROVs are important activities at WHOI. Addition of sensors to those vehicles has also been an important area of development in the last few years. Observatory systems are another theme. Mine burial, AUVs, and optical properties of coastal waters are ongoing programmes with consequences for homeland security. No special programmes that I am aware of are directly the result of 9/11. There have been no changes in research policies. I think we at WHOI are insulated somewhat from rapid response problems by a long pipeline of research funding, although we are encouraged to apply our understanding of ocean processes to national needs.

Remote sensing techniques are leading to the oceans becoming more and more transparent to us. Will remote sensing replace in situ measuring equipment in the future?

In situ measurements will never be displaced entirely because accurate point measurements and measurements at locations inaccessible for remote sensing still require in situ sensing. However, remote sensing will recover most of the velocity observations in the future, particularly at the surface and close to shore installations. Horizontal current profilers provide a new means of remote sensing of rivers and harbours that is safe from shipping. Boundary layer measurements where turbulent fluctuations are small-scale still require in situ sensing (including Acoustic Doppler Velocimeters).

What do you see as the link between oceanography and hydrography and have you any ideas about the exchange of information between the two disciplines?

It is interesting that there is only a small overlap between practitioners in these two fields that are closely related, at least in the fluid physics portion. Both are concerned with sediment transport, wave processes, turbulence, and buoyancy effects. Oceanography also embraces biology, chemistry and geology, and is primarily a geographic science. But the links are through such meetings as the CMTC and Hydrography Conferences. There is overlap of attendees.