The Continuing Development of the IHO Category A Hydrographic Surveying Program at the University of Otago

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Key Words: Hydrographic Surveying, Education, New Zealand

SUMMARY

The University of Otago had its Hydrographic Surveying program first accredited by the FIG-IHO-ICA panel in 2002. In its first guise there was considerable reliance on the Royal New Zealand Navy and other agencies for the provision of practical training. In recent years the University has purchased a multi-purpose research vessel, the R/V *Polaris II*, as well as a Benthos C3D combined sidescan and multibeam. This acquisition, along with other equipment purchases, has meant that the practical training and allied research can be conducted in house.

This paper looks at the recent changes in the structure and content of the Category A program as a result of new acquisitions. It will also compare and contrast the conduct of Hydrographic Surveying education in both Naval and University environments (as the author has been involved with both), and discuss proposed future developments to help meet the needs of potential students in the region.

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1. INTRODUCTION

In 2002, the Hydrography Program at the School of Surveying, University of Otago, was approved by the FIG-IHO-ICA International Advisory Board at the Category A level. It was comprised of 23 subjects (called *papers* in the University of Otago), covering the content of the M5 Standards of Competence of Hydrographic Surveyors, 9th Edition. The papers could be taken as part of an undergraduate or postgraduate qualification, or a combination of the two.

As the School of Surveying is the National Surveying School for New Zealand (the only tertiary institution in the country teaching a Bachelor of Surveying (Bsurv) Degree), a large portion of the syllabus requirements could be found within papers designed for the BSurv Program. Other components wer covered in papers in the Mathematics, Physics, and Marine Science Papers. Only a small proportion of the syllabus needed specific papers to be designed and implemented for the syllabus to be covered.

1.1 Royal New Zealand Navy involvement

The original program also included a field experience period, generally towards the end of the program, onboard a Royal New Zealand Navy (RNZN) survey vessel. The period had to fit into the deployment schedule of the RNZN, which was not necessarily best suited to the semester system used at the University for the teaching of the other papers.

The students got to see the operation of, and participation in, a hydrographic survey in action (or at least part of one, noting most surveys are 2-3 months in length, with student attendence more like 2-3 weeks). However, opportunities for being involved in the management of the survey were limited, certainly not the extent of taking over the conduct of the survey.

1.2 New assets at the University

In recent years, the University has upgraded its coastal/offshore vessel from the 15 metre R/V *Munida* to the 21 metre R/V metre R/V *Polaris II*. It has also acquired a deployable Benthos C3D combination sidescan and multibeam, with a sub-bottom profiler in the same housing. This can either be pole mounted on the starboard side of the Polaris, or towed like a regular sidescan 'fish'.

Figure 1. The University's Research Vessel, the R/V *Polaris II*

These acquisitions have allowed a diverse range of survey activities, from shallow water open boat (~5 metre) single beam surveying to multibeam onboard the *Polaris* in coastal waters, to be conducted with University assets. Extended multiday fieldwork can be programmed more easily into the University timetable – noting of course that the vessels are used by a number of departments, and appropriate planning is used. Students are thus able to take over the planning, management and product creation of these fieldwork periods. The final two week survey is now programmed as the culmination of all the theory and practical work conducted through all the papers, where the students complete all aspects of a survey with products to the National Hydrographic Authority's standards.

2. PROGRAM DEVELOPMENT

With equipment and staff changes over the years since 2002, the program has developed from a collection of papers meeting the criteria to a more cohesive flow of learning through a designed program. There is still use made of experts in the various departments, but the 'hydrographic specific' papers are now more coordinated with better access to equipment. The aim is to achieve a cohesive one year subset of papers that can be taken beyond the BSurv papers, so that any student who completes a BSurv or equivalent (at Otago or elsewhere) can then easily proceed to completing the Category A program in one year. This subset will also be reduced if the student has other related education, maritime qualifications for example.

But the development of the program has been very different in the University arena as opposed to a Naval school. This is due to the different environments, and each has its pluses and minuses. I believe it is worthy of some analysis, to further development of hydrographic education.

2.1 Designing the Timetable

There are two main ways of designing a timetable. And to describe them, I shall borrow some terminology from Basic Electronics. The first is to have a timetable in *series*. By that, I mean that each day in a course, and all of the hours in a day, can be uniquely allocated. This is the model used in the Naval courses, which tends to lead to teaching subjects in blocks, one after the other. The advatntage of this model is that it is possible to continue the flow of teaching in a subject, lectures presented in order one after the other, with appropriate practical work immediately conducted. If a whole day, or a series of days, needs to be dedicated to a fieldwork exercise, in boats for example, then that can be appropriately located within the timetable.

In order for this to be possible, it is necessary to be able to have both staff and equipment available as desired, programmed into the course on a day by day basis. Which is quite achieveable when all the courses taught in the education establishment are presented in a similar fashion. Naval schools plan their courses in this way, and can program staff and equipment accordingly, allowing experts to present on different courses as needed. What this model doesn't allow for, is students choosing different components within a course. All courses in Naval schools have entirely prescribed contents – each has a specific job related purpose.

The situation within universities is entirely different. The majority of courses have large elective components – relatively few are made up of entirely compulsory contents. This is way the timetable used tends to be the second model, a timetable in *parallel*. To allow students to have maximum freedom of choice of subjects (leaving aside the issues of pre-requisite knowledge, etc), then the subjects are presented simultaneously. This is facilitated by the week-long timetable, repeated throught the teaching term (often a semester), with any deviations (like longer multi-day field work) only possible during term breaks. Students can then choose their subjects as required, provided the actual allocated hours within the week do not clash.

Because this is the model that is used, most staff will have their teachbing time allocated by hours of the week, rather than days of the year. Thus, even a course that has completely compulsory set of subjects will tend to be administered and timetabled in the same way. This has the disadvantage of needing to slice up content into the regulated '50 minute' slots.

On the plus side, it allows the use of subjects that are available (and appropriate) to a number of courses, like mathematics, physics, even marine sciences. This allows a larger number students to attend than just those involved in the hydrography program, with subsequent time (and monetary!) economies of scale.

There are advantages and disadvatages to each system. The Naval system tends to allow for more fluid timetabling and easier flow of teaching, whereas the university system tends to allow access to a much larger group of expert staff available within the various departments. The ideal scenario would be to have a combination of the two – the ability to freely timetable in series, with access to a large number of expert staff and equipment.

2.2 Nautical Sciences

The teaching of Nautical Sciences is one of the major differences between Naval and University courses. There are two broad reasons for including Nautical Sciences in a Hydrographic Program. The first one is that the graduate will be working, for at least some of the time, on a boat. And there is a whole range of issues involved that aren't readily evident to people who have never worked on a boat. The notion that equipment needs to be tied down or it may become a hazard, or that a fire can't be handled by just calling the fire brigade, can be a surprise for someone without any maritime experience.

Likewise is the effect of the weather on working on a boat – particularly on hydrographic surveying, where equipment performance can be dependent on conditions. As an example, if you are surveying on land, a buildup of wind will most likely have little effect. You may have to shield a total station so that it doesnt move in the wind while taking readings.

But on the water things are quite different. A build up of wind will very soon mean a buildup of waves. The size of the waves will depend on how long the wind has blown across water (the fetch), and how deep the water is. There will be an effect on instruments. There will be more motion (pitch, heave, roll) – will one or more of these increase enough to start decreasing the accuracy of data? Will the vessel's motion be such that air bubbles from the increased wave action are directed underneath the transducer, affecting data?

Now the conduct of the survey is affected. Will changing the direction of survey lines ease the motion affecting data – or make it worse? Is there another area nearby in the lee of the wind (if near land) that can be surveyed instead? Or is it necessary to stop surveying – and how does this affect the timeline of the project?

Even if the surveyor is not the one in charge of operating the boat, they need to understand the relationship between data collection and the environment – and this needs to be experienced in the field.

The second reason for including Nautical Sciences is more specific to surveying for Nautical Charting. There is a distinct need to understand what data is needed, and how important it is, in marine navigation. A prime example of this can be seen in the discussion regarding the groundings of the M/V *Star Opal* (Lusk, 2009a), the *Queen Elizabeth 2* (Lusk, 2009b), and the M/V *Rocknes* (Smit, 2009). The last incident resulted in the loss of 18 lives.

In each case, the quality of the hydrographic information is analyzed as a potential factor in the grounding. This would not happen on the land. Many factors are considered in determining the cause of road accidents, for example. The visibility, experience of the drivers involved, alcohol and/or drugs, the safety equipment on the vehicles, traffic signage, etc could all be considered. But the accuracy of the road map would not. This helps demonstrate just how critical hydrographic data is to vessel safety, and thus how this needs to be appreciated by the hydrographic surveyor.

2.3 Student's maritime experience

In a Naval run hydrographic program, the majority of students are Naval officers with appropriate deck qualifications, and as such they already have considerable maritime experience, and understand the needs of the mariner. For the courses I have undertaken (the Royal Australian Navy Category B course run in Sydney, Australia, and the Royal Navy Category A course at Plymouth, UK), this mariner training was not part of the course per se, the deck qualifications were pre-requisites instead.

These types of students have skills and abilities well beyond that outlined in the IHO Syllabus. But in a course run outside of a navy, for example at a university, it is very likely to have students who have never set foot on a boat, let alone have any significant maritime qualifications. Not that I am suggesting that they need to – but they do need to understand the maritime world as I have outlined above.

So how much training is enough? Even with my experience to date, this is not an easy question to answer. As much maritime experience as possible, certainly, but this can't be at the expense of the other components of the course. I am keen to follow up on this in years to come, when current students take up positions in charge of surveys.

Currently, in the Otago program we have papers specifically dedicated to the Nautical Sciences, including coastal navigation fieldtrips independent of survey work. Students also steer the small open boats (with appropriate guidance software) during single beam surveys, and the *Polaris* during multibeam surveys. They may not be as proficient as Naval personnel, but are given every opportunity to understand the maritime world.

3. THE STANDARDS OF COMPETENCE

The Standards of Competence for Hydrographic Surveyors (now called S-5 by the IHO on their website) provide significant guidance as to the Nautical Science components that need to be included in a program, if it is to receive accreditation, as it does for the other subjects involved. But what is not detailed in the Standards is the reasoning behind the inclusion of the various components in the syllabus. The majority are understandable, straight forward and necessary to a solid understanding of hydrographic surveying.

But the presence of a number of the included objectives is not so immediately apparent. It might not be immediately clear why, for example, Maxwell's Equations need to be understood (S-5, B3.5 (d)). Or why logic and integrated circuits need to be understood (B3.7 (b)). I have no doubt that during the meetings discussing and revising the various components of the syllabus, that the reasoning behind the inclusion of the various elements was outlined. Possibly similar to the disussion I have outlined above regarding the Nautical Sciences. I believe that to assist in consistency of teaching, and to assist potential students in understanding the course requirements (given that the Standard is freely available online), that a small summary discussing the inclusion of each subject and its elements would be a beneficial inclusion in the Standards of Competence.

4. THE NEED FOR A SOLID THEORETICAL UNDERSTANDING

The technology involved in hydrographic surveying is continuously increasing in complexity. The number of soundings collected per day has gone from hundreds to millions, in some cases billions. And the need for accuracy is becoming ever greater.

As an example, in the Port of Los Angeles, there is a minimum underkeel clearance requirement of only 0.46 metres (Port of Los Angeles, 2008). In order to achieve this, the bathymetry data must be surveyed to a much smaller uncertainty, as the underkeel clearance calculation must also take into account the vessel draught and motion characteristics, and real time tide measurements, all with their own uncertainty values.

To deal with the ever growing amount of data, and the need for greater accuracy, techniques like the CUBE algorithm, and its associated Navigation Surface, have been introduced. They should not be 'black box' techniques. I believe that to make the most effective use of them, a proper understanding of how each piece of equipment works – the echosounders, motion sensors, tide gauges, sound velocity profilers, which goes right down to the underlying physics of how each one makes measurements. This is the best way to understand their limitations, and their uncertainty values. An understanding of statistics, to determine how individual uncertainties can be combined into total positional uncertainties, is vital to understanding how the values used in the CUBE algorithm are determined.

And this underlying theory is all included in the Category A syllabus. By continuing to develop the Category A program, combining a solid theoretical understanding of modern technology with practical use of hardware and software, I believe the University of Otago provides a solid hydrographic education. When this is combined with properly documented work experience, as in the system used by the Australasian Hydrographic Surveying Certification Panel, I believe that the surveyor is well placed to run modern and future surveys to meet the most exacting of needs.

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BIOGRAPHICAL NOTES

Scott Preskett is a former officer in the Royal Australian Navy (RAN), with qualifications in Hydrographic Surveying and Mine Warfare. He has served on various Patrol Boats, Survey Ships and Minehunters, mainly operating in Northern Australian and Papua New Guinean waters. This service included a posting as the Executive Officer of HMAS *Paluma*, conducting beach and harbor surveys in support of United Nations forces in East Timor in 2000. Scott spent several years as an instructor at the RAN's Hydrographic School, in Sydney, Australia, including a posting as the acting Officer in Charge. He left the RAN with the rank of Lieutenant Commander to take up a position at the School of Surveying, University of Otago, New Zealand.

Scott has completed IHO Category B training at the RAN Hydrography School, and IHO Category A training with the Royal Navy at Plymouth, UK. He holds a Bachelor of Science from the University of Adelaide, a Postgraduate Diploma in Hydrographic Surveying from the University of Plymouth, and a Master of Engineering Science from the University of New South Wales. As well as teaching on the Category A program, Scott is currently enrolled in the Doctor of Philosophy, conducting research into motion sensing using multi-antenna GPS.

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