Accreditation of the Cat. B Hydrography Program in Belgium

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SUMMARY

In 2013, a 1-year English spoken curriculum degree of "Postgraduate in Hydrography" in Belgium was accredited by the IHO (International Hydrographic Organization). The program (Cat-B) is a cooperation between the Geography Department of Ghent University and the Institute for Hydrography of the Antwerp Maritime Academy, which is the hosting institute. Based on IHO standards for certification and quality, a postgraduate program was established that included four 3-week periods of theoretic course teaching, each theoretical period separated by 6-week periods of practice.

A study that was carried out a few years ago about hydrographic education in Belgium pointed out a shortage in hydrographic training in this country. Before the introduction of the new "Postgraduate in Hydrography", most hydrographic surveyors in Belgium work in one of the big dredging companies where they received additional specific hydrographic surveying training.

For the construction and implementation of the program, a round table discussion was set up to assess the audience, procedures and desired outcomes for the industry. Governmental organizations and the maritime industry participated in this discussion. A unique fact is that these entities are involved very actively in the program.

The aim is to combine the compulsory theoretical courses with on-the-job practice with partners in the industry to ensure maximum competence. All courses are lectured in English, and courses can be taken up over several years to facilitate part-time work. Furthermore, a selection committee has been installed to assess exemptions, in order to enable active hydrographers to study only the modules that are relevant for them. These procedures allow for a qualitative and professional, yet accessible program.

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1. INTRODUCTION

The postgraduate programme cat. B as a collaboration between Ghent University and the Institute for Hydrography of the Antwerp Maritime Academy started on the 17th of September 2012 and got its IHO accreditation in April 2013, providing an answer on the large need for trained hydrographic surveyors [1,2]. A programme with cat. A is under study. The 1-year program (Fig. 1) consists of 4 theoretical modules of 3 weeks each, fitted in a two-semester system. Between the theoretical modules, the fieldwork is planned. At the end of each semester, a two week study period followed by an examination period, is included.

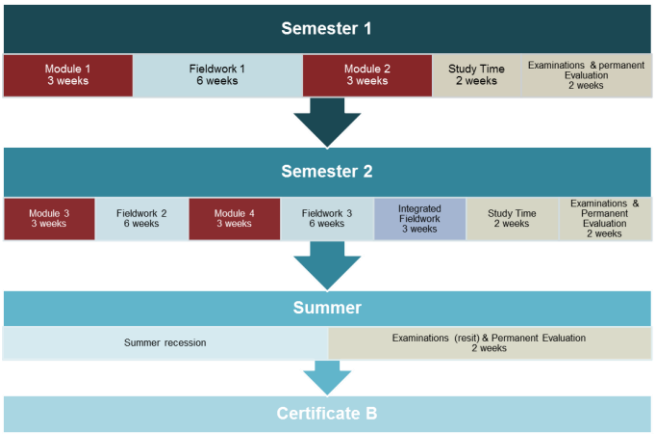

Figure 1. – 1-year program of postgraduate in Hydrography cat. B

	Course Title	ECTS	Class Hours	Location
1	ICT	3	24	UGent
2	Navigation	6	48	HZS
3	Safety	3	24	HZS
4	Seamanship	3	24	HZS
5	Tides and Currents	3	24	HZS
6	Hydrographic Surveying	6	48	UGent
7	Geodesy and Cartography	3	24	UGent
8	Data Management	3	24	UGent
9	Geology and Geophysics	3	24	UGent
10	Legal Aspects	3	24	UGent
	TOTAL THEORETICAL CLASSES	**36**	**288**	

Figure 2. – Theoretical courses in the cat. B program

The location of the theoretical courses is divided between the campus of the Antwerp Maritime Academy (HZS) and the campus of Ghent University (UGent), with a relatively fast access between both cities (ca. 45 min. travel time by easy public or private travelling) and the boundary condition that both locations are never used the same day.

As can be seen from Fig. 2, the navigation related topics are taught at the Maritime Academy while the geodesy/data management/geology and ICT related topics are provided by the Geography, Geology and Informatics Departments at the Academic University in Ghent.

2. STUDY SUBJECTS "POSTGRADUATE IN HYDROGRAPHY CAT. B"

The relative weights of the different subjects can be analysed in Fig. 3 and 4, knowing that 1 ECTS corresponds to 8 teaching hours of theory (+16 h study time).

Information and Communication Technology	24 h
Basics	**12**
Computer hardware	2
Software development procedures	5
Internet and intranet communications	5
Software analysis	**12**
Architecture operating systems and functions	6
Database structure	6

Tides and Currents	24 h
Theoretic and dynamic tidal principles	**4**
Tidal measurements	**4**
Non-tidal variations	**6**
Tidal streams and currents	**4**
Admiralty tide tables and their use	**6**

Navigation	48h
Charts	**6**
Chart datums	1
Nautical charts + ECDIS	3
Aids to navigation: buoys, beacons, publications, notices to mariners	2
COLREG	**12**
Rules of the Road	9
Case studies	3
Instruments	**8**
Compasses	3
Radar and ARPA	3
Sextant	1
Errors	1
Manoeuvring	**5**
Manoeuvres	3
Anchoring	3
Towing	3
Navigation	**5**
Coordinate systems	3
Positioning (fixes by peloris and sextant)	1
Pilotage	1
Meteorology and Oceanography	**12**
Meteorology	6
Oceanography	6

Seamanship	24 h
Ship Construction	**8**
Stability	**8**
Ropes and Wires	**8**

Safety	24 h
GMDSS	**8**
VHF, SSB, wireless telephone, satellite communications	4
Navigational warnings	2
EPIRB	1
VTS	1
Safety	**16**
Fire extinguishing tools and systems	3
Survival suits	4
Small boats, lifeboats and life rafts	3
Fire and boat drills	2
Safety procedures (ISM)	4

Figure 3. – Theoretical courses at the Antwerp Maritime Academy HZS

Geodesy and Cartographic Systems	24 h
Principles of geodesy	**6**
Geodetic computations	**4**
Approximation and estimation	**3**
Grids and graticules	**3**
Transformation methodology	**4**
Theory of map projections	**2**
Three dimensional geodesy	**2**

Legal Aspects	24h
Product Liability	**5**
Law of the Sea	**13**
Case studies	**6**

Hydrographic Surveying	48h
Positioning	**10**
Horizontal and vertical positioning fundamentals	4
Errors	1
Deployment	1
Elevation measurements and computations	2
Heave	1
Orientation	1
Bathymetry	**14**
Acoustic positioning concepts	4
Underwater acoustics	4
Non-acoustic bathymetric techniques	4
Interferometry	2
Hydrographic Instruments	**24**
Horizontal and vertical positioning	6
Single-beam echo sounders	2
Side scan systems	2
Multibeam echo sounders	2
ROV	1
Real-time data acquisition and control	4
Management, processing and analysis of acquired data	3
Satellite systems	2
Sextant and theodolite used for bathymetric data acquisition	1
Errors	1

Data Management	24 h
Analogue data capture	**4**
Management, processing and analysis of spatial data	**8**
Data presentation	**8**
Nautical charting and production	**4**

Geology and Geophysics	24 h
Marine Geology	**8**
Earth's magnetic field	**3**
Earth's internal structure	**1**
Seismic profiling	**3**
Geotechnical sampling	**3**
Deposition and erosion	**2**
Environmental impact	**4**

Figure 4. – Theoretical courses at Ghent University (UGent)

3. FIELDWORK

The fieldwork accounts for 24 ECTS and is subdivided into 2 parts: the "Integrated Fieldwork" (Fig. 5) consists of 120 hours of practical exercises organised within both institutes and these exercises are closely related to the theoretical subjects, while, on the contrary, the "Field Training" (Fig. 6) consists of 576 hours (ca. 5 months) of practical training in private companies of the hydrographic sector. Special attention has been given to the evaluation of this fieldwork, for which a "Training Record Book" was introduced with an extensive list of skills that could (and should for the biggest part) be acquired. This comprehensive portfolio, to use during their training and professional career, allows students to have guidelines of what to aim at during their fieldwork. Fieldwork supervisors can accurately assess skills, competences, and assignments and the Examination committee gets proof of student's practice during fieldwork.

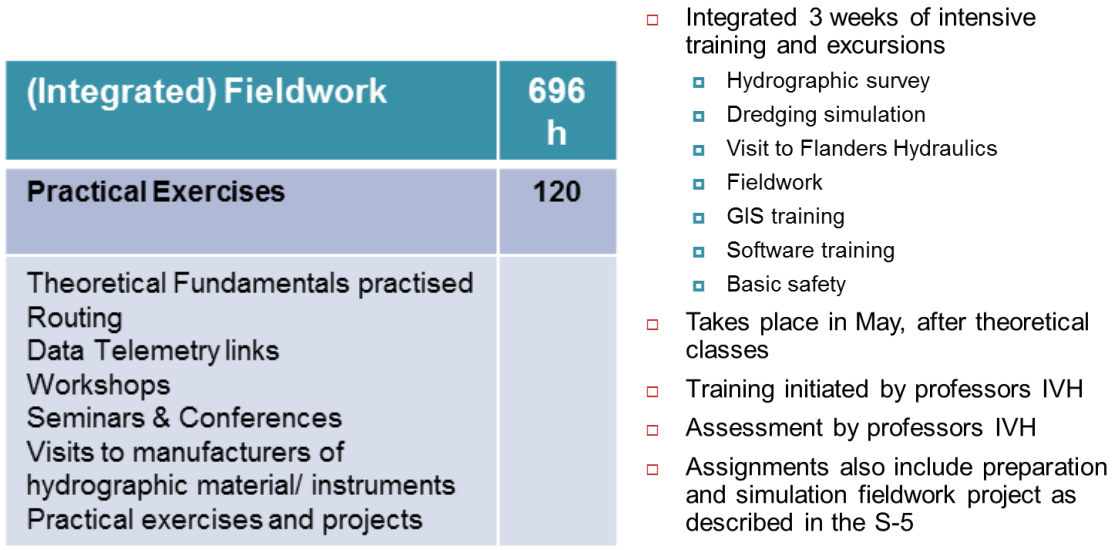

Figure 5. – Integrated Fieldwork at HZS and UGent

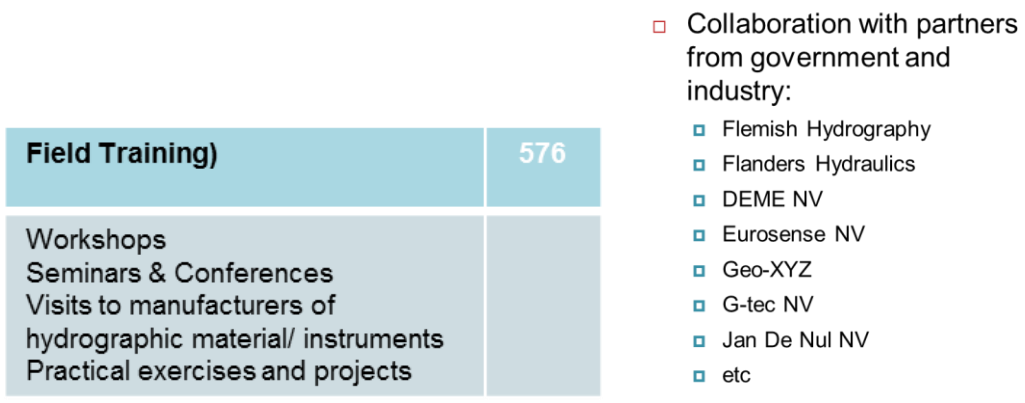

Figure 6. – Field training in private companies

4. ASSESSMENT

Assessment of the educational program is a vital issue: The Antwerp Maritime Academy is ISO 9001-2008 certified and reviewed by internal and external audits (by "Det Norske Veritas") to guarantee the quality of the application of the IHO standards. All procedures are incorporated in the Internal Quality System (IKZ) of the Antwerp Maritime Academy and all courses and modules are also assessed by the students.

5. ENTRY REQUIREMENTS

The entry requirements are threefold:

- A Bachelor Degree or equivalent from a European university or college, or from an overseas institution recognised and legalised by its government.
- An attest of « Mathematics & Physics » through a recognised higher education diploma supplement. Diploma supplement should mention the items of IHO Standards.
- Proficiency in the English language, proven by a first degree EU English language programme, TOEFL, IETS, GMAT or alternative proof.

The application portfolio with the required certificates and an interview by experts in the selection committee assess the information provided. Exemptions are granted based on the application portfolio and the interview.

6. INTERNATIONAL COOPERATION

International cooperation in education programs is an important target of the program. As an example of this, there was in 2012 and 2013 the possibility for the students to participate in an "European Union Erasmus Intensive Program" which aimed at providing intensive courses jointly proposed by european universities, ENSTA Bretagne (France)[4], Ghent University (Belgium) and HCU University (Germany)[3], and the CIDCO (Interdisciplinary Centre for the Development of Ocean Mapping) (Canada), as an associate partner, and at organizing a hydrographic and topographic surveying camp. This project took place at the "Lake of Vassivière", one of France's largest artificial lakes exploited by EDF, France's global energy company and was coordinated by Prof. Nicolas Seube (ENSTA). Six (2012) or ten (2013) teams of students were tasked to achieve the survey instructions given by EDF like in a real professional context. The main objective was to survey this 10 km² lake to focus on points of interest like dam infrastructures, ports, bridges and to open navigation channels for a given level of the lake.

For the first time in Europe, a fieldwork involving a large number of students and international teams was experienced. The ideas underlying this project were to:

1. Give the students an opportunity to learn in an international context by making international teams;
2. Make them work both on hydrographic and land surveying problems and face challenging topo-bathymetric surveys of infrastructures;

3. Make them use a wide variety of equipment (LiDAR, sonars, TLS, etc.);
4. Give the students the responsibility of a whole survey, including hydrographic instructions, survey planning, and quality assessment and reporting to the client.

The Lake of Vassivière environment offers many challenges for surveying. The following features enable us to confront the students with difficult situations:

- The presence of sediments especially soft mud in some areas;
- A time varying water column environment because of the dam turbine running during the survey;
- Very shallow water areas;
- The presence of infrastructures (dam, water outflow, ports) which required high accuracy and precision surveys;
- The presence of GNSS multipath environments due to surrounding woods or bridges and a relatively poor coverage of GNSS permanent stations, located at more than 60km from the site;
- A very long coastline to survey (more than 47 km);
- The interpretation of GNSS buoy measurements in order to monitor absolute reference level of the water plane;
- The presence of submerged infrastructures (roads, bridges, houses, mills, walls) dating from before 1951 (date of construction of the dam).

During summer, the water level in the lake has to be kept between 647m and 650m in order to guarantee the possibility of nautical activities and the operation of taxi boats, used in order to minimize car traffic around the lake. To face low water levels (the minimum envisioned lake level is 643m) due to climatic changes and to guarantee a minimum flow in the Vienne valley, an accurate bathymetric map is required in order to plan lake infrastructure modifications (ports, channels).

The main objective of the project was to produce a full coverage high resolution map of the Vassivière Lake. A total coverage at Order 1 (S-44, OHI standards) was done for bathymetric chart and volume computations, and for infrastructures monitoring and navigation purposes, a total coverage at Special Order was conducted. One of the objectives was to check for any problems or obstacles to navigation that may exist in case of low rating operation of the reservoir at 643m. The imposed TPU (Total Propagated Uncertainty) was 15cm for a 95% confidence level and a gridded DTM with cell size of 1m for navigation areas and 0,5m for infrastructures areas (dam, outflow).

During the project, students were assigned to reach a high level of productivity in land surveying. They had to find a way of using the equipment that was allocated (total stations, GPS, TLS) in order to get the most relevant land survey information: data for control points with the 2D laser scanner, data for beach modelling, profiles, etc. The role of the staff was limited to provide technical assistance for topographic measurement tools, for bathymetric

work supervision, for data processing and for coordination of geodetic work. All teams had to manage independently and also had to make daily reports to the staff. Moreover, the staff managed to give a series of lectures on specialized topics.

Before starting each camp, particular attention has been given to the calibration of the MBES (Multi-Beam Echo-Sounder), the VML (Vessel Mounted LiDAR) and their Inertial Measurement Unit (IMU) to know precisely the boresight angles and lever arms between the various sensors. Special attention was also devoted to the minimization of the TPU through very accurate instrument calibration. The calibration of the VML/IMU was performed in advance in the laboratory on a sphere scanned from several points in order to replicate the movements of roll, pitch and heading. Before the calibration, the VML and the IMU were installed on a fixed bracket. The assembly remains the same for the transport of the instrument and when mounted on the boat. For calibration of the MBES, a patch test was conducted on the lake a few days before the beginning of the fieldwork.

To perform the topo-bathymetry surveys, the ENSTA Bretagne team had deployed their survey vessel called "Panopee" (Fig. 7). The different workstations on board controlled the sonar, the VML and the quality control in real-time. The boat was equipped with a MBES Kongsberg EM3002, from Boskalis, a VML Leica HDS6200 and a sidescan sonar. Mounted on a survey vessel, each component of the integrated system was coupled with an IMU (Octans 4 from IxSea). Robust geo-referencing and motion compensation enable the production of precise map of the lake from a combination of MBES and VML instruments.

Figure 7: ENSTA survey vessel

After the project, the students were assigned to create a nautical chart of the lake by using the CARIS S-57 Composer (Fig. 8). They designed a chart devoted to safety of navigation, considering the importance of traffic on the lake during the summer. The result is a 1/10 000 compilation scale chart, referenced to the vertical datum 646m (IGN69). The coastline was determined by using VML data and topographic data. Obstructions have been identified in order to design safe isobaths.

The added value of an international cooperation for such a survey training project lies in:

- The usage of a wide variety of equipment provided by the participating institutes;
- Student work in international teams, in an unknown location;
- The possibility of a large scale project, motivated by the industry (EDF);
- A multidisciplinary team from several countries which allows us to plan a wide variety of fieldwork and post-processing activities.

Figure 8: Nautical chart of Vassivière Lake, France

7. CONCLUSION

The start in Belgium of the first higher hydrography cat. B education [5] marks a milestone. The initiative was taken by The Antwerp Maritime Academy as hosting Institute and, together with Ghent University as academic partner, an attractive program was developed in accordance to the IHO rules, and this resulted in the IHO accreditation of the "Hydrographic Surveying cat. B program" in April 2013 [6]. Special care was drawn to the quality assessment of both the program, using internal and external auditing, and of the fieldwork of the students by introducing the concept of a "Training Record Book". International cooperation is highly appreciated as demonstrated by the Erasmus Intensive Training Program as an example of international cooperation in the field of hydrography education and proving that such experiences provide a very high added value for the students, the staff and the industry.

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BIOGRAPHICAL NOTES

Prof. dr. ir. Alain De Wulf is full-time professor at Ghent University (Belgium), researching and lecturing on the general principles of 3D data-acquisition techniques in the domains of land and hydrographic surveying and quality aspects of geodesy in particular. He is vice-chairman and secretary of the Hydrographic Society Benelux. With his expertise in hydrographic surveying, he is developing specialised software for the processing and quality assessment of hydrographic data acquisition sensors. He was and is involved with his scientific research team in different projects, ranging from topographic campaigns for archaeological projects (Malta, Altai (Russia), Thorikos, Titani (Greece), etc.) till bathymetric projects involving vertical reference surfaces and GNSS buoy tide measurements. In these projects, recent developments in surveying engineering, photogrammetry, bathymetry and geomatics are actively applied in state-of-the-art and integrated 3D data acquisition techniques and platforms.

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