WORMLEY DIVING 1967 - 1995

The contributions to Scientific Diving from Wormley, NERC, and in the UK

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Introduction

Scientific Diving is a small part of marine and freshwater research. It uses a method of life support and transport enabling the researcher to live and move below the surface of the water, exposed to the surrounding water pressure, and making observations, recording data, taking photographs or video, placing and recovering instruments, manipulating tools or chemicals, and so on. The duration underwater is limited by the supply of breathing gas (usually less than 1 hour), need to conserve body heat, and the properties of gases under pressure.

Notwithstanding these limitations, the ability to watch events and move about in 3 dimensions, to work with one's hands, responding instantaneously to changing events, the opportunity to take samples in context, and monitor or manipulate processes close-up, has provided scientists with a tool that has been exploited by many thousands of people worldwide, and many hundreds in the UK. It is an ideal tool for research in shallow water, down to depths usually less than 30m, and almost always less than 60m. The technique has been used by geologists, zoologists, physicists, botanists, chemists, engineers, psychologists, fisheries scientists, and archaeologists, and there are many publications demonstrating this activity from the period covered by this paper (e.g. Ross 1967; Woods 1969; Woods and Lythgoe 1971, Flemming 1969; 1972a; 1978). Many marine laboratories and universities worldwide support small or large diving teams (e.g. AAUS 1996; Florida State University 1989; University of Delaware 1972; Flemming 1973; Flemming and Miles 1974; NOAA 1975; Willis and Flemming 1975; OSHA 1979).

British Antarctic Survey diver under ice.

Background at NIO/IOS Wormley

When I joined NIO Wormley in February 1967 there was no diving team although some staff had experience of sports snorkelling and diving. I had learned to dive in the Royal Marines in 1956-57 breathing closed-circuit oxygen, and had conducted research both as an undergraduate and for my PhD using self-contained underwater breathing apparatus (scuba) breathing open circuit compressed air. In 1965 I conducted joint experiments with the Royal Navy on self-contained, partial recirculated helium-oxygen diving. (Baddeley and Flemming 1967). At NIO I intended to conduct research on changes of sea level and coastal tectonics in the Mediterranean, using my own diving experience, and collaborating with other research divers in the UK and abroad.

In 1967 the only safety regulation at a legal or statutory level was the 1960 Factories Act, which was wildly out of date. In addition there was the training standards and practices of sports diving as published by the British Sub Aqua Club, of which I was a member (e.g. BSAC 1979). During the 1960s the exploitation of offshore hydrocarbons in the North Sea expanded rapidly, with the immediate effect of a demand for commercial divers and incidentally a rapid increase in fatal accidents to divers on the rigs. By the mid-1970s the fatality rate offshore was of the order of 3 divers per year in UK North Sea, that is in the range of 1% per year, (Warner and Park 1990; Limbrick 2002), and this became a national scandal, with questions in Parliament, and anxious debates in the Society for Underwater Technology. By comparison, the fatality rate amongst sports divers is 2 per 10,000 at risk per year, that is 0.02% per year, and the fatality rate for scientific divers in the UK was zero in 1967, and is still zero for the last 60 years (Bellamy 1996). (Based on personal knowledge and correspondence with the present personnel at SDSC.)

There are fundamentally 4 different ways for divers to obtain life support while working underwater: 1) self-contained, scuba, air-breathing or any gas mixture, open circuit, and swimming with fins. 2) self-contained. scuba, closed or semi-closed circuit, mixed gas, swimming with fins. 3) Surface supply, breathing gas supplied through a hose, with electrical conductors for heat, voice, and video, diver usually wearing boots and walking, but can use fins. 4) Saturation surface-chamber and bell diving, with the diver living under pressure for many days at a time, breathing oxy-helium mixtures with helium recovery, complex umbilical providing power, light, heat, video, and communications, plus a support team of engineers and medics on the surface.

There are strong reasons for trying to make breathing gas last as long as possible. If the diver is using scuba, then the quantity of gas is limited. On open circuit, each inhaled breath is subsequently exhaled into the water. The diver only uses a fraction of the oxygen that passed through the lungs. On closed circuit, or semi-closed circuit, the inhaled gas is breathed out into a rubber bag or counterlung and then inhaled again through a CO2 absorbent filter. The result is that the diver gets many “bites” at the same gas, and hence metabolises a much bigger fraction of the oxygen. If the diver is on surface supply, or working from a bell, the diluent gas is often helium, which is very expensive, so in that case the gas is either recirculated, or pumped back to the surface to recover the helium for later use.

Scientific research divers use almost exclusively types (1) and (2) since they provide maximum mobility in 3-dimensions, while commercial and industrial diving contractors in the offshore hydrocarbons industry use almost exclusively types (3) and (4). Other employed groups using types (1) and (2) include the police, fire service, coastguards, Army Engineers, fish-farmers, and professional film camera operators for feature films and television. In addition, a number of commercial diving companies working in shallow water for environmental and archaeological surveys use types (1) and (2).

A simple analogy for the complexity and cost of the different types of diving can be made by comparison with road transport. Type (1) is equivalent to a bicycle or small motorbike; type (2) is equivalent to a powerful motorbike or small van; type (3) is equivalent to a commercial lorry of 5 -10 tons; and type (4) is equivalent to a vehicle of 30-50 tons with added complexity of, for example, refrigerated food storage or a huge rotating concrete supply. In terms of cost, type (1) is a few hundred to a few thousand pounds; type (2) 5 – 10,000 pounds; type (3) hundreds of thousands of pounds; and type (4) millions of pounds.

Safety for all types of diving requires that the diver must be supplied with a gas mixture that is safe to breathe at the working depth, the descent and ascent should prevent the diver retaining dissolved gas in such a way that would risk "bends" or decompression sickness, and the overall support and planning should allow for the environmental conditions and returning the diver safely to shore with no long-term adverse medical effects. Beyond these broad factors, the different types of diving require radically different equipment, provisions, specifications, limitations, maintenance, restrictions, and on-site backup teams to ensure safety throughout the operations.

From 1974 to 1997 Government Departments including the UK Health and Safety Executive acting on behalf of the Department of Energy Diving Safety Section issued a series of Statutory Instruments to control diving safety and reduce accidents. The key SI that strongly effected scientists was Statutory Instrument 399 (1981). This Regulation attempted to force identical prescribed diving safety procedures on all divers at work, thus eliminating scuba. This, and the subsequent safety notices and up-dates, caused a situation verging on regulatory chaos, as explained in my book of memoir (Flemming 2021, Chapter 8). It was as if the Department of Transport required cyclists to have anti-jack-knifing systems, automatic constant monitoring of tyre pressure, and an on-board back-up supply of 50 kilos of refrigerant. The correct decision should have been to ban the use of lightweight self-contained diving techniques (scuba) on offshore platforms and working amongst heavy machinery, and then draft regulations that were exactly matched to the diving techniques being used in each sector. This would be equivalent to banning bicycles and mopeds from motorways. But this separation of types of diving and their relevant controls was not done until 1997. The unfortunate UK approach to new diving safety regulation in the 1970s and 1980s strongly influenced legislation in many European countries, and in the British Commonwealth.

Thus, my role at Wormley was a combination of conducting my own research, working with other scientific divers in UK and globally, and managing a constant regulatory and legalistic battle against the British HSE. The HSE finally capitulated in late 1994, and conceded that the techniques and procedures that British scientific divers had been using for the previous 20 years were superior to the procedures proposed by the government SI Regulations and the HSE.

Research diving projects 1960 - 1997

When I joined NIO I had already conducted a series of deep water surveys of Pleistocene coastal caves in the depth range 30 – 80m in the Mediterranean. This material was included in my PhD dissertation, and I converted the data into publishable papers (e.g. Flemming 1972a) while at NIO. I also used the data from underwater archaeological surveys in the Western Mediterranean (Flemming 1969) to define coastal regions of tectonic activity.

In 1966 I was a founder member of the Underwater Association for Malta (abbreviated as the UA) that brought together many scientific divers in the UK, from government labs and universities, as well as attracting overseas members. Other members were C. C. (Bill) Hemmings at DAFS, John Lythgoe (Institute of Ophthalmology, London), and John Woods (Met Office). We organised conferences, and published a book of the proceedings entitled Progress in Underwater Science that continued every year from 1967 to 1992. I was also a founding member and first Honorary Secretary of the SUT that was founded in 1967. SUT had a diving committee that supported commercial and offshore diving.

A team of divers preparing the GLORIA MkI vehicle for recovery

In 1969 NIO launched GLORIA for first time, and the engineers found that the connection of the trailing float and the main power conducting cables required an inflatable boat working alongside the main fish, and then people had to get into the water to make everything secure. There were several technical staff on board who had sports diving experience, and very soon IOS had the nucleus of a diving team: Ray Peters, Roger Clements, Stewart Willis, and later Peter Schultheiss. Tony Laughton instructed me to prepare a set of diving rules for IOS (Flemming 1970), and then a report on work done by the divers (Willis and Flemming 1975).

Rockall. This photo shows how even moderate swell makes landing from sea challenging

The IOS divers participated in a range of open ocean projects, including two cruises to obtain rock samples from Helen's Reef, adjacent to Rockall, in 1972 and 1975 (Binns et al 1973), and freeing of the propeller of Discovery after it became fouled by the towing cable for the TOBI vehicle.

Codes of Practice for Scientific Diving

Richard Pope, NERC Safety Adviser, established a NERC committee on Scientific Diving, which I chaired, and this was soon extended as the UK Scientific Diving Supervisory Committee (SDSC) to include almost all Government Laboratories and Universities employing scientists who dived in the course of their work. I chaired SDSC (See Flemming 2021, Chapter 8). Because of the high accident rate amongst commercial industrial divers working on the North Sea offshore rigs there was a constant attempt by HSE to eliminate scuba diving for all working divers, as it was wrongly deemed inherently dangerous. The SDSC edited and published a series of Codes of Practice that were used widely in the UK, and internationally, with versions published by UNESCO (Flemming 1972b; Flemming and Miles 1974; Flemming and Max 1987, 1990, 1996). SDSC advised institutions not to comply with those parts of the HSE Regulations that were dangerous, and this advice was approved by Chairman NERC, Sir Hermann Bondi (1980-84). The battle against dangerous regulations, and the uncertainty of the status of working scuba divers, caused many scientists to abandon diving in the 1980s, and European collaboration between diving teams became impossible. The deaths of two student divers in a school that complied strictly to the rules of HSE, and did not use the NERC/UNESCO codes, brought matters to a head in 1994. HSE abandoned the existing legislation, and a completely new set of Regulations and Advisory Codes of Practice (ACOPS) was introduced in 1997. The principles of the 1997 Regulations and ACOPS have been routinely updated, and remain in force in 2022. The statistical analysis of the safety of scientific diving was published by Bellamy (1996), while a review of scientific diving in Europe was submitted to the European commission (Flemming and Lonsdale 1994).

In summary – impact and innovation

NIO/IOS was principally a deep water research establishment, although it undertook progressively more work on the UK continental shelf. The diving team was never intended to have major funding as a research unit or program but it was more of a service to other projects and organisations.

Nevertheless it had a scientific impact through the resulting publications, and expanded the boundaries of diving experience. For example, NIO/IOS purchased a multi-compartment recompression chamber in about 1971 and Stewart Willis and I did courses on chamber operation. During the Rockall dives in 1972 and 1975 we provided training chamber dives for RN personnel on board the RFA vessels, and are probably the only civilians ever to have done this. Obtaining geological samples from around Rockall in open oceanic waters, 240 miles from land in bad weather and then dating them at IGS was also a major achievement.

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Archival

Numerous boxes of my correspondence, minutes of meetings, and books and manuals on scientific diving safety have been deposited with the Historical Diving Society. Address: The Diving Museum, No.2. Battery, Stokes Bay Rd, Gosport, PO12 2QU.
https://www.thehds.com/

WEB LINKS

https://en.wikipedia.org/wiki/Scientific_diving ;
https://en.wikipedia.org/wiki/Underwater_Association

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