DIVING WITH COMPUTERS

A Personal view

David Davies

Since I began my love affair with diving I have seen many changes both in attitude and equipment and, in general, have agreed with the direction recreational diving has been heading although there are still some trends I would like to see reversed such as the deterioration in the level of water skills that new divers seem to have.

In the early days, diving tables, which we now take for granted, were rarely used and if they were used, the only ones available were the US Navy tables. However, as many divers at that time dived with neither watch, contents gauge nor depth gauge any thought of table use was really superfluous.

Once diving started to become more popular and there developed a demand for more and better equipment and formal training in its use, then these items became more readily available, mandatory for the well dressed diver and increasingly recommended by dive schools who could see the prospect of extra sales at the end of each course. These schools then began to teach their students how to use this equipment and how to read the dive tables. The Wilks and O'Hagan article in the SPUMS Journal in 1991[1] showed just how effective this training was and how little the students remembered of the intricacies of these tables once they had completed their basic course. Experience gained in the navies of the world with these tables suggested that if "fudge factors" were used in conjunction with the tables there seemed to be a lower incidence of decompression illness in their divers. These factors included reading a deeper depth than actually dived, reading a longer time than actually spent on the bottom, ascending slower than the arbitrary 60 feet per minute and having a rest near the surface prior to the final ascent.

Development of the microchip allowed the introduction of small computers for business and then personal use. Some lateral thinking led to the development of a submersible device which could calculate the theoretical uptake and distribution of nitrogen in theoretical tissue compartments according to an built in mathematical model by measuring the depth and time at frequent intervals during the dive. The resulting display gave the diver an indication of how long he could remain at depth before requiring decompression stops. As a result he could alter the dive plan, during the course of the dive, and gain more bottom time. These early computers were notoriously unreliable and were based on the US Navy table algorithm with the assumption that the rate of elimination of nitrogen was the same as the rate of uptake by the tissues.

When dive computers were originally introduced it was the veteran divers who first appreciated their value. They used the instrument as an accurate depth and dive time recorder and on the basis of their experience added their own "fudge factors" depending on prevailing conditions, just as they had done before with the tables, and they modified their bottom times accordingly.

Then began an intense promotional campaign by manufacturers, distributors and dive shops who realised that there is more profit in selling an expensive computer than a cheap set of tables. As a result, less experienced divers became aware of this additional item of equipment which they could show off to their companions and brag about their increased depth, bottom time and "safety". They dived for the times and depths specified on their computers and often failed to add in the fudge factors that their more experienced senior colleagues had been doing. They forgot that they should not be sharing computers or that buddy pairs did not dive identical profiles and some problems arose. As it was still an expensive piece of kit the computer became somewhat of a status symbol and the computer diver tended to belong to that group which had the best equipment, dived often and had extensive overseas diving holidays.

SPUMS members seemed to be the exception possibly as a result of several powerful articles published which slated the use of dive computers and extolled their vices. These articles were written by authors who had eminent standing in the diving medical community and who made anecdotal reports of a few cases of divers suffering from decompression illness after diving with a computer.

Now, more recently, many dive schools have started adding a computer to all their loan and hire gear so that novice divers being introduced to the sport now have a computer to look at rather than trying to juggle their minds between the watch, the depth and contents gauges and their copy of submersible dive tables. Their introductory course gives them only a cursory instruction in use of the tables so that, basically, they know no other way of diving than with a computer.

Just as most drivers have no real knowledge of how the brakes, motor or ignition systems work in their car so do these new computer divers have little knowledge of what the little black box on their wrist is doing and why they are getting the display that they are seeing. It is this new generation, brought up in the belief that the computer is omniscient, accurate and infallible, which sorely requires proper education in the science of diving but this subject is being neglected by the educators with the result that, in the event of a computer failure, these divers have no fall back position on which they can rely.

This group has been thoroughly inculcated about the desirability of slow ascent and has a firm adherence to the myth that spending five minutes at five metres at the

end of every dive can overcome any transgression of depth or time during the dive and so be a "safe" diver.

Initially the mathematical model for these computers was based on the US Navy tables but as development progressed and more experience was gained the developers incorporated other more "conservative" algorithms based on the Bühlmann, Bassett and DCIEM tables. As a result, different computers subjected to the same dive profile can display significantly different permissible bottom times, ascent rates and decompression stops. This can be a source of great confusion to the buying public and has led to increased competition between the manufacturers and distributors to promote the "safest" dive computer. It is my impression from talking with divers that prior to the purchase of a new computer, many divers will compare the published bottom times for each and go for the one that gives them more dive time with shorter surface intervals.

Interestingly, there does not appear to have been a significant change in the numbers of cases of decompression illness presenting for treatment since the widespread introduction of this instrument.

Scientists and diving doctors have long known that physiology of the human body does not conform to a strict mathematical model. The blood flow, rate of metabolism, temperature and a multitude of other factors alter from tissue to tissue, moment to moment according to prevailing circumstances and this cannot be programmed into any computer. The current generation of computer cannot make allowance for fatigue, dehydration, hangover, sea sickness, work levels before, during or after a dive, age, experience, anxiety or the presence of an undetected patent foramen ovale. They make no allowance for variations either between divers or within the one diver over the course of the dive, the day or the week. This may well change in the near future as computers become more sophisticated, the programs are improved and more environmental parameters are monitored. The computer will not, however, monitor variations in regional blood flow, tissue metabolism or tissue oxygenation although new computer models are now monitoring body surface temperature and variations in breathing gas consumption as a reflection of the work of diving. These instruments may also have the capacity of having their stored data transferred to another computer which, at a later time, can then be used to track the course of the dive minute by minute. As a research tool this opens up many possibilities as to the aetiology of bubbles and the origin of decompression illness.

My personal experience with a computer is over only 35 dives. Prior to its purchase and use I would invariably return from any diving trip, be it one dive or several dives, utterly exhausted. If I had a dive first thing in the morning the rest of the day was a write off.

In retrospect and after a great deal of navel gazing I attribute this to showers of microbubbles and I constantly give thanks that none of these ever became symptomatic. For thirty years this has happened even though I rarely dived deep and, apart from the occasional emergency ascent when the hookah ceased to function, always tried to ascend slowly. Hand over hand up the anchor rope was the usual practice. Since I began to use a computer which has a 10 m/minute ascent rate alarm I no longer have the fatigue and lethargy and I am much happier with my diving. My wife has even remarked that I am now able to mow the lawn after an early dive, something which was beyond me before. Certainly this is anecdotal but it is my experience.

Computers are not infallible. Divers still get bent, but, is this the fault of the computer, the diver, or is it just a random event? If computers are so dangerous as some of our senior colleagues seem to suggest, why is there no significant change in the number of bends cases presenting for treatment? All accept that the computers currently on the market are accurate depth gauges and time keepers. Most computers now activate automatically on entering the water, something watches never did. They all have large numbers that are easily readable underwater which my watch never had and I find increasingly useful. They have all the required information in the one convenient field so that the diver does not have to look from watch to depth gauge to contents gauge to submersible dive tables and then do quite serious mental arithmetic to estimate how much longer he can remain at that particular depth. Most computers have a rate of ascent alarm which encourages the diver to ascend at or slower than the recommended rate. The newer models are using the 10 m/minute rather than the former 18m/minute. Prior to this divers had been measured ascending at anything up to 40 m/minute. My message here is that the computer is a compact device that, provided you read and understand the manual, is easy and convenient to use. Like computers in other walks of life they are becoming relatively cheaper to own and more reliable in the field.

Just as dive tables had their limitations, so do computers in that their algorithms cannot be pre-programmed to cover every contingency. Dives must learn that the computer is there to provide guidelines and to dive safely the diver should remain within these guidelines and not push them to the limits. Doctors and scientists who continue to argue against the use of computers for recreational diving on the grounds that the algorithms have yet to be properly tested, the algorithms are incomplete, the computers may occasionally fail during the course of a dive and the computers make no allowance for physiological changes between divers and over a period of time seem to forget that the computer is here, and is here to stay. With time dive computers can only get better.

Reference

1 Wilks J and O'Hagan V. Queensland scuba divers and their tables. *SPUMS J* 1991; 21(1): 11-14

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WHY I USE A DIVE COMPUTER

Guy Williams

I began using a dive computer in the late 1980's, when the first of the modern generation of dive computers came onto the market, and have been using one ever since, although I have updated the model three times. Before this I used a conventional set-up with contents gauge, watch and depth gauge. My first depth gauge was an old oil-filled gauge (a not particularly accurate instrument, and like most divers I never had it serviced) with no maximum depth indicator (MDI), I updated this unit to a more modern model unit with an MDI, and I noted that many of my dives were suddenly deeper than I had previously recognised. I continue to use a dive watch, but only to tell the time. I recall not infrequently descending on a dive, thinking about photography and my camera gear and forgetting to set the bezel on my watch. I believe most of the audience have done this at least once, a computer does this automatically.

At least with a computer, it only requires to be activated before entering the water, everything else is automatic. Computers log depth and time with great accuracy, and as a bonus offer advice on decompression/no-decompression requirements, again without requiring any input. Previously I was a user of the US Navy tables and later the PADI recreational tables. I saw in a recent review in Pressure, that a US Navy survey produced 75% incorrect answers on table usage. Unfortunately no one seems to have a copy of this survey so I cannot test myself. If divers, as they do, run out of air because they do not look at their gauges, how can we expect them to look up the tables, and follow them accurately.

My first computer was an early Oceanic Datamaster, with air integration, I found this a great step forward. It was easy to operate, had a clear display and was very accurate. I could spend more time enjoying my diving and less time on the procedural aspects of diving.

I now use the a current model of air integrated Datamaster. I find it a delight to use. However computers are not yet perfect. I have had computers fail, but only on the surface during the power-up self check. I should add that the Australian diving industry is excellent with replacing defective equipment under warranty. I carry a spare computer, partly because I believe that all computers can fail and therefore a backup is useful. I also carry a Spare Air, so I guess I like spares. However the main reason is that with a gauge on the end of a high pressure hose, and my eyes on the viewfinder of my camera, I find the best position for a gauge is beside the viewfinder. I would prefer a wrist mounted unit as I am used to gauges on my wrist. However this is the year that air integrated hoseless dive computers have appeared on the market, so perhaps in the future Sony will incorporate a dive computer's display in the viewfinder of their cameras.

I believe that air integration is a useful feature, as it accurately predicts a recommended dive time, based on my air consumption or on no-stop limits, whichever is least and to allow enough time to ascend safely. Another useful feature is a low air warning, a number of computers now produce an audible warning when air levels are low and a persistent warning when air reserves are critically low. The audible warning also alerts other divers in the vicinity, if they are aware of its significance.

At last year's meeting Chris Acott presented details of his diving incident survey, in which being out of air or low on air was a significant factor in many incidents. I believe air integrated dive computers will make this much harder to achieve.

Another feature of my dive computers, and I believe some others, is an ascent rate warning, i.e. if I exceed the recommended ascent rate there is a visual and audible warning. I find it interesting the number of times that the ascent rate warning beeps and flashes, on dives when I would not have noted an excessive ascent rate, particularly on dives with no reference point for ascent, such as an anchor line or reef. Perhaps another feature that could be incorporated in future computers is a descent rate indicator, this would be useful for diving Pelilu Comer in Palau, with its vertically down currents.

I also like the bar graph depicting my nitrogen loading, if I follow the manual and stay out of the caution zone, then I always remain 10 minutes outside the no-stop limits, combined with a 5 minute safety stop. I believe this is a useful safety feature. It is informative to see my progress towards the nostop limits. I should add that I have read the manuals that came with my dive computers, on more than one occasion.

Dive computers, like all instruments need to be cared for. I am careful to protect it from excessive trauma, and I keep it in my buoyancy vest pocket, to protect the gauge and the reef from accidental damage. At the end of a