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# Computing Your Way into Trouble?

*Some say computers make diving more dangerous*

While most divers assume that their dive computers are as reliable and valid as an automobile odometer, to some scientists dive computers and their algorithms remain troubling. They point to scores of cases where divers conducting no-decompression dives fully within the limits of their computers get seriously bent. In 1995, several scientists, physicians and professional divers met to discuss their reservations.

We sport divers are flooded with stories about the wonders of computers in the pages of this and other publications. Perhaps another, more critical view of computers needs to be presented. The following are critical comments gleaned from the *Report of the Proceedings of the 1995 Workshop on Computers*. After all, if we don't write about it, who will?

## Designed-In Danger

Australian physician Dr. Carl Edmonds is the leading international critic of diving computers and the dangers of placing blind faith in the devices. He blames the industry for unabashedly promoting computers:

"When we pulled the rug out from under dive computers in 1987 with our reports, pressure was brought to bear to change our views. This was initially in the form of telephone calls from prominent personalities in the diving industry, and I classify these as 'testimonial calls' or 'manufacturers' mouthpieces.' Similar methods were used to promote various dive computers in the popular dive magazines (*Undercurrent*, 1986), utilizing

prominent personalities as role models, as opposed to supplying factual data on the computers."

Edmonds has ignored industry politics and continues to speak out. To him, why divers following computer profiles get bent is no mystery — he sees computer algorithms violating what science knows about diving physiology. In the calculations used to construct the U.S. Navy tables, he points out, the figures are always rounded upward. Thus, for example, 52 minutes at a certain

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**Max H. Hahn of the Federation of German Sports Divers notes that American training organizations have a policy against decompression diving. This, he says, leads many American divers to buy the computer with the longest no-decompression limit.**

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depth is rounded up to 60, and a depth of 52 feet will be rounded to 60 feet. Navy tables round up; computer algorithms don't.

To Edmonds, these liberal calculations are dangerous — especially, he notes, when combined with shortened surface intervals. "What has not been appreciated," he says, "is that the

longer the surface interval, the safer the dives." For example, "if one considers purely square wave dives in recreational diving ranges, a surface interval between 2 and 4 hours [is] required before the computer would approximate the U.S. Navy table. . . . Many tables in computer manuals show the no-decompression limits and compare these to the tables. The 'bottom times' in the tables refer to the descent time plus the time spent at depth. The times given for computers usually refer only to the time to be spent at depth — that is, no consideration to the descent time."

In dives deeper than 120 feet, he says, the few minutes extra to descend can be very significant. "No-decompression times given for computers need to have this extra time, or a modification of it, added to their alleged 'bottom time.' Otherwise, the computer is made to appear safer than it really is.

"Thus, for tables, a '10-minute no-decompression dive' may require two minutes of descent time, during which there is less nitrogen uptake than in the remaining eight minutes on the bottom. For the computer, 10 minutes does not include the descent time, and therefore the correct 'bottom time' for a dive to that depth is in excess of 10 minutes.

"This is why many computers quote 'allowable no-decompression limits' but then exceed them when the meter is tested in the chamber, during deeper diving."

In a separate paper, Max H. Hahn of the Federation of German Sports Divers notes that American training organizations have a policy against decompres-

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sion diving. This, he says, leads many American divers to buy the computer with the longest no-decompression limit to follow what he calls “the politics, the policy of some diving organizations.” He sees this as less of a problem in Europe, where decompression diving is without taboo.

## Clauses for Lawyers

Edmonds says that to counter the algorithm problems that lead to bends, computer manufacturers include “safety factors” and “nonliability clauses” in their manuals, an “indication of the problems computers have caused. Safety factors should be incorporated into the algorithm if they are required for safe diving,” not left to the small print in the manual, which is either not read or forgotten many months down the track, then “resurrected during litigation proceedings.”

Edmonds adds, “The moment that you add safety factors into your experimental dive protocol for computers, you are no longer testing those or computers. What you are really testing is the values of the safety factors applied to them.”

Hahn adds fuel to Edmonds’ argument: “Most of the don’t, avoid, and beware-of rules — which at best are found in dive computer manuals but not yet in computers, after years of sales — could be integrated into proper computational algorithms. This would help get rid of the helpless out-of-range rules by which some instruments abandon the diver by turning off computation and leaving the diver with nothing more than a depth gauge and a timer when certain limits are exceeded.”

## Test? What Tests?

Edmonds is also critical of the lack of uniform testing to validate

computers to ensure safety. He notes that manufacturers not only have the computers available to test, they have their own mathematical models already on the

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## Safety factors should be incorporated into the algorithm if they are required for safe diving, says Dr. Carl Edmonds, not left to the small print in the manual.

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computer. But they don’t make this information available to

independent researchers, so it takes them months to perform real-time dives in chambers to determine the tables and analyze the data, when it “could be achieved by the computer manufacturers within the day.”

He says that independent testing should be required for all newly introduced tables and model-based computers. “A computer should be demonstrated to be valid physiologically and mechanically, and be electronically reliable.” Furthermore, “with computer tables so vital to individual safety, one might expect some independent regulation. But there is none. Manufacturers are free to put any tables into a computer, test them however they care to — or not at all — and no one watches over their shoulders — no government body, no scientific body, no dive organization.”

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Currently housed in the Medical Building at Duke University, the Divers Alert Network just broke ground on its new four-story, \$3.5 million Peter B. Bennett Building, named for DAN’s executive director.

## *DAN: Does Bigger Equal Better?*

Having dived into the scuba industry at about the same time, I’ve watched DAN grow from a tiny organization in 1980 to an entity with a membership of 120,000, their own Cayman offshore insurance company, and now their own skyscraper. I even helped them along the way with free *In Depth* ads and editorial support. In return, DAN supported our efforts to provide a platform for the dive travel and gear consumer.

Feeling a little estranged from this new, bigger, less communicative DAN and prompted by a few comments from readers, I called an old friend, Chris Wachholz, who is now DAN’s director of special projects, and talked about DAN’s rapidly changing size, image, and real estate.

Chris told me that DAN needed more space to remain efficient and provide the level of service divers have come to expect from their medical information and emergency hotline (15,000 calls a year), insurance, and emergency evacuation assistance, as well as to collect and process diver accident and fatality information. They bought the building, Chris explained, for the same reason people buy a home instead of renting; the cost of office space is rising, and buying is cheaper over the long run. Other nonprofits are doing the same, he said — it means they’re in it for the long haul.

J. Q.

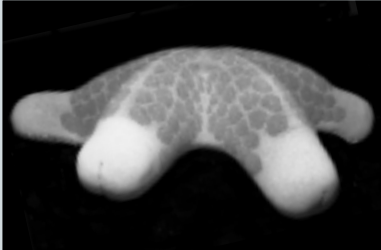
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## The View from DAN

Before you rush to discount Edmonds as a conservative old

fob — after all, you've never had a problem with your computer — read the response from Dr. Peter B. Bennett, the president of DAN:



### Do You See What I See?

Do you ever look at unusual animals underwater and think about what they resemble? Ever see one that reminds you of human anatomy and think, "I've been out at sea too long"?

There's a seastar that's common in the South Pacific, *Choriaster granulatus*, that I have for years jokingly called a "penis star" because each of the star's five rays resembles an erect penis. At my slide-show presentations, my name for the seastar always gets me a laugh from the audience when the phallic-looking echinoderm appears on the screen. Now it seems I am not the only one who sees the resemblance.

Recently, in California, an entire sixth-grade class was disrupted when the kids all got excited over a picture in one of their textbooks. It turns out my penis star photo had been purchased for publication in the textbook from my stock photography agent. As you can imagine, a bunch of 11-year-olds finding naughty bits in their schoolbooks can work themselves into a pretty good frenzy.

But then, so can a bunch of grownups. Unaware of the sale, I was surprised to receive a call from my agent asking me to help her prove that this was indeed a photograph of an actual animal that had not been altered in any way. Apparently the teacher, horrified that a reputable company would intentionally publish pornography, got her school to make a formal complaint to the publisher.

I was baffled. Did the teacher actually believe that a professional marine-life photographer would cobble together a quintuple willie and torpedo his own reputation by allowing the photograph to be published?

The publishers' lawyers were worried. If this was a plot to pervert and contaminate our youth, were they liable?

My agent was concerned. Had I perpetrated an obscene hoax on the schoolchildren of America?

I assured my agent that the photo [similar to the one above] was indeed of an actual seastar that just happened to look like five human penises joined at their bases. My agent passed the word to the publisher. Everyone calmed down.

In a phone conversation with my agent, the teacher had asked, "Can you believe anyone would choose that picture?" My agent told me, however, that she had trouble locating the shot from the teacher's description. She could find nothing in the photograph that would cause it to be rejected.

All of which just reinforces the ancient proverb: The penis is in the eye of the beholder.

Chris Huss

*Chris Huss is a full-time professional photographer specializing in marine wildlife photography. His pictures have won over 65 awards and appear in countless magazines, books, brochures, and postcards. Based in Seattle, he leads dive photo trips all over the world.*

"I think Carl Edmonds is very straightforward. He always shoots straight, and he is very logical and speaks common sense, if with a rather sharp tongue. Nevertheless, what he said made a lot of common sense. . . . If the computers let dives become very long, I would predict that we have a major problem in their use. They just will not do the job that is required; there is the impasse the manufacturers face. The computers really are only as good as the physiology on which they are based, and we do not yet know what we are doing."

Dr. Bennett adds, "I have been interested for a long time in why live-aboards don't seem to have problems with decompression illness at the level of offshore divers or boats coming out of the various resorts. We looked at some of the profiles and began to understand what was going on. They dive five or six dives a day. They were doing their deep dives first, and then they become shallow and shallower. By the evening or certainly late in the day they were running into very shallow dives, very long dives. I mean, in a sense they are doing a throughout-the-day decompression.

"They just don't get into the problem compared with the people on a day boat that are doing two or three dives; they work on a computer with the dives relatively closely packed because the boat wants to get back in. So they have an interval at surface of one hour or less; if the guide really wants to get back faster, she cuts it to 40 minutes. So they get into problems."

### Longer, Deeper, DiveDiveDive

Decompression sickness (DCS) is on the upswing. In the workshop, researchers from DAN and Duke University reported that while the diagnosis of embo-

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lism (AGE) has been fairly constant, the percentage of decompression illness cases in computer divers increased by 45 percent from 1987 to 1991 (381 cases). This trend may simply reflect increased computer use in the diving population; however, they note that the trend for computer divers is "to dive significantly deeper and longer."

Dr. Max Weinmann of the Harper Hospital in Detroit, Michigan, also expressed his concerns: "*Undercurrent* heralded the lifting of the Queensland [Australian government] limit of three dives per day virtually with the fervor of getting rid of a Fascist rule.

"Now, concerning the finding that 35 percent of divers with DCS did not have any identifiable symptoms, it is of profound concern that instruments are being introduced which are creating computer-literate but

table-illiterate divers, who, when the devices fail (and they do fail), are totally incapable of making appropriate adjustments.

"They are diving four, five, six times a day, and they feel that they have a license, since the

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### **In a sense, live-aboard divers are doing a throughout-the-day decompression.**

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computer tells them it is okay, to embark upon much more aggressive dive profiles and thus put themselves at risk.

"The majority of divers attribute muscle aches and pains to over-aggressive exertion. And, on examination, subtle neurocognitive deficits are often missed.

"So I think we are under-diagnosing decompression sickness. Divers are presenting themselves late, if at all. It is a profound worry that the computers are being used so freely."

### **Bone-Kill Demon Diving**

While all divers are concerned with bends, few consider the longer-term effects of bone necrosis, the slow death of bones found in working divers who have made thousands of dives. A serious disease, it has appeared in heavy-diving scuba instructors and recreational divers.

Whether increased bottom time causes bone necrosis is still open to speculation. But Edmonds worries about bone necrosis in computer divers who have been inadequately decompressed.

"We'll see about this in a few years," he says.

Ben Davison

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# **The Good, the Bad, and the Just Plain Ugly**

## ***Readers report on dive destinations near and far***

Reader reports are in for the '97 edition of the *Travelin' Divers' Chapbook*. It's new, it's improved, and it's bigger than ever. Just as soon as I dot all the i's and cross all the t's on 300 more pages, it will be mailed; you'll probably get it after Thanksgiving. Here's most of the bad and the ugly. Next time you'll see more of the good.

Kathy Sours (Peoria, Illinois) was not pleased with **Cha Cha Cha Dive Shop on Cozumel** (November 1995). It could have been because her "divemaster was

forever preaching safety, but underwater, when he wanted you to move over, he would grab and jerk you quite suddenly. Once he grabbed my hand away and my mouthpiece went sailing off." Or it could have been because "he took another diver's arm and pushed it under an overhang of coral. Unfortunately, a spotted eel was under there and it bit her. Back on the boat he offered no first aid or apology." Maybe it was just because "when filling out our logbooks, Edmundo would sometimes refuse to tell us the

names of the reefs." I guess some divers are just hard to please. (011-52-987-2-23-31)

Lesley Hand (Lafayette, California) also thought he should have gotten an apology when he was diving from **Galapagos Aggressor** in November 1995 and one of the inflatable operators ran over him in the water: "Never received an apology nor an explanation." To add to the insult, he had "reserved a camera with multiple lenses and a close-up kit in advance, but they