Tech Diving Mag

Research - Development - Exploration

Doing What Works

No Problem!

Book Review: Great British Shipwrecks

The Physiological Basis of Decompression Tables

Diving Pioneers & Innovators: A Series of In Depth Interviews (John Chatterton)

Issue 10 – March 2013

Contents

Front cover image © René B. Andersen (www.uvgalleri.dk).

Editorial

Welcome to the tenth issue of Tech Diving Mag.

A wealth of information along with some interesting stories are brought together by our generous contributors for this issue: retired NASA researcher Michael Powell (MS, PhD), accomplished diver, instructor trainer and book author Steve Lewis and world renowned industry professional Bret Gilliam. Get to know more about them and read their bio at www.techdivingmag.com/contributors.html.

As you might know, Tech Diving Mag is based on article contribution from the readership. So you're always welcome to drop me a line if you're interested in volunteering an article. One more much appreciated thing is your photos (even without articles)! For submission guidelines, take a look at www.techdivingmag.com/guidelines.html.

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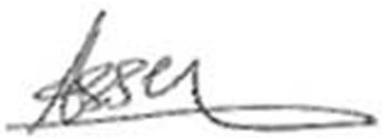


Asser Salama
Editor, Tech Diving Mag

Doing What Works ...

a slightly different philosophy on gear configuration

By Steve Lewis

© Andy Connor

I confess that I am about as far from beinga dive-gear freak as it is possible to be. I do own lots of dive gear and I am lucky enough to be asked to test dive gear on a regular basis. These requests to test-dive kit cover items as diverse as a newly-launched rebreather, a modified design for a dive mask, and lots of stuff in-between; so by definition, and in spite of my indifference to dive gear, I know a little about it. I am certainly not a Luddite when it comes innovations and new ideas or technologies; so distrust of change is not an issue. What may be a factor is that I reserve my love of things inanimate for guitars, hand-crafted boats, and sports cars. Those things I can look at and drool over for hours. They are the pinnacle of art and industrial design: form is function at its apex. Dive gear not so. A piece of dive kit is just a tool that helps me do my job, and while I appreciate good design and a quality-assurance process that helps to add weight to a manufacturer's assertion that a piece of gear is fit for purpose, that's as far as my love affair goes with any piece of dive gear.

Therefore, what follows are at best rough guidelines rather than a definitive "how-to." It begins with an overall philosophy or approach to gear selection, and then shows in some detail, how that philosophy is applied to configuration and use (stowage and deployment). The intention is to show the reader how a team might interpret the gear configuration guidelines for use with their kit and in their conditions.

Although this is not a definitive study, our hope is that this article and the next will help you; and that your personal quest to discover what works and what does not, is a short and thoroughly enjoyable journey.

Common Principals: Hogarthian meets Doing What Works DW2

Cave diver and reluctant gear guru, Bill Hogarth Main, is not some fictional figure created to frighten the meek into conformity. He is just a guy who has been cave diving for a good while and, as far as I know, he still guides at a couple of select caves in North Florida: the area of the USA where he makes his home.

Hogarthian Gear Configuration is named after Bill because it is based on the minimalist approach to kitting up that he popularized among cave divers before cave diving and technical diving came out of the closet. Because of this approach, Hogarthian has been referred to as the Zen of Cave Diving. Not a bad definition really since the Alpinist Way or Minimalist Approach to any active, high-stress, high-risk sport is commonly linked to the mindless-in-the-moment alpha awareness that Zen practitioners promote.

In the years since the Hogarthian concept was introduced to the wider diving community, the principles, which in the original form were VERY straightforward and abundantly clear, have been distorted and applied to concepts that have, to some of us, strayed from admirably sensible to whacked-out and weird.

With his tongue firmly in-cheek, cave explorer Larry Green coined the phrase "Doing What Works" or DW^2 some 20 years after the original Hogarthian concept hit the streets. He intended DW^2 to describe a slightly updated look at kit configuration which stuck closely to Hogarth's main tenets; including its most important: **Constant focus on improving the system, because nothing is perfect.**

Before we continue, let's expand each of the main points of Hogathian approach through the DW^2 lens to be sure we have a grasp of the whole concept.

SIMPLE: nothing convoluted or contrived, and if something can be shaved off, filed down, or trimmed off, it is done. An example of simple might be a piece of kit that can be fixed properly with stuff available from a hardware store. (This was explained to me when discussing the pros and cons of the technology available for cave lights with Bill Main and Lamar English when I had hair, but the idea remains sound.)

Simple also means that a diver resists any temptation to buy 'add-on' gadgets that over complicate or compromise clean design without adding function. Obviously, you can buy whatever appeals to you, but the suggestion in this approach is that you avoid fussy solutions to problems that don't exist and that may introduce more potential for failure. For example, the scuba gadget equivalent of a retractable dog leash is an over-complicated solution to the need to clip a piece of kit like an SPG to a diver's harness. A bolt snap does the trick with less cost, takes up less real-estate, and provides a very serviceable solution with far less complication.

SERVICED: it should be pretty easy to get this one straight. Nothing goes into the water that is not in working order.For basic life-support gear – stuff that delivers gas – serviced means gear that is checked out and serviced by a qualified technician according to guidelines published by the manufacturer, following at least the service schedule suggested by that manufacturer. It also means that every piece of kit has its function fully tested before it is taken into the water. So, regulators should be breathed from, valves opened and closed (and opened again where appropriate), hoses and hose connections inspected for wear and tear (and replaced if showing signs of age or abuse), Schrader valves inspected and tested, seals and straps inspected and stress-tested, primary and back-up lights checked for adequate charge, and so on.

STANDARD: means that you and the other members of your dive team have agreed on the appropriate way to plan and execute your dive. Standard when it applies to kit, enables each and all team members to provide rapid help with a full understanding of what to do if something hits the fan during a dive. The guideline to standardize broadly applied, covers the attitude and mental approach of team members to the operational niceties (and limits) of the team itself and theequipment it will be using on their dive.

It would be easy to interpret this guideline naively and mandate brand specific, even color specific elements of kit to team members for every dive in all conditions, and ignore innovation, new options and better solutions. This is not, in my opinion, in the spirit of the original concept and certainly not DW^2. While it might be simple and less bother to suggest that everyone follows the leader no questions asked, this approach is from optimal, and certainly does not encourage questions or allow for innovation. If the technical diving community has learned anything during the past 20 years or so, it is surely that the process of gear design, gear selection and gear configuration is one of evolution – triggered perhaps by small revolutions, but essentially a constantly developing slow progression of ideas and methods based on best practice. And best practice is by definition and application, anything but static.

In part, this is perhaps why the definition of Standard in the context of a Hogathian or DW^2 approach is the most fluid and difficult to pin down. For example, as I write this, it seems to me that the ubiquitous canister light – the "standard" primary light for technical and cave divers for a generation – is outdated technology with too many potential failure points to warrant its use on critical dives. Several handheld lights are less bulky than the current standard, have no chord to manage, have fewer failure points, are just as powerful and have workable burn times compared to canister lights that retail at more than twice their price.

SHARED: means that in essence, your buddy has your six-o'clock (your backside if you are unfamiliar with analog time-pieces). This principle can be applied to most of what is taken into the water and certainly ALL of what is essential, but the FUNDEMENTAL thing shared is GAS. Tech divers follow gas rules that dictate that a portion of the gas in YOUR tanks belongs to your buddy.

This concept is at the core of team diving and technical diving especially. Here's the basic rule: As technical divers on open-circuit equipment, we are conditioned from our earliest technical training onward to carrying extra gas – one-third of our starting volume is for our buddy, and half of the deco gas we have with us, is for sharing with our buddy in an emergency. These rules are sacrosanct: no reasonable dive plan would suggest compromising the margin of safety offered by these basic gas management guidelines. And they extend to closed-circuit gas planning too. CCR divers routinely carry gas which, in the case of a serious malfunction, use for themselves or shared with a buddy.

And the shared philosophy extends to other things beside gas. Perhaps the most important and most often ignored and overlooked is that we share the responsibility to plan our dives! In addition, we share the work of carrying additional gear needed on dives, and we share the role of mother hen while looking out for the well-being and safe return of our fellow team members. Shared is simply a basic and fundamental necessity in this type of diving.

SUITABLE: if a piece of kit was never intended or designed to cope with the dive environment, resist the urge to force the issue. Pushing the functional envelope of a piece of kit is what test divers are paid to do; and then only in controlled conditions.

It needs to be pointed out that when a diver does a "suitability-check" it should be applied critically to every component of his or her kit. A common mistake and one that opens a diver up to potentially serious grief is only to analyze the life-support systems and gas choices. Of course these are important: will this regulator perform at depth; is this the right mix for this dive; is there enough life left in the scrubber to keep me safe if something happens and I have to spend longer in the water than planned. However, checking for suitability means a little more.

Let me give you an example. When I dive CCR, at least one of my bailout bottle is connected through the unit's manifold directly into the system that feeds my OCB (Open-Circuit Bailout).

In one analysis, this bottle does not need to be fitted with a traditional second-stage. However, because I dive as part of a team, I have to consider the potential of sharing gas with a buddy and handing him or her that bottle at some point on the way back to fresh air. Until recently, I had a short hose (about 60 cm or 24 inches) on that second stage. Doing drills with students, it was apparent that that length hose was inconveniently short. It was in essence, unsuitable.

In the final push, when there are doubts about the suitability of a particular piece of kit for a dive, the best action is to replace it with something that is known to work: a longer hose, a better first-stage, warmer thermal togs, a hood that fits, no matter what.

STREAMLINED: now this particular suggestion should come as no surprise to anyone who has read any book on technical diving. Short version: do not look like a Christmas tree, so tuck away or completely get rid of things that dangle. Aim for minimal resistance when swimming. (I was once called on this score by Bill Main for wearing a drysuit to go cave diving. But when you think about streamlining in the fullest sense, a baggy, telescopic drysuit does have the potential to create drag in a medium800 times denser than air.)

Streamlined equipment is important as well in helping to keep stress and task-loading levels low. In a way, streamlining goes hand-in-hand with suitable, shared and simple: if it's possible to leave it behind do so. From time-to-time I have had students ask if they can bring a camera with them on training dives. With the advent of tiny digital models such as Go-Pro, the default answer (No) is under review… depending on the dive.

At some point, the definition Hogarthian got high-jacked because people started to apply it to kit choices and configurations that were many zip-codes away from what started out as a good idea. Hence the birth of DW^2.

A final thought before we move on to some specifics. There is certainly nothing wrong with progress, and smart innovations in industrial design, electronic engineering, and materials manufacturing have made fools out of many of us who said: "I'll never do that!" But I am not sure that moving away from the six basics guidelines that originally defined Hogarthian Configuration, and that now form the basis of DW^2, constitutes good thinking or best practice. So let's tow the line until something better comes along.

This article is based on a Chapter from Steve's new book on deep diving due for publication this summer.

No Problem!

By Bret Gilliam

There are certain people that you instinctively know are in control of situations. Some may be natural born pilots who could land a washing machine on a trash can lid; the ship captain who could bring in a cargo when the rest of the fleet hid in port from the storm. Maybe the engine mechanic who gets the island's generator going again with a handful of mismatched Volvo parts, three hair pins, and part of Kate Moss's Wonder Bra for a fan belt. Or the guy who survived for sixteen days in a life raft with nothing but a soggy Twinkie, two rusted fish hooks, half a Grateful Dead concert ticket, and four ounces of three-day old Bong water from a 1960's vintage hash pipe.

Yeah, these are the characters that you jump up behind and follow out of the burning movie theater without even considering another exit. Or you simply take their advice without argument as they casually say, "don't eat the purple berries," when you're a couple hundred miles up the Amazon basin. Because beyond all doubt, they've got the "right stuff" and the only stuff you've got is still stuck to the bottom of your hiking boots.

I knew a guy like that named Dave Coston. He was about thirty-five when I first met him in 1971 and, of course, it amazed me that he could still walk upright unassisted at such an advanced age… much less stand the rigors of professional diving. My perspective, honed from accumulating twenty-one birthdays of my own, left me convinced on my own absolute immortality and Dave spent the next five years or so showing me how idiots like myself could survive extraordinary circumstances in spite of our immaturity.

St. Croix in the early 1970's was gold mine for a guy like Dave who could do just about anything and do it well. He'd dabbled in construction, electrical engineering, landscape architecture, heavy equipment operation, and finally settled on diving as means of combining his hobby with a career that was suitably swashbuckling but would still allow him membership in the local yacht club.

Dave wasn't an imposing figure physically. He probably topped out at 150 pounds or so including his faded Greek fisherman's cap. His hair and neatly trimmed beard had gone prematurely white so he sort of had a look that conjured up an image of your grandfather who just finished an "Iron Man" contest.

He was a man of few words and did not suffer fools gladly. Those of us who knew him well had learned to listen precisely to what he said and then do exactly as bidden. Otherwise we had discovered that the barge septic tank emptied a ton of effluent on top of you or a blast of compressed air removed all body hair and several outer layers of skin when you turned the valve the wrong way. Then he'd smile wryly and inquire what you hadn't understood about his original instructions. You learned quickly around Dave Coston. Actually that seemed like the key to survival and whatever retirement plan we might hope for.

But he would never ask anyone to do something that he wouldn't do himself. He led by example and his eager disciples fell in line behind him just glad for the opportunity to learn from the master.

All of us knew how to dive; hell, that's what we did for a living. But Dave taught us the skills to be valuable underwater craftsmen and to think through a problem and apply the easiest way to a solution instead just getting a bigger hammer and pounding harder.

And in spite of the fact that what we did was inherently dangerous, he always emphasized how to best apply safety procedures and made us map out elaborate contingency plans for whatever project we took on. His vision would save us all from losing various body parts to underwater pneumatic tools, being sucked into high pressure water intakes, chopped up in dredges, or blown up in our TNT charges. It would also teach us to save his life.

Coston with world record Oceanic Whitetip shark, 1972

In July of 1971, Dave had a contract involving over a hundred divers working on lowering the ship channel approach to Hess Oil's plant from a controlling depth of 45 feet to 60 feet. This involved one hell of a lot of explosives, several large tugs and half dozen giant dredge barges to remove the aftermath of our little demolition exercises.

By the end of the first week visibility along the island's south shore was about twelve inches and pretty much everything underwater was done by touch and feel. It was no place for the claustrophobic. In fact, it helped a lot to stay sort of perpetually wired and not think too much about the hazards.

One day a barge capsized and spilled a load of four-foot diameter pipe all over the sandy bottom. It was days before we were able to sling these monsters and get them raised again. Shortly after that we resumed our systematic blasting. Our standard drill at the end of each day was a diver sweep of the blast area to see if we needed to mark any large debris for separate hoist before the dredges moved in. Since we couldn't see anything due the visibility, the teams would work on buddy lines and measure objects by arm span. If you couldn't reach around something, you sent up a float buoy and another team would come down and sling the boulder or whatever and haul it away.

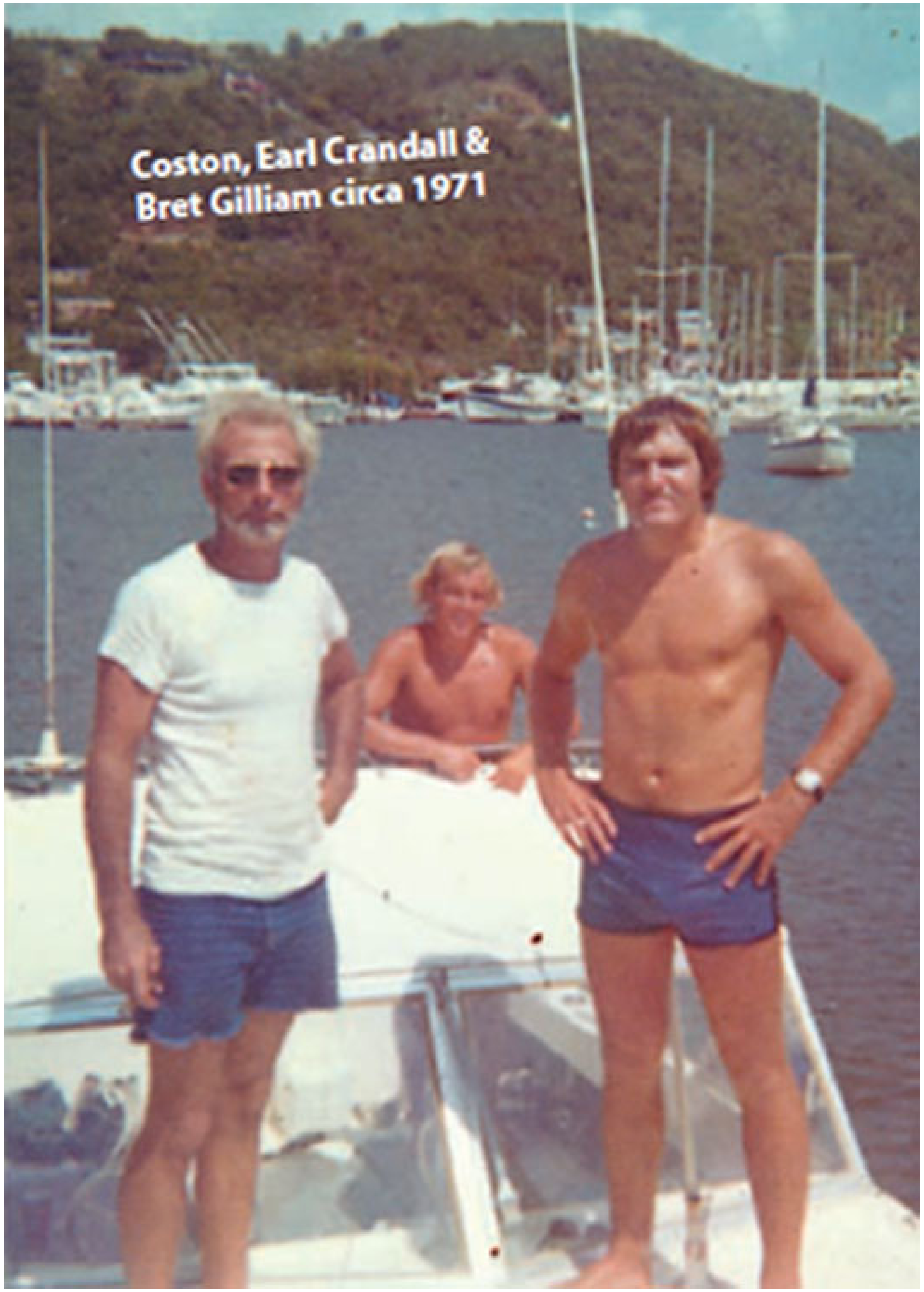
Late one afternoon around 4:30, Dave was swimming the end of a sweep line when he slammed into a large object. Examining it by feel, he quickly determined that it was one of the big dredge pipes that had fallen overboard earlier and not been found. Since these things were nearly a hundred feet long he deployed a float from one end and began to swim to the other end. When he arrived at the pipe opening he fanned the sand from underneath to pass a loop around for his other float buoy.

But while he had his hand under the pipe, another energetic crew had rigged a sling on the other end and had the dredge begin lifting. In a split second, his left hand was pinned to the bottom as the other end was raised. It was just enough force to pin his fingers between the flat rock of the sea bottom and the pipe so he couldn't remove them... but not enough to crush them. The dredge crew held the north end of the pipe about three feet off the bottom and waited for the other end to be rigged before finishing the lift. Meanwhile they had unintentionally anchored Dave beneath the south end of some very heavy plumbing.

All efforts to extract his fingers were futile and he was left alone in zero visibility to ponder his options. He knew that all divers were due up by 5:00 PM or his dive supervisors would send out search teams. He was just able to read his pressure gauge, about 1700 psi, and that didn't seem likely to last him long enough until help would get there. And then he'd still have to deal with getting his end of the pipe raised and getting his hand out.

Most of us dove those days in canvas overalls and simple backpacks. Dave had added an early edition floatation vest after getting left offshore one day and bobbing around in the six-foot swell treading water. He quickly sized up the situation and calculated that his tank wouldn't last long enough in fifty feet of water before he drowned.

Necessity being the mother of invention, he decided to employ his vest as a rebreather. He orally inflated the vest and then began breathing from it until the CO2 built up to an uncomfortable level. Then he'd switch back to his regulator, catch his breath with good clean air from the tank, vent the vest, and start the cycle all over again. Over an hour went by. The topside teams were scrambled looking for him to no avail and he was down to less than 300 psi in his cylinder.


Coston, Earl Crandall & Bret Gilliam circa 1971

That's when he decided to amputate his fingers with his knife. He had thought it all through and knew he needed to start the cuts in advance so he could get a good clean break through the bones at the last moment. It took him another few minutes to work his small utility knife over his fingers and begin the first incisions. He wanted to use his heavy dive knife to break the bones and paused to reach back to position it for the final plunge. A quick look at his gauge confirmed he was down to about 100 psi. Time was up. He lay quietly to catch his breath and hoped he wouldn't pass out from the pain that was about to come.

As he reached in to drive the knife blade down with all his force, he felt the shaft poke something soft and a corresponding grunt of surprise and outrage. He'd jammed his knife right into the shoulder of sweep diver, Ralph Yula, reaching around the pipe end.

We'd finally figured that Dave had to be somewhere along that submerged pipe after finding his buoy at the other end. But it took nearly twenty minutes of careful search to find him. Ralph began buddy breathing with Dave and deployed his own float. Three of us dropped in on them within two minutes and lifted the pipe off Dave's hand.

He calmly pulled his fingers free, holstered his knives and swam slowly to the surface in the remaining twilight. As he related the story to us on the boat, we listened in fascinated horror. Finally someone asked, "Do you really think you could have cut off your fingers and not passed out?"

"No problem," Dave replied. "Remember, I didn't have to do the thumb. That would have been a difficult angle. Yeah, if I had to do the thumb I'd have *really* been in trouble."

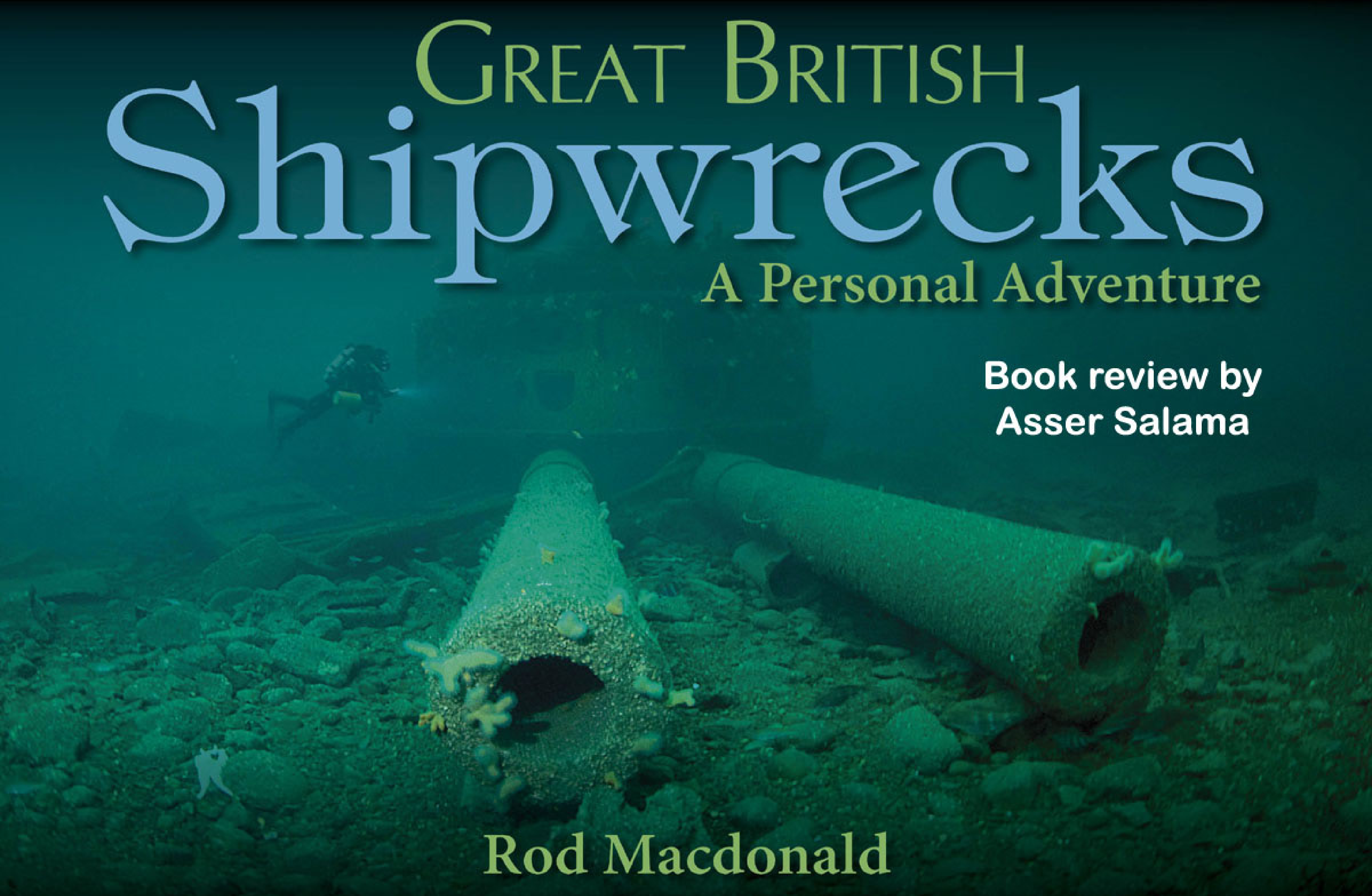
Ten minutes later with his wounds patched up with duct tape and caulking cotton, he stood on the dive platform and directed the team "to get that goddamn pipe out my ship channel!"

On the ride back in, Dave lit one his favorite "Rum-soaked Crooks" cigars and honed his knife blade on a whetstone. His accompanying lecture on the best method to effect a clean bone break was greeted by several group "hurls" over the lee rail. But the teacher had our undivided attention.


Dave Coston

GREAT BRITISH Shipwrecks
A Personal Adventure

Book review by Asser Salama



Rod Macdonald

Whether it's through documentaries or books, I always find shipwrecks, their history and stories interesting and informative topics. *Great British Shipwrecks*, the latest publication from internationally acclaimed wreck diver Rod Macdonald, is one more fascinating, easy-going read that comes with sketches and well-shot pictures.

Thirty seven of the greatest and most famous wrecks lying in British waters –some within the normal sports diving limits and some need "technical" experience– are described in detail, including the story of the final voyage and the circumstances of the eventual sinking. *Great British Shipwrecks* covers battleships, submarines, ocean liners, along with different equipment, machinery and cargo including Bayern 15-inch gun turrets and Sherman tanks. The wrecks are mainly located at Scapa Flow in the Orkney Islands, in the North Channel in the Irish Sea between Scotland and Northern Ireland, and all the way to Scotland and the North Sea.

One of the main attention-grabbers of *Great British Shipwrecks* is the quality of illustrations; really good job done by marine artist Rob Ward. This comes hand in hand with its landscape A4 format, which allows better display for bigger pictures and illustrations. Good choice!

To the contraire of Rod's former book *The Darkness Below*, except for the "dive guide" section on each wreck, *Great British Shipwrecks* does not include diving technicalities, which makes it a book for everyone interested in wrecks and their history. The book is a coffee table read that even non-divers will enjoy.

Rod's descriptive way of writing answers the reader's questions. If you're a diver, you'll be able to know exactly what to expect. And since Rod's approach to locating and identifying wrecks is that immaculate, I recommend that he considers filming a "wreck detective" series of documentaries.

***Great British Shipwrecks* comes in 160 pages and is published in softback by Whittles Publishing. It is available for £18.99 excluding P&P at:**
www.whittlespublishing.com/Great_British_Shipwrecks

This book is also available in North America from NBN Books at: www.nbnbooks.com

The Physiological Basis of Decompression Tables

By Michael Powell

The tables displayed in this page are for illustration purpose only. Do NOT use them for actual dive planning.

Depth (m)	Depth (ft)											
12	40	→	5	15	25	30	40	50	70	80	100	110	130
15	50	→		10	15	25	30	40	50	60	70	80	
18	60	→		10	15	20	25	30	40	50	55		
21	70	→		5	10	15	20	30	35	40	45		
24	80	→		5	10	15	20	25	30	35			
27	90	→		5	10	12	15	20	25				
30	100	→		5	7	10	15	20	22				
33	110	→			5	10	13	15					
36	120	→			5	10	12						
40	130	→			5	8							
			A ↓	B ↓	C ↓	D ↓	E ↓	F ↓	G ↓	H ↓	I ↓	J ↓	K ↓

NEW GROUP	A	B	C	D	E	F	G	H	I	J	K
← A ←	24:00 / 0:10	24:00 / 3:21	24:00 / 4:51	24:00 / 5:52	24:00 / 6:35	24:00 / 7:06	24:00 / 7:36	24:00 / 8:00	24:00 / 8:22	24:00 / 8:51	24:00 / 8:59
← B ←		3:20 / 0:10	4:50 / 1:40	5:51 / 2:40	6:34 / 3:25	7:05 / 3:58	7:35 / 4:26	7:59 / 4:50	8:21 / 5:13	8:50 / 5:41	8:58 / 5:49
← C ←			1:39 / 0:10	2:39 / 1:10	3:24 / 1:58	3:57 / 2:29	4:26 / 2:59	4:49 / 3:21	5:12 / 3:44	5:40 / 4:03	5:48 / 4:20
← D ←				1:09 / 0:10	1:57 / 0:55	2:28 / 1:30	2:58 / 2:00	3:20 / 2:24	3:43 / 2:45	4:02 / 3:05	4:19 / 3:22
← E ←					0:54 / 0:10	1:29 / 0:46	1:59 / 1:16	2:23 / 1:42	2:44 / 2:03	3:04 / 2:21	3:21 / 2:39
← F ←						0:45 / 0:10	1:15 / 0:41	1:41 / 1:07	2:02 / 1:30	2:20 / 1:48	2:38 / 2:04
← G ←							0:40 / 0:10	1:06 / 0:37	1:29 / 1:00	1:47 / 1:20	2:03 / 1:36
← H ←								0:36 / 0:10	0:59 / 0:34	1:19 / 0:55	1:35 / 1:12
← I ←									0:33 / 0:10	0:54 / 0:32	1:11 / 0:50
← J ←										0:31 / 0:10	0:49 / 0:29
← K ←											0:28 / 0:10

Group	12 / 40	15 / 50	18 / 60	21 / 70	24 / 80	27 / 90	30 / 100	33 / 110	36 / 120	40 / 130
A	7 / 123	6 / 74	5 / 50	4 / 41	4 / 31	3 / 22	3 / 19	3 / 12	3 / 9	3 / 5
B	17 / 113	13 / 67	11 / 44	9 / 36	8 / 27	7 / 18	7 / 15	6 / 9	6 / 6	6
C	25 / 105	21 / 59	17 / 38	15 / 30	13 / 22	11 / 14	10 / 12	10 / 5	9	8
D	37 / 93	29 / 51	24 / 31	20 / 25	18 / 17	16 / 9	14 / 8	13	12	11
E	49 / 81	38 / 42	30 / 26	26 / 19	23 / 12	20 / 5	18 / 4	18	15	13
F	61 / 69	47 / 33	36 / 19	31 / 14	28 / 7	24	22	20	18	16
G	73 / 57	56 / 24	44 / 11	37 / 8	32	29	26	24	21	19
H	87 / 43	66 / 14	52	43	38	33	30	27	25	22
I	101 / 29	78 / 4	61	50	43	38	34	31	28	25
J	116 / 14	87	70	57	48	43	38			
K	138	99	79	64	54	47				

00 RESIDUAL NITROGEN TIME IN MINUTES.
00 MAXIMUM DIVE TIME IN MINUTES. REPETITIVE DIVE TIME SHOULD NOT EXCEED THIS NUMBER.
00:00 Hours:minutes format.

"TEXAS SHARPSHOOTING"
It is easier to predict events in the general population than an event in a specific individual. That is why insurance companies make more money than fortunetellers do.

Almost all tables today are based on the method initially developed by the English physician and physiologist John Scot Haldane in 1908. This article will explore what is involved in his procedure and how it applies to the recreational SCUBA diver. Most importantly, the article will discuss problems to be avoided in the use of tables.

Before I came to live in Houston and work for NASA at the Johnson Space Center, I had never heard of the term "Texas sharpshooting." It involves a way of producing a remarkable set of shots all of which fall within the bull's eye. What is done is to hold the gun steady, say braced against a fence, and shoot at a barn some distance away. Pulling off several shots will put them in a tight pattern. One then draws a small circle around the shots and then a series of widening circles. The whole thing looks like a target with an amazing set of bull's eye shots. Well, it is a trick, of course.

Now, what has this to do with dive tables? The tables give very good predictions, and it seems as though there is great science underlying everything and considerable accuracy. Actually, the table designer has a whole set of dives, both safe and unsafe, and the final table limits are set such that the table corresponds to the correct answer – known, of course, in advance. There are really no predictions. It is Texas sharpshooting. Tables that are more modern do have some scientific underpinnings.

Tables have very scientific-sounding parts such as critical supersaturations and halftimes. Not all of these are completely real. There are times when it is necessary to recognize that a very workable *mathematical model* is does not necessarily correspond to *physical reality*. The "spin" of electrons and "wave-particle duality" of light [the simultaneous wave and particle nature of light] are two examples of conflicting models; both are right and both wrong – it depends on circumstances. In a similar fashion, the decompression algorithm [calculation method] devised by J. S. Haldane uses many different "tissues" to describe the uptake and elimination of dissolved nitrogen from the body. It is increasingly difficult to view these "tissues" as actual anatomic locations notwithstanding considerable attempts in the past by researchers to do so.

BECAUSE DECOMPRESSION TABLES CONTAIN EXACT NUMBERS, THEY GIVE THE APPEARANCE OF A *STRONG THEORETICAL* BASIS AND THE IMPRESSION OF PRECISION THAT DOES NOT REALLY EXIST.

TISSUE HALFTIMES

Haldane introduced into diving physiology the major components found in the calculation methods for diving tables today. These were:

(1) The idea of gas uptake and elimination *halftimes,* and

(2) The concept of *sustainable supersaturation* as a method of ascending to the surface while at the same time avoiding bubble formation and the "bends."

The "Point Most Difficult to Obtain" - Tissue Halftimes

When the Royal Navy required deeper diving tables, they turned to their consultant Dr. John S. Haldane to tackle the problem. Haldane was a specialist in environmental medicine and worked on poisons gases in coal mines, heat stroke, and now deep diving.

From his studies of blood circulation, Haldane was aware that after 13 rounds of blood, the body should be 1/2 saturated, approximately equal to 10 minutes. Complete saturation would occur in about 1 hour. Based on circulation, after one hour at a given depth, the decompression obligation would not change. He was also aware that blood flow was not equal to all parts of the diver's body. This one-hour duration for saturation time was much too small as was known at that time from diving and compressed air [tunnel] experience. From the knowledge that blood flow definitely varied from tissue to tissue, Haldane logically proposed that **different blood flows** resulted in **varying rates of gas uptake and elimination, and saturation**. **Saturation** was much longer than the earlier, simple estimates.

The longer the workmen remain in the caissons, the more slowly they should undergo decompression, for they must allow not only time for the nitrogen of the blood to escape, but also allow the nitrogen of the tissue time to pass into the blood....this last point is the most difficult to obtain...

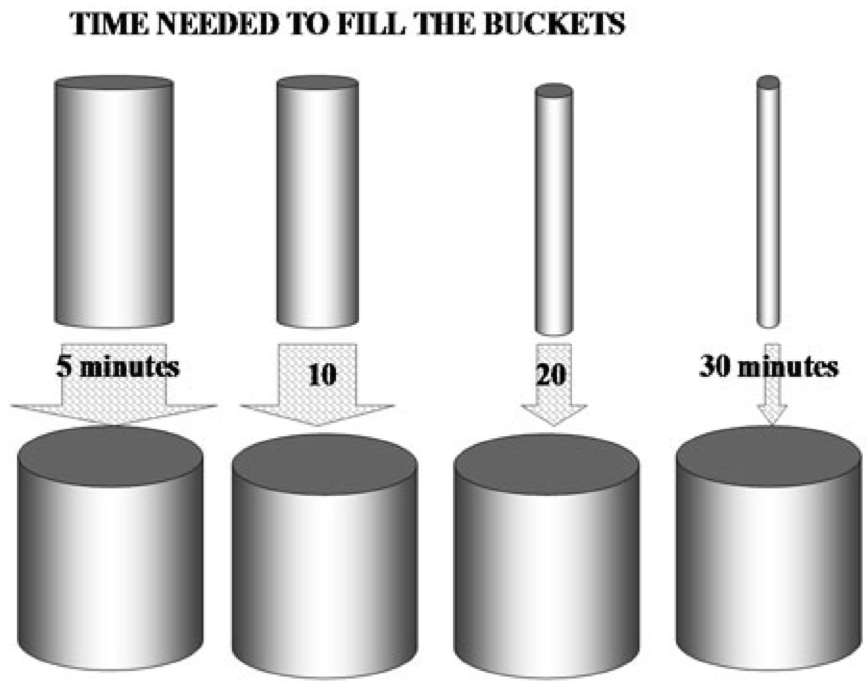
- Paul Bert, *Barometric Pressure*, 1878.

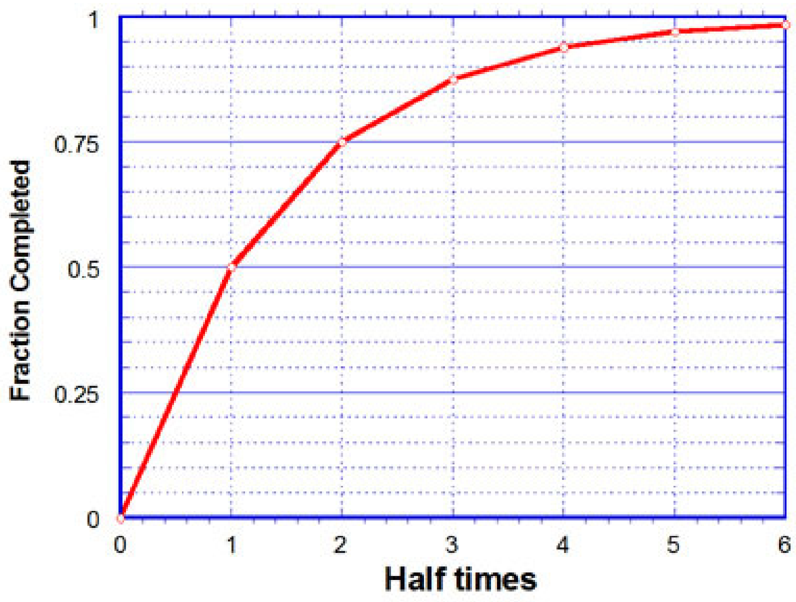
A system of ***half times*** was used by Haldane to allow calculation of the dissolved nitrogen content is tissues; this would give him a method to determine the "point most difficult to obtain." Half times are common enough in our vocabulary; we know about them in a quite general way with regard to isotopes and radioactive decay (where they are often referred to as an isotope "half-life").

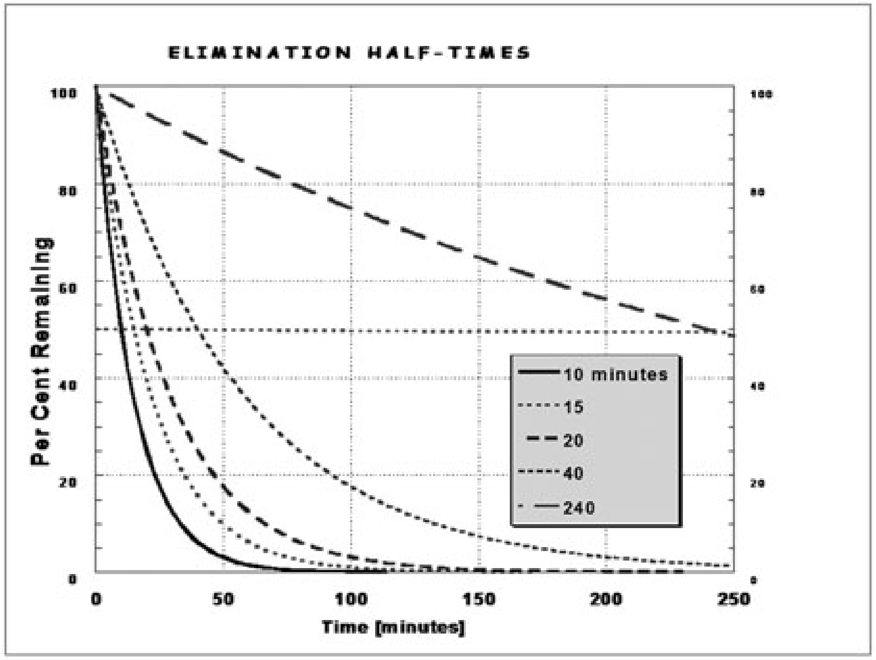
Halftimes and Tissue Gas Uptake and Elimination

This halftime concept was utilized by Haldane to visualize the process by which the dissolved nitrogen was added or removed from the tissues by the blood. Haldane assumed that dissolved nitrogen was exchanged in living tissue by the simple mechanism of blood flowing through capillaries and dissolved nitrogen moving into and out of the tissue. The figure shows pipes [blood flow] filling buckets [representing tissues]. Clearly, larger blood flows fill the tissues more quickly. Additionally, the buckets can be of different volumes again changing the filling times.

This is basically the concept used today. The rate at which the dissolved nitrogen was removed was postulated to depend on the amount of blood flow, that is, so much blood per minute through a given volume of tissue. The dissolved nitrogen is carried by the blood to the tissues that act as a "sponge." Blood transport is then the limiting step for all tissues. [This is not true for the very fast tissues, but we will not get into that in this article. There is some degree of diffusion limitation.] The figure shows the nitrogen absorbed for each elapsed halftime. After about six halftimes, the tissue is virtually saturated. Nitrogen elimination is the mirror image of uptake – assuming all of the nitrogen is dissolved. Any nitrogen in bubbles would be eliminated very slowly. There are some who believe that the "compartments" might actually be small portions of a tissue. Thus, muscle tissue is not homogeneous but rather has muscle fibers, connective, and fat tissue.







Halftimes are selected to produce a spectrum of gas exchange constants that will produce a good table. More halftimes do not give better tables, but rather only make tables with stop times that are in fractions of a minute.

Some tissues have a better blood supply (e.g. muscle) than do others (tendon, for example). It must be admitted that the exact physiological and anatomical meaning of the halftimes as applied to decompression at the tissue level is not clear. A different anatomical correlate for each individual halftime "tissue" is not necessarily implied, although many divers think of it as such. **However, decompression tables are *calculated based on joint-pain DCS* and the halftimes relate to something producing this problem. Quite probably, that "something" is nerves in connective tissue for "bends" pain; no one knows for certain**. ***Halftimes*** are just a bookkeeping system.

The halftimes chosen by J. S. Haldane were 5, 10, 20, 40 and 75 minutes and were selected to handle the extremes of diving known at that time (1908), and the results of his experiments done with goats. Over the decades, as dive depths increased with improved technology and the time required for decompression increased, it has been found necessary to extend the halftimes to as much as 600 minutes. Again, this is a calculation scheme only. I personally believe, as do a few others, that long halftimes are the result of a free-gas phase, i.e., bubbles present in the tissue. A tissue with such a limited blood flow to create such a long a halftime would not have a reasonable blood supply and oxygen to be viable.

Variable Halftimes

Many tissues do ***not*** have a constant blood supply; muscle is highly variable and the brain and spinal cord are unvarying. Blood flow is often dependent on metabolic need, and capillary density could be increased with activity, that is, more capillaries could be opened. This variability is *not* built into tables. ***This is a very important concept, and divers must realize this***.

A tissue that is actively exercising will have a very large blood supply. A diver swimming against a current underwater will require oxygen for the muscles and the blood supply will be increased. The halftimes in the calculation method, however, do not change. Let us say that the table designer used faster halftimes of 5, 10, 15 and 20 minutes for the table. Because of the musculoskeletal activity, the halftimes should be *modulated* or shifted to, for example, 3, 7, 12, and 15 minutes. This will model the increased blood flow and the increased loading of nitrogen into the tissue. The *correct* model [I believe] for this *active diver* would show that more dissolved nitrogen is present in the tissues than indicated in the initial model. We do not have models that "modulate" or "slide" and modify the nitrogen uptake and elimination based on activity. [My often-discussed, mythical deco meter, the *"Bends Buster"* would have a sliding scale based – probably - on heart rate, but such device does not yet really exist.]

Just as exercise during the bottom phase can boost nitrogen uptake, rest while off gassing during the surface interval can reduce the elimination rate. Sleeping during the inter-dive surface interval is a bad idea as this significantly reduces the blood flow. In addition, if DCS problems arise while you are asleep, they will not be noted, and helpful measures such as oxygen breathing would be missed.

Divers should not sleep between dives, as tissue perfusion would be at its lowest. Nitrogen washout would be at a low rate, and tissue dissolved inert gas will be underestimated by the algorithm whether it is a table or a decompression meter.

In the calculation of decompression tables using Haldane's method, the "tissue" halftimes are considered separate and unchangeable. This, however, is not to say that Haldane did not recognize that you can give the system a little boost.

…it seems desirable that where work has been done in compressed air, so that the muscles and associated tissues have become rapidly saturated with nitrogen, there should also be muscular exertion during decompression. The rate of desaturation will thus be increased so as to compensate for its increased rate of saturation.

- J. S. Haldane, "The prevention of compressed-air illness. " *J. Hygiene Camb. 1908 p.354*

A practical application of this exercise augmentation of nitrogen washout was investigated by the US Air Force and NASA for their prebreathe procedures. Nitrogen elimination at an increased rate would considerably reduce instances of DCS during extravehicular activity [EVA]. Increased cardiac output and blood flow to active muscles are major effects of exercise. Evidence from laboratory tests funded by NASA suggests that exercise during oxygen prebreathe increases perfusion of skeletal muscle tissue and connective tissue and reduces the incidence of joint-pain DCS. It is hypothesized this is the result of an increased rate of nitrogen elimination.

Now, if you wish to increase nitrogen washout, musculoskeletal activity is a wonderfully effective method. You might say to yourself, "What if I was exercising while in the uptake phase of the dive (bottom portion) and very sedentary in the washout portion (topside portion)." The worst-case scenario is when divers are fighting a current while below and, finally reach the surface, and they "crash" exhausted on the boat. Clearly, you can see where this is going. Were it not for the very liberal limits used by table designers, divers could often have problems with decompression sickness.

The Haldane halftime method uses constants that are fixed, and do not change with the diver's activity level. This can result in decompression sickness that would not be expected. Recognizing that your activity level will greatly influence tissue nitrogen exchange will help you to increase your chances for a safe dive conclusion.

The Haldane system is successful because a "big target" is allowed. The diver stays a long distance – concentration wise – from a DCS problem. [That is why there are large safety margins in dive tables and NDLs.]

With microbubbles present, and fluctuating blood perfusion, there is no possible way that dissolved nitrogen could be described in any but a few simple situations. To make the system work, large *safety margins* must be built in. These margins come from the no-decompression limits. This is another part of the Haldane system, and we will look at that next.

ALLOWABLE SUPERSATURATION

Haldane was well aware that divers could surface directly without any decompression stops if the time at bottom was limited. Haldane needed to know what the maximum allowable [safe] times were underwater, and we refer to these as the *no-decompression limits* [No-D Limits or NDLs]. He determined the times using goats as experimental subjects and later used Royal Navy divers.

In an earlier article in *Tech Diving Magazine*, I discussed micronuclei and what they do in the body of the diver. For those of you whose memory is no better than mine is, I will give a short recap of what this meant. Microbubbles are needed to explain why enormous pressure changes are not needed to produce decompression bubbles [and DCS]. Liquids are held together by intermolecular forces. In water, these cohesive forces are very big. A pressure change of hundreds of atmospheres would be needed to tear the liquid apart, that is, make a hole or bubble. Clearly, such large pressure changes are not needed

It is a well-known fact that liquids, and especially albuminous liquids such as blood, will hold gas for long periods in a state of supersaturation, provided the supersaturation does not exceed a certain limit. In order to decompress safely it is evidently necessary to prevent this limit being exceeded before the end of decompression.

- J. S. Haldane, "The prevention of compressed-air illness. "*J. Hygiene Camb*.1908

Tissue halftimes and "critical supersaturation" are the two cornerstones of Haldane's method. The body already has many tissue micronuclei present from thermal activity [producing submicron-size bubbles] and physical activity [stress-assisted nucleation producing micron size]. Bubbles cannot expand because of surface tension constricting them unless the partial pressures of the dissolved gases is excessive. This critical size is probably the physical basis of "allowable supersaturation." If there were no tissue nuclei at all, a diver could ascend from miles beneath the surface. Really! Haldane did not know about micronuclei, as the concept had not yet been developed.

No Decompression Limits

It is a fact well known to those practically acquainted with work in compressed air that even with very rapid decompression there is no risk of caisson disease unless the pressure has exceeded a certain amount. It seems perfectly clear that no symptoms occur with less than one atmosphere of excess pressure, however long the exposure may be.

- J. S. Haldane, "The prevention of compressed-air illness. " *J. Hygiene Camb.1908 p.355*

When divers speak of **decompression limits**, they are referring to the restrictions on the duration that one can remain at a given depth without incurring an obligation to pause during ascent at a decompression stop; these are commonly referred to as the **"no-decompression limits" [NDLs] or the "no-stop limits."** These "limits" are often considered by divers in such a way that it is clear they are regarded as **truly fixed** by nature in the same manner as the boiling point of water or the speed of light. At this point, I will let you in on the palace secret; ***there are no true table limits***. Let us see why this is true by observing how researchers have determined the *"no-stop decompression limits"* for a set of exposures.

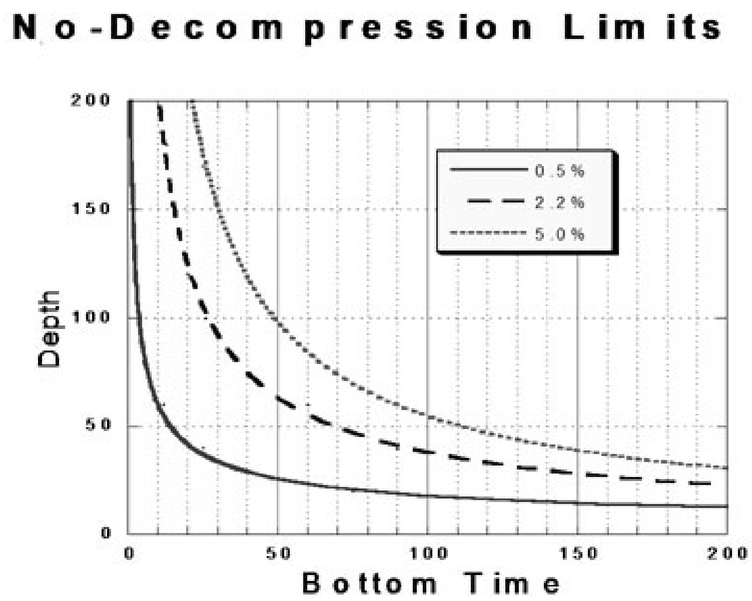
Determining the No-D Limits

We begin by imagining that a research group wishes to determine the maximum time limit for a depth of 60 feet (of seawater). They put out a request for volunteer dive subjects with the goal of recruiting twenty individuals; this, even today, is considered reasonable for one time/depth combination. They begin with a trial bottom time of 90 minutes for this depth and find, let us say that they get joint pain in ten of the twenty subjects for an incidence of DCS of 50%. This is, of course, much too high, so they try again with a bottom time of 85 minutes; this time, they find that again there are problems in eight of twenty individuals. They work their way down in bottom time until they come to no DCS in twenty subjects when the bottom time is 70 minutes. Since they wish to add a degree of safety to their table, they reduce the allowed bottom time at 60 FSW to 60 minutes. The US Navy has one set of limits, PADI another, the British Royal Navy and so forth. All are a bit different depending on the goals of the development team. These could include operating conditions such as rough seas, cold water, etc.

If one had access to 10,000 subjects, one would probably find that possibly two of 10,000 divers would have DCS even at 60 minutes bottom time. When tens of thousands of SCUBA divers are out on any given summer weekend, it is not surprising that a few will have some DCS even if it is very mild. Doppler-detectable bubbles can often be found in recreational SCUBA divers; most likely, there are also cases of subclinical DCS in this same diver population.

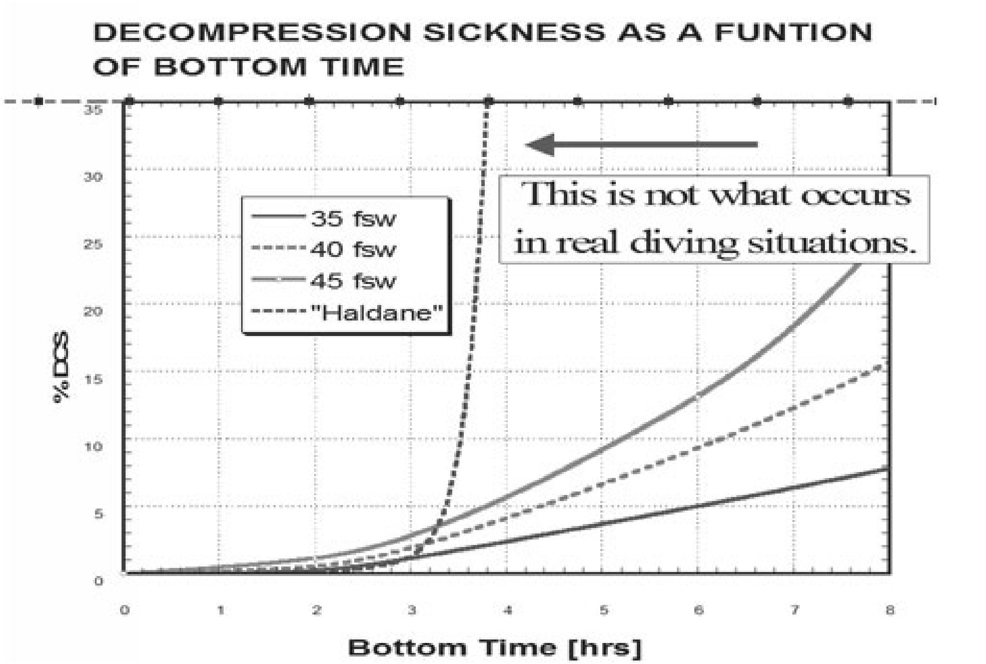
In the graph, we see a representation of no decompression limits with [calculated] incidences of decompression sickness. This means that as the dose of nitrogen is increased, so also is the probability of decompression sickness.

Many divers hold the opinion that there is truly a "bends/no bends limit" in diving. ***The numbers in the tables give the impression of exactness***. Divers, even experienced divers, have been known to reenter the water to "recompress" because they believe they are in extreme danger of DCS since they have slightly exceeded the No-D limits. . They sometimes do this in a hasty, unplanned fashion and death has resulted.



Divers who exceed the table limits for their dive should remain on the boat - and breathe oxygen, if possible. It is never a good idea to reenter the water, often done too hastily, to "complete" the decompression.

In the next graph, we see an example of what many divers believe occurs with DCS and diving. That is, there is a sharp increase in DCS probability when the nitrogen loads increase by a very small amount. They believe that if the bottom time is three hours, the DCS incidence [in this hypothetical example] will be zero. If the bottom time is increased to three hours and twenty minutes, the DCS incidence will shoot up to 35% or greater. Not so. When some divers "push" the limits believing that they are "immune" to DCS; the truth is, they are simply within the normal [statistical] safety limits. There is no skill or magic involved. DCS incidence is not a "step function" where the DCS probability suddenly changes from zero to one hundred percent.



We see divers who believe themselves resistant and go straight from diving to boarding the plane home. These are the "wet hair" divers. Should a diver have a serious case of DCS from this behavior, the plane may need to divert from its course and land to get the diver to treatment. Such has happened, and the diver received a bill for the cost of fuel to facilitate treatment from reckless activity. This is not a way to end a vacation. It is certainly not a cost you wish to incur – nor a planeload of angry fellow passengers!

The Decompression Ratio

Haldane realized to construct actual decompression tables for deeper depths, that is, extensions of no-stop tables, it would be necessary to determine the **relationship between pressure reduction** and **appearance of "the bends."** In experiments with goats he found that the ratio of decompression depths was more important that the absolute magnitude of the difference.

The Limiting or Controlling Compartment

It is a relatively straightforward matter to calculate what partial pressure of nitrogen would be found in each of the "tissues" envisioned by Haldane. Let us see how that all comes together to make a gas loading analysis and a table. We consider a dive to 170 feet for 15 minutes. The dissolved gas accumulates in each "tissue compartment" as can be calculated from the half-times of 5, 10, 20, and 40 minutes. At the conclusion of the 15 minute bottom time, the decompression is performed such that the depth chosen will produce a decompression ratio of 2:1 in the compartment with the most partial pressure, the **limiting "tissue."** In this case, the 5-minute "compartment has the greatest calculated partial pressure of dissolved inert nitrogen. The table designer then allows the diver to ascent such that the ratio of gas pressure in the 5-minute tissue is in a 2:1 ratio with the absolute pressure (in this case, to 50 feet). [*Absolute pressure*, fsw depth plus one atmosphere] is the common coin for all pressure considerations.] Since the diver is shallower, all of the tissues begin to lose gas. [If we had tracked the 120-minute compartment, it would still be gaining gas at the depth of the first stop.]

After a short duration, the 5-minute compartment has lost enough gas that one can again ascend, now to the 40 foot depth. A short time later, the 5-minute "compartment has lost enough dissolved gas that it is no longer "controlling." The limiting compartment is not the 10-minute one, and it controls when the ascent can be made to 30 feet. After almost 35 minutes of dive time, it is the 20-minute compartment that has the greatest dissolved gas pressure, and it now becomes the "controlling" one. It determines when the jump is made to the 10-foot stop. Eventually the 40-minute compartment determines when the ascent can be made to the surface. Computers can do the calculations very quickly, and they have been a boon to table designers. Small decompression computers do the calculations while at depth.

Different Supersaturations for Different Compartments

Robert Workman MD of the US Navy found from experimental trials that different compartments could generally sustain different calculated tissue supersaturations without the manifestation of joint-pain decompression sickness. Haldane's model postulated that "allowable supersaturation ratios" of 2 to 1 would be allowed in *all* "tissues." General thought today proposes that "fast" compartments can sustain higher partial pressures of nitrogen since these pressures are held for only a very short time.

MAXIMUM PRESSURE REDUCTION RATIOS FOR DIFFERENT HALF-TIME COMPARTMENTS

HALF-TIME [MIN]	MAXIMUM NITROGEN PRESSURE	"SURFACING RATIO"
5	104	3.15
10	88	2.67
20	72	2.18
40	56	1.76
80	54	1.58
120	52	1.55

Fortunately, the variations in calculated supersaturation were rather orderly and could be predicted simply. Extrapolations beyond the tested limits are always difficult and frequently do not work if the projections are too large. In the end, one had developed a quite usable **bookkeeping** or **accounting scheme** for the development of tables, but not necessarily one that had a true physiologic basis.

The "tissue compartments" of the Haldane system are (i) not large identifiable anatomical entities, (ii) the uptake and elimination half-times are most assuredly approximations to more complex mathematical functions, and (iii) the "supersaturation limits" are general "limits" were gas phase formation is improbable but not impossible.

Different groups will determine different no-decompression limits that will in turn modify the entire decompression matrix. It is thus evident that there is not a single decompression scheme to bring one to the surface. In actuality, these represent not only differences in the original individuals making the No-D trials, but also differences in ascent rates, differences in allowed risk, variations in the use of oxygen, and so forth. Inter-table comparison is not a straightforward process. Every diver realizes that tables and meters differ to some degree.

Ascent Limits

As we briefly read about micronuclei, these are present in all parts of our body. All bubbles are constricted by surface tension, the Laplace pressure. The gas in a bubble will often have a greater pressure than the dissolved nitrogen in the liquid surrounding it. It is for this reason that bubbles will eventually shrink and dissolve. It is also for this reason that certain "over pressures" must exist in the dissolved nitrogen in the surrounding fluid for a bubble to grow. ***How much "over pressure" is needed is what physically accounts for what appears to be an allowable supersaturation***. You actually can sustain a dissolved nitrogen partial pressure greater than the surrounding, hydrostatic pressure, but it is not because of some "stable supersaturation" or any "critical supersaturation."

Microbubbles come in different sizes. The micronuclei are present in our bodies with different radii *and* different concentrations for each radius. The description is referred to as the *size distribution function*, but the exact size-number distribution in tissues is not known. They must be there or larger bubbles would not be present upon depressurization. I know it sounds like a tautology to say that we know tiny bubbles are present because decompression produces bigger bubbles – but it is not.

Joint Pain and Tissue Half-times

Well, what is left of the Haldane method, you ask? You appear to have picked the bones clean! In reality, the Haldane algorithm, or calculation scheme, is rather successful for generating tables within the boundaries of prior existing decompression knowledge. Where the Haldane system fails is:

1. its rigorous black-or-white concepts of treating decompression sickness as a "yes" or "no" entity [the "limits"],
2. its inability to handle micronuclei, and
3. the non-linear response of the body to DCS and the gas phase.

We have already discussed the fact that DCS does not come in an all-or-none fashion. "Step over the line and you are a goner." In fact, there is truly "subclinical DCS." You can have a very marginal case of "bends" where e.g., your knee hurts, but you are not quite sure. In a sense, it is like a fever. You can have a slight, mild or a high fever that is life threatening, and all temperatures in between.

Another problem is the inability to handle micronuclei. Contemporary two-phase models do attempt treat this problem. These tables create proper deep stops that result in faster ascents and safer dives. What is not yet built into the tables is a treatment of musculoskeletal activity or "work." Whatever nuclei might be present in the diver on the surface are removed when the diver descends and pressure squeezes these into solution; this is essentially automatic. The problem of differences in diver susceptibility to DCS might be the result of differences in nuclei concentration during ascent. Tables do not have any way to account for this. Of course, susceptibility might be caused by something other than nuclei concentrations, but this is still a mystery.

The non-linearity is that positive feedback which results when free gas blocks a capillary and prevents the further elimination of dissolved inert gas. Fast tissues are reduced to slow tissues. Offgassing does not occur at the rate expected and DCS can result.

In addition, we have the disturbing entity called "tissues" that are responsible for certain cases of DCS. As Brian Hills PhD pointed out many years ago, there can be obvious problems with this description. Suppose, for example, that you make a short deep dive and build up too great an overpressure in the 5-minute "tissue"; you could get a pain in the wrist. Or, let us now suppose, that you perform a dive to 50 feet for too long a duration, and get too great a supersaturation in the 20-minute "tissue, and you get a pain, again in the wrist. Again, suppose a saturation dive to 100 feet and a very slow ascent, but an overpressure develops in the 420-minute "tissue," and you get a pain in the wrist. You can see the picture developing here; the wrist cannot be a 5-, 20, and 420-minute "tissue." Certainly, we are discussing a spectrum of **processes** whereby it appears that the gas "loads" and "unloads" into "tissues."

As an additional safeguard, the diver is directed to keep his arms and legs constantly moving during each stoppage, so as to increase the rate of circulation and guard against the chance of the rate of desaturation during his ascent being proportionally less than the rate of saturation during his stay on the bottom while he was doing work.

- J. S. Haldane, The prevention of compressed-air illness. *J. Hygiene Camb.* 1908 p. 367

There were times in the past, more than one hundred years ago, when long halftimes were not considered. In cases where mines were pressurized to hold back the water seepage and prevent flooding, animals such as mules were used to work hauling dirt and rocks. It was found that it was impossible to decompress the animals and get them out of the mines. We know today that the animals were fully saturated; they did not have eight-hour shifts. A decompression [ascent rate] of about four feet per hour would have been necessary. By the time this was known, machines had replaced mules. Prior to this, the animals were shot.

RODGERS OR *DSAT* MODEL

This model is a Haldane-based concept but uses an elimination half time [sixty minutes] for repetitive dives that is are more suited to recreational divers with only a limited amount of gas in their SCUBA tanks. The offgassing halftime for the US Navy tables is based on the 120-minute half time since these are primarily designed for decompression dives with long bottom times. Commercial and military divers are surface supplied and can stay underwater for hours if necessary. Long half time compartments are loaded.

Gas uptake and elimination is tracked for each compartment with decompression (or direct ascent) based on maximum loading of some compartment. What is not commonly recognized is the manner in which repetitive dives are calculated. You might think that the unloading of the compartments could be calculated; the dissolved nitrogen would then be added to the compartments in the succeeding dive, or dives. This is correct in principle but difficult in actual practice. It would be necessary to have some tabular method to add dissolved gases in all compartments immediately prior to the next descent, and this would require many pages bound into an enormous book. The US Navy considered this and decided to proceed with a simpler system. They simply chose to track the off gassing of the 120-minute compartment knowing that all faster compartments would be largely depleted. They based their "repetitive groups" on the dissolved nitrogen in this slowest compartment.

This is fine since US Navy divers are in the main surface supplied and undertake operations with fairly long bottom times. This is not the case with SCUBA where the air supply is definitely limited. In practice, the sixty-minute compartment [not the 120 minute] is the slowest compartment to gain much nitrogen in recreational SCUBA diving. This would then be the compartment to consider in repetitive diving. Rodgers recognized this and presented the idea to PADI for a new set of tables specifically designed for the recreational diver. PADI acknowledged the idea but insisted that any new tables should be tested, not simply calculated.

Rogers also revised the NDLs based on studies by Dr Merrill Spencer. The allowable supersaturations were founded on Doppler ultrasound measurement of bubbles in divers. The NDLs were reduced to detectable gas bubbles and made the system more conservative compared to US Navy tables.

Single-day Dives

Following the calculation of tables, a test program was planned. PADI awarded the contract to me and the Institute of Applied Physiology and Medicine. Tests involved SCUBA divers recruited from the Pacific Northwest area. They were volunteers and were not paid for their participation. There were 234 different individuals, 69% were men, and 31% were women. Subjects were mostly in the age range of twenty five to forty five years.

Subjects exercised [in rotation] on a small rowing machine in the hyperbaric chamber. The chamber was kept warm to promote circulation and gas loading. Subjects were semi recumbent, again to promote circulation. All test dives were to the table maximums. Some shallow dives were tested although they could really only be performed in a chamber [or with air bottle switches at depth]. Most dives were repetitive ones.

When the subjects surfaced, they were monitored for decompression bubbles with a Doppler ultrasound device. Readings were made with the subjects squatting and flexing their knees. Scoring was by the Spencer-Johanson protocol.

There was no prescribed exercise activity while on the surface. At the time these tests were made, the effect of exercise was not recognized. No tables have been tested with subjects haling tanks on the surface. It is a DCS-inducing problem if you do it. As I have mentioned before, heavy exercise following a dive is not recommended, although some activity should occur to promote blood flow.

Following the chamber test series, open water tests were from the 56-foot dive boat *Starfire* in waters of the San Juan Islands. There were twenty divers per test. For these tests were utilized three PADI instructors, two additional support staff, and monitors from IAPM. These dives were repetitive ones, but only the third dive was to the table limits. Dive times were limited because of the cold water. These dives had first been tested in the dry chamber before using them on the boat. The boat staff handled the divers' tanks and equipment. Divers did ascent the boat ladder with tanks. Doppler monitoring was performed on the boat. No difference in Doppler score was found between the chamber divers and those in the open water. No cases of DCS were encountered on either chamber dives or those in the open water. In all, 911 individual dives were performed. This indicates the conservative nature of the tables.

The only other table-testing program that was this extensive was that at DCIEM in Canada at what is now called Defence R & D Canada. Other tables have utilized open water data for their development.

Multi-day Dives

No sooner had the trials been completed than live-aboard boats appeared and with them the advent of multiday diving. Since PADI wished to sell tables for this form of diving, another test series was required. The original idea called for six dives per day for six consecutive days. Decompression sickness was encountered and the program was terminated and planned again for four dives per day for six days.

This was a complicated test logistically as the Human Subject Review Board desired that all individuals remain together at all times. This required that no one could go home and all persons were housed together in a hotel near the IAPM recompression chamber.

COMPUTER MODELS

Phone Home

Ocean Systems, Inc. developed tables for decompression from deep dives of several hundred feet with a bottom times under one hour. The tables for decompression were in a book, the same as you would find US Navy dive tables. An idea developed to shorten decompression by not rounding the dives to the nest deepest depth and next ten-minute interval. The dive ship would phone the dive parameters to the Ocean Systems laboratory in Tarrytown, New York, and in a very short time, a table would be computed and sent back to the dive team. Thus, a dive to 553 feet for forty-four minute would not be rounded to 560/50. A clear saving could be realized in some situations. For several reasons, such a procedure was not used, but it is clear that, in principal, a computer-generated schedule was attainable for every dive situation in the field.

The Slide Rule

Dive tables were initially calculated in the 1940s with a slide rule or a mechanical calculator. One would determine what the inert gas partial pressures were in each of the Haldanian "tissues" after the time at the bottom, and then as one remained at each decompression stop. After a certain time period, the inert gas partial pressure would have dropped to the point where it was below the "supersaturation point" at which gas bubbles would form in the "tissue." One would then advance shallower to the next depth. This was a tedious process since it required considerable time. In principal, it could have been done in the water although the dive had better be short for one could have easily exhausted a SCUBA bottle while performing the arithmetic! With a mechanical calculator, the process might have gone a little faster, but, nonetheless, the process was the same:

1. calculate inert gas pressure,
2. wait at the decompression stop until the inert pressure falls to a suitable level,
3. proceed to the next shallower stop.

Electronic calculators took away all of the tedium, but they did not remove the calculation method -- the algorithm. That has remained the same since Haldane's time.

Enter the Microchip

Today, with the advent of the microchip that combines calculation capability with small electrical power use, it is possible to do the calculations, once performed slowly at a desk, in real time underwater with a device worn on the diver's wrist. The algorithms have not changed (although the limiting ascent ratios, the "allowable supersaturations" for each "tissue", certainly have been reduced for the recreational SCUBA diver.

The fact that the dive meters simply perform the same table calculations as were performed by the early developers of the US Navy tables is quite a surprise to most divers. They generally believe that some fantastic process, quite customarily attributed to electronic computers, is performed. The only sensor decometers contain is a pressure gauge.

The beauty of the device is that it can perform the calculations not only in real time, but the calculations can be performed for a variety of random dive profiles. Thus, one is not restricted to deepest depth for the full bottom time. But, and here is the big "but", there are no magical gas sensors for you as an individual. Many divers seem to act, and possibly believe, that there is a connection between their body and the "brains" of the calculator. Not so! Look at the device. Do you see any wires, any inert gas sensors, relaying information from your body to the machine? Alas, I am afraid not. The device simply calculates a generic table that would apply to every diver who performed that exact dive profile. Now that is certainly not a bad thing, it is not a feat to be disparaged by any means, but the algorithms are not really "personalized" in a physiologic sense.

Dive computers are simply portable devices for generating decompression tables in the field. They essentially do not contain any algorithms that are different from those originally used by table designers since the 1940s. Dive computer schedules are not necessarily any safer than a printed table. There are not any connections between the diver's body and the dive computer to sense the body levels of inert gas.

With today's smaller digital computer, we simply move the calculation device to the diver and eliminate the phone line. The point is we have the same algorithm and just a variation from a printed table. While not often considered by recreational divers, the algorithm in the dive computer is the same as that employed in an office for the calculation of dive tables. Submersible dive computers are simply portable devices for generating decompression tables in the field.

Computers are a popular tool for recreational divers especially for repetitive and multilevel diving. The two earliest devices were mechanical analog meters. In 1955 appeared the *Foxboro Decomputer Mark I* that had two compartments with halftimes equal to forty and seventy-five minutes. Gas loading and unloading was simulated by flow of gas through porous ceramic resistors between small bellows exposed to ambient pressure (depth) and bellows in a vacuum. It did not simulate U.S. Navy tables in most ranges. Next was the *SOS Decompression Meter* appearing in 1959. It also had a porous-plug resistor.

We also have the *DCIEM Analog Computer* (1962), a mechanical device with four compartments to simulate uptake and elimination in a series configuration and effective half times of five to over three hundred minutes. Though successful, it was very complex and not practical for recreational diving. Last was the *Farallon Decomputer* (1975) that utilized four semi-permeable membranes that simulated two tissue half times. These mechanical devices exhibited effects of age usual to mechanical systems.

An early digital device was the Canadian *XDC-1* and *XDC-2* (mid-1970s). It used a keyboard to input dive data, could be used in real time, but it was not for underwater use. The first diver-carried meter was the *Cyberdiver (XDC-3)* and contained a microprocessor. It had a high initial cost and need four 9-volt batteries every four hours. Other models followed. The next to appear was the Swiss *Decobrain I* (1983) that was table based and did not allow multilevel dives. The successor, *Decobrain II* (1985) was a model-based decompression computer.

There are now many decometers on the market, and they have different NDLs depending on the data from which they were derived. They are on-the-spot generated decompression tables. They have the same limitations as all tables. ***Because the values in tables and computers are expressed in definite numbers, they give the impression of physiological precision that does not in fact exist***.

a. . They are always to the "model limits" – tables must be made more conservative to allow easy readability and reduced size, dive times are "table limits" and more conservative.

b. They are not magic talismans. You cannot buy two devices and alternate your dives to increase your bottom time. Stories of this do exist!

c. Dive computers are not physically attached to your body in such a way that inert gas and/or bubble formation can be tracked in you, for that dive, on that day. These devices contain only a mathematical model that is general for the whole dive population.

They do allow for easy calculation of repetitive dives but they are not a medical or physiological gauge. A diver must remember that computers never "allow" dives – *Nature allows dives*. I heard a diver once remark, "I got bent once, so I bought a computer and haven't had a problem since then." Well, possibly the "bent dive" had considerable activity or was way over the limits. A "down side" of computers is that computer schedules are always calculated to the "model limits." Tables must be made more conservative to allow easy readability and physically reduced table size; dive times are "table limits" and more conservative.

These electronic devices are currently one of the hottest items on the market for recreational diving. What is curious is that many divers look upon these decompression aids as if they were almost "other worldly." They are often viewed as devices introduced by "super science" to solve all our decompression problems. While there is no question that they represent a very useful addition to recreational diving, it is important to understand just what it is that you are buying and using.

The Magic Talisman

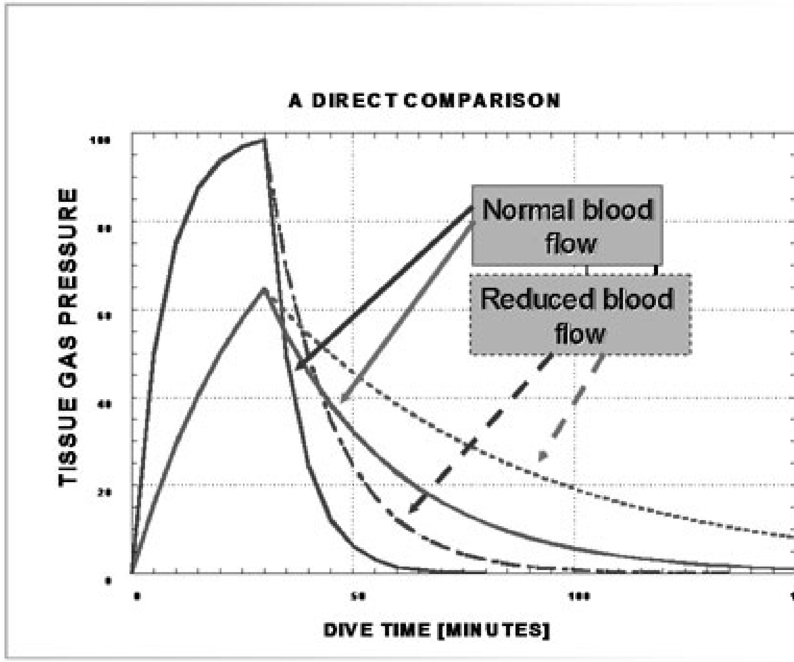
I hope that no one will use these wondrously useful devices in a manner in which some individuals were reported to use the older mechanical decompression meters. These allegedly true incidences border on a *magic talisman*. One diver was reported to have found that the SOS mechanical meter would "clear" faster and move into the safe zone if it was put in the sun. (I wonder if he sat in the sun at the same time.) Another diver found that the meter would "clear" faster if put on the hot, vibrating air compressor. Another simply left it on the boat when it moved into the red zone, and then took it down with him when it cleared. Another had two "deco meters" and alternated them. These true stories are hard to top with fictional ones; truly, we are talking about magic talismans here.

TO PLACE ALL OF THIS IN ITS PROPER PERSPECTIVE, THE GREATEST WORRY OF THE DIVER LIES WITH DROWNING OR AN OUT-OF-AIR SITUATION. IT IS ALWAYS A SHAME TO SEE DIVERS DISCUSSING THE ADVANTAGES OF DIVE METERS WHILE GIVING ONLY PASSING THOUGHT TO DEVICES TO RENDER SUITABLE AID WHEN THEY HAVE EMPTIED THEIR TANKS OF BREATHING AIR.

Ever a smart move is carrying one of the bright-colored inflatable "sausages" and, for some dives, a "bailout bottle." Additionally, a knowledge of your dives [if only roughly] so that you can turn to tables to complete the dive day should your meter fail, say, from battery loss. Making a realistic "guesstimate" would allow one to determine where they are in terms of gas loads if they had only tables. All is therefore not a total loss.

What Is Not in Tables or Deco Meters

A diver must remember that tables, and meters, dare not tested for dives with big physical activity underwater and rest on the surface. This causes unsymmetrical gas loading. The figure illustrates this with two compartments. The solid lines are gas uptake and elimination in the manner envisioned by the table designer.



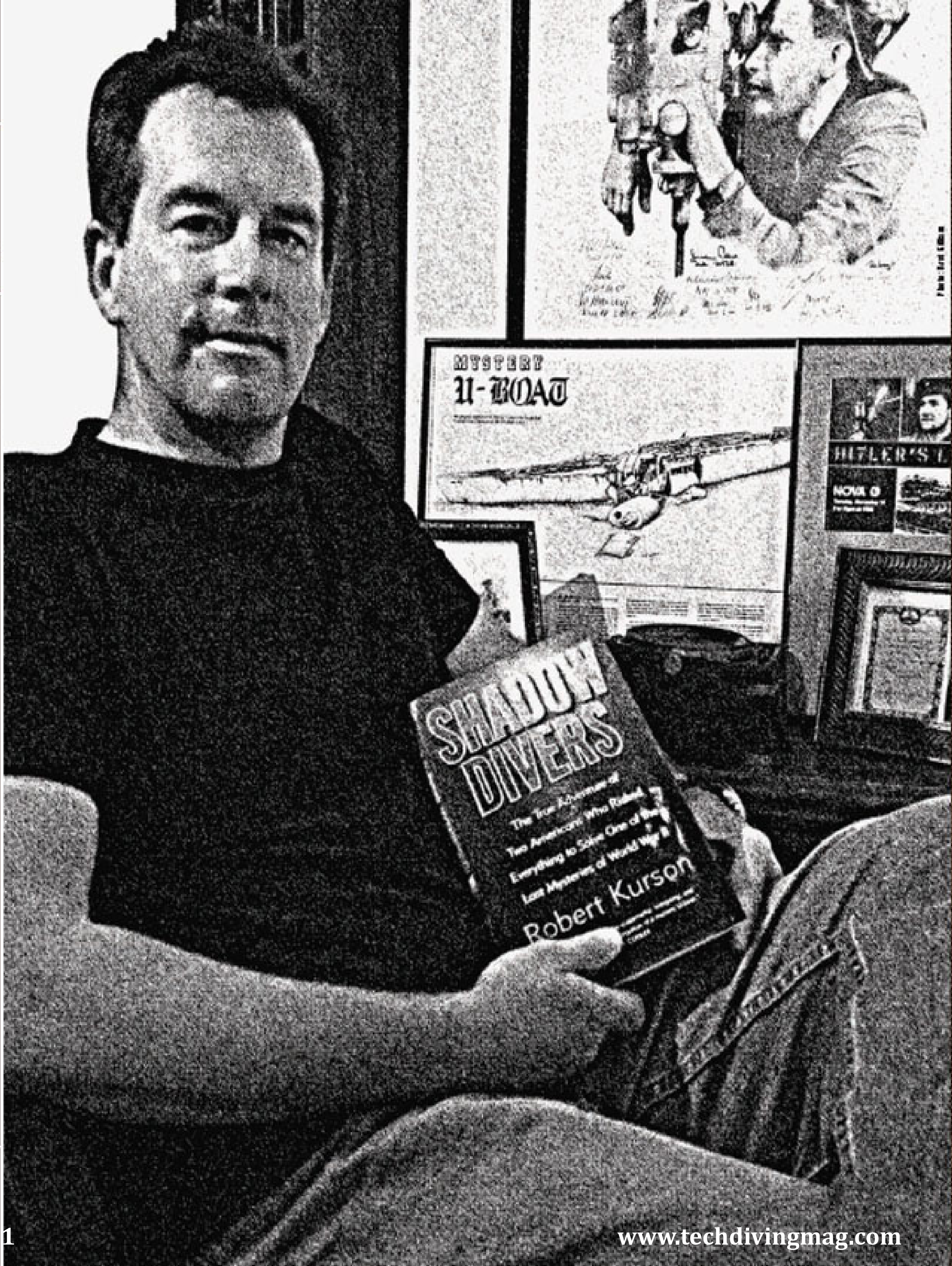
We see that elimination and uptake are represented by the same halftime for a given compartment in a given period. The dotted line illustrates what happens should the diver sleep between dives. The blood flow is reduced and gas elimination is reduced. Tables are not tested with extremely active bottom gas loading and most have resting conditions at the surface. No tables are tested with the subjects, for example, moving tanks after the bottom portion. Divers who are very active in the water should realize that this is not how the table was made. Short surface intervals before boarding a plane and struggling with luggage and dive gear can be aggravating for micronuclei formation.

A similar situation would occur should the diver be very active during the dive. Such would be the case if the divers were swimming against a current for some time and muscle activity were increased along with blood flow. Upon reaching the surface, the diver's activity level is reduced along with the blood flow. Should another dive follow, clearly the proper tissue gas loads have not been calculated.

Another factor concerns the number of tissue micronuclei. These have been known to exist for several decades although their exact nature is unclear. Only *dual-phase models* make any attempt at including them. These are the models of Brian Hills PhD and Bruce Weinke PhD, for example. They allow for nuclei size change at depth and allow for deep stops. These models, however, do not allow for a change in nuclei number with musculoskeletal activity. My work at NASA indicated a reduction in DCS in individuals at rest during a depress to altitude compared to the same individual when active at altitude. [All test subjects started at sea level and therefore all had the same, saturated, gas loads.] Depending on the activity level, the change in nuclei size or number could make a change in DCS incidence.

In recent years another model, called the *SAUL model*, was appeared. It relies less on compartments but rather on diffusion between a "critical compartment" [the one responsible for joint pain] and surrounding tissues that feed this tissue by diffusion. To my knowledge, a table has not yet been produced and available for purchase.

ALL PHOTOS FROM JOHN CHATTERTON COLLECTION EXCEPT AS NOTED



John Chatterton

OUT OF THE SHADOWS

BY BRET GILLIAM

In many ways, John Chatterton has lived a charmed life. He saw combat in Vietnam as a battlefield medic and heroically risked his own life to render aid to his fellow soldiers. In spite of repeated exposure to artillery, mortar and rifle fire he emerged unscathed after a year "in country."

He then put in nearly 20 years as a commercial diver and later came within minutes of being trapped under the World Trade Center towers on September 11, 2001. He lost his car, clothes and wallet when the attacks occurred just as he was gearing up to dive beneath the area on a diving job. He escaped on foot in his wet suit. His cell phone was found in the debris by a fireman who used it to help coordinate rescue efforts. Meanwhile, Chatterton was picked up by a rescue boat that took him to New Jersey desperately hoping to get word to his wife that he had survived.

His passion for shipwrecks and their exploration diverted him from his full time vocation as a commercial diver in the late 1980s. Without fanfare, John established himself as one of the real purists in the north Atlantic wreck diving community as he took part in expeditions to the *Andrea Doria* and scores of other wreck sites in the region. But it was a chance trip to scout a rumored wreck located 60 miles off the Jersey coast in 1991 that forever altered his life.

Chatterton was the first diver to ever lay eyes on an unidentified German U-boat from WWII that had lain undisturbed and undiscovered for nearly 50 years entombed on the silty bottom at 230 feet. This began a six-year commitment to determine the wreck's history and identity. Famously known simply as the "*U-Who*" since all naval archives had no record of any submarine, from any navy, being where it was… Chatterton and dive partner Richie Kohler set out to prove the U-boat's provenance and honor her war dead still contained in her dark hulk. The quest tested their mettle in many ways as rival wreck diving groups attacked with vicious (and undeserved) criticism and attempted to run interference. Meanwhile the wreck itself proved an unforgiving and claustrophobic environment that seemed to defy all attempts to conquer… and ultimately claimed the lives of three fellow divers.

Although a lot of Chatterton's pioneering wreck dives had been chronicled in various books and magazine articles within the diving industry, ironically it was a non-diving, unpublished author from Harvard named Rob Kurson who finally got his story straight in the runaway best seller *Shadow Divers* released to both critical and commercial success in 2004. Kurson's gripping account of Chatterton and Kohler's exploits in pursuit of the *U-869* attracted a mainstream audience that was fascinated by the story of two men's lives that became intertwined in a naval detective thriller that read with the pace of Clive Cussler novel. But the non-fiction tale of deep wreck exploration, tragedy, sacrifice, and final fulfillment captured the imagination of nearly a million readers and set the stage for a major Hollywood movie to be adapted from the book. Production is scheduled to begin in 2007 with a major studio behind the project, an award winning director, and speculation about which A-list actors will be cast to play Chatterton and Kohler.

With the first proceeds of his royalty stream, Chatterton uprooted himself from New Jersey and planted new roots in Maine. I caught up with my new neighbor and old friend who now lived just across Casco Bay from my own island home.

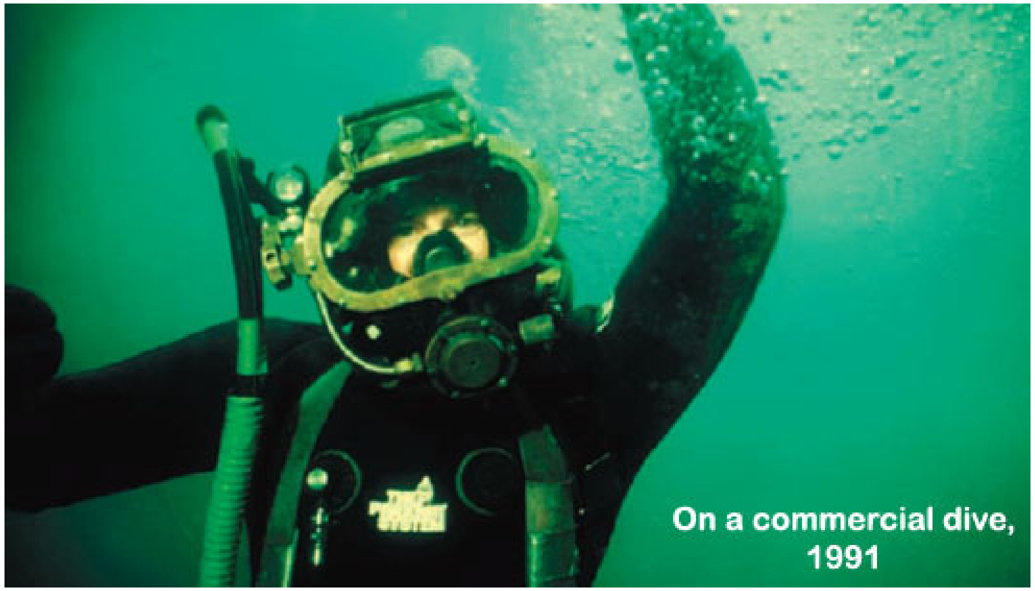
We're sitting in your waterfront home in Harpswell, Maine, which cracks me up because it's the first interview that hasn't required me to get on a plane and travel. I discovered Maine

ahead of you, what brought you up this way? I thought you were a Jersey boy?» My wife Carla and I were living at the Jersey shore, but we were living on the impoverished land side, not the Atlantic side of the street. We decided that we wanted to live by the water, and we wanted to kind of get away from traffic, from rush hour, that sort of thing.

So you moved to Maine to get away from all the urban stuff that drives everyone insane, but had you ever been here before?» We had friends here in business, the Lone-Wolf documentary film group in South Portland. We visited and we fell in love with the place like you did. We had to move.

Maine has become almost an outpost of a lot of diving professionals. You moved here, I came back in 1991, Stan Waterman has been living here since his dad bought a place in Sargentville around the turn of the century. Bill Curtsinger, one of *National Geographic*'s long time underwater photographers, has been here for years. Chris Newbert moved just across the border in New Hampshire from Colorado, and Mauricio Handler, who's a wonderfully talented photographer from the British Virgin Islands, relocated to Brunswick, right up the road here just this last year. So it's actually become an interesting enclave of divers that have come here and set up shop.» Maine's way of life is something that certain people embrace. Maybe that's the appeal to divers. Divers are so much interested in going their own way, being rugged individualists and that sort of thing, they are less inclined to follow.

Yeah, the lemmings aren't falling off the cliff here very often, that's for sure. Let's go back a bit. You grew up in Long Island, where did diving come in?» As a kid, I lived at the beach. I was always surfing, snorkeling, diving, spear fishing, that kind of thing. I think I made my first scuba dive with some neighbors. I was ten years old, they made an aluminum tank with no weight, and I just kind of floated around on the surface. I quite literally remember looking down into the water and seeing the light rays penetrating down into the water and thinking "What's down there?" Diving was a sport for me that became a vocation. I guess I got sucked in.


On a commercial dive, 1991

After high school you volunteered for the army as a medic, saw combat duty in Vietnam, and got honorably discharged after four years. What next?» I went to Florida got a job at the local hospital down there working as an arterial blood pulmonary function technician. But I felt like I wanted to do a little bit more, I wasn't sure exactly what that was, and I moved up to New Jersey. And now I'm a guy with a background in construction, commercial fishing, and respiratory therapy, and I came to the conclusion - almost through an epiphany - that the best course of action for me was to become a commercial diver.

Where did you go to pick up this training?» I went to trade school in Camden, New Jersey, The Divers Academy of the Eastern Seaboard. It's still there. Most of the graduates from commercial diving schools end up going out to the oil patch where most of the work for commercial divers is. But I was going to be much happier working in the underwater construction business as opposed to taking off for the gulf. I was working on dams, bridges, bulkheads, pipeline jobs, all kinds of things, and I remember the first time I put a helmet on and got in the water. My breakout dive was working for a power plant for Con-Edison in NYC on the 11-7 shift.

Trying not to get sucked into the intake?» Yeah. Well, they are memorable dives, and that was certainly one of them. You've got all this phosphorescence in the water, and you have the hum and vibration of machinery all through the plant. It's not an easy job but I kept at it for over 20 years. You start out low, but very quickly I became a diver, and then I was a foreman, a supervisor, and that sort of thing. I enjoyed the work. I liked putting a hard hat on and getting down in the water and figuring out how to get the job done. There were very few downsides.

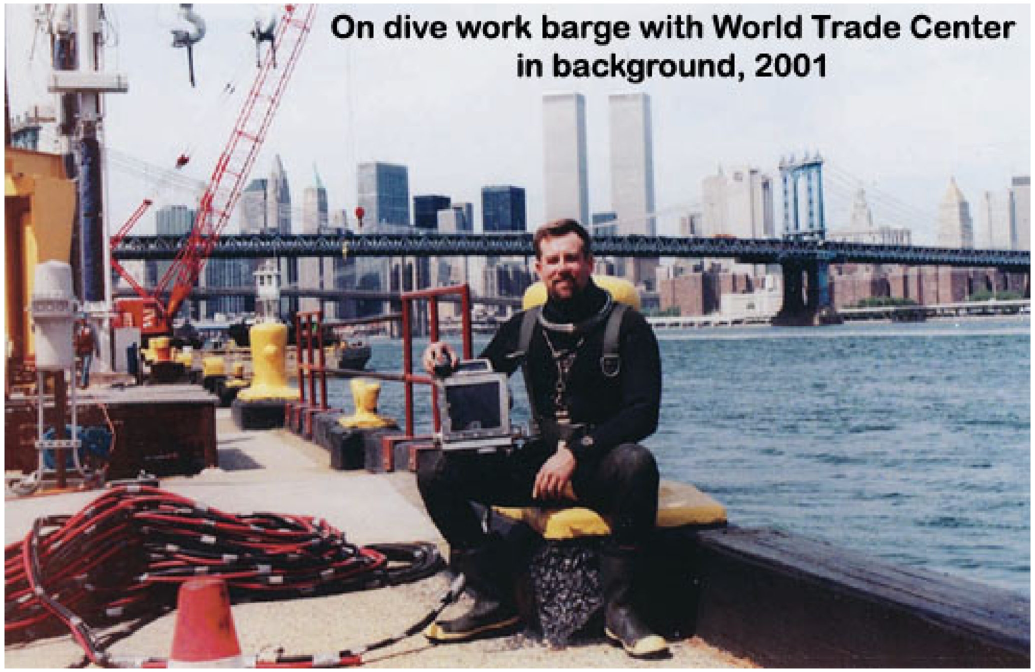
You began to have some interest in sport diving, motivated by an interest in wrecks.» Well, commercial work slowed down. And I thought what I'd like to do is get in the water and do some fun dives. Some light and easy scuba dives, just to keep my head in it; to keep on top of it as a professional diver. That was in 1982.

You and I came from similar backgrounds… ex-military, ex-commercial, so we were exposed to technologies, methodologies that really were completely beyond the average diver. Did you find a conflict there when all of a sudden you've got guys working in deep, dark, cold water, and thinking there might be a better way of doing this?» I was interested in wreck diving. The thing that really appealed to me was the complexity of it. When I put a hard hat on, I knew I had my job, and the guys in support have theirs. Everyone's working together. It doesn't matter if it's your tender, or the guy on the crane, or the guy working communications, or the other divers, everybody had a job. Not on scuba. On a shipwreck, you're not part of the machine, you are the machine. Everything comes down to your responsibility. It's physically challenging, just to be capable of carrying the equipment. You're in cold water, you're in deep water, and you need to maintain a physical fitness level that will carry you through when things go bad.

At the same time, there's the intellectual aspect. It's not just about understanding diving. A lot of that was what I brought in from commercial diving, studying dive physiology and technology, making your own dive tables, and all that kind of thing. You also want to understand shipwrecks and what it is that you're looking at. You're talking about maritime history in its entirety. So you've got something that is physically demanding, intellectually challenging, and you have to add to psychological stress. You find yourself in intimidating situations. You need a certain degree of mental toughness. You really need to develop the determination to bring all this together. When I looked at wreck diving, I was totally enamored with the complexity of the activity.

What wrecks were you regularly visiting?» For me, it centered in two places. The *Andrea Doria* and the Mud Hole in New York, a place that really only got about 200 feet deep. But you are talking about extremely difficult dives. You were in visibility that may be as little as one foot. You're trying to work off a bottom that is extremely silty, confusing just because of the orientation of the wrecks itself, and you're talking about fishing nets all over the place. There was even one wreck where the mast was still intact and there was a fishing net draped across it. A friend of mine got disoriented in 190 feet of water, decides to blow back to the surface. Blows right into the fishing net, and stops. It was an environment about as intimidating as it can get. We used to say we would go to the *Andrea Doria* to tune up for diving in the Mud Hole. Conversely, when you were picking up a lot of dives in the Mud Hole, by the time you got to the *Andrea Doria*, you were ready to go.

The *Doria* wasn't so much the depth, wasn't so much the current, wasn't so much the cold water or limited visibility – all those were factors, but thing about the *Andrea Doria* was the vastness of the interior. The *Andrea Doria* was perfectly willing to give you far more rope than you needed to hang yourself.


On dive work barge with World Trade Center in background, 2001

In the same era, I had contacts for a long time with guys who were doing really pioneering stuff in cave and deep diving. They were always looking for any innovative way to try to give them the edge to come back. In the late 1980s, when I was exposed to wreck divers in the north Atlantic, it struck me that there was little interest in crossing over the technology that these other divers were using and trying to apply some of that to wreck diving. How did you look at this whole situation? As a commercial diver, you were used to having certain disciplines. How did you feel about guys who were blindly penetrating these wrecks with no comeback protocols?» Philosophically, at the time, there was a world of difference between wreck divers and cave divers. I don't mean to say there was an antagonist relationship between the two, but cave diving techniques and technology were being developed for the caves. Wreck diving was a different environment. Now, I'm a certified cave diver, and I understand what running lines is all about, but in shipwrecks, the problem with a guideline is sharp edges. It is not a line-friendly environment.

That brings us to the discussion of the practice known as "progressive penetration" which entailed studying blueprints and architecture of these wrecks to try to give you the edge of being able to recognize your whereabouts inside the wreck and find your way back out. Unfortunately, this produced a very mixed safety record.» All of that came from the *Andrea Doria* because that was a very well documented wreck. There were extensive, detailed deck plans, and the wreck wasn't very old so you could really identify where you were. But the most important thing was to proceed slowly. That system worked very well for me and most of the divers. But where the system broke down was when divers who came and observed what we were already doing perceived progressive penetration as something akin to "go inside, swim around, but remember the way out!" That is where divers really got themselves in trouble. There were many fatalities associated with those divers on the *Andrea Doria* – going inside, getting lost, and not being able to find your way back out again.

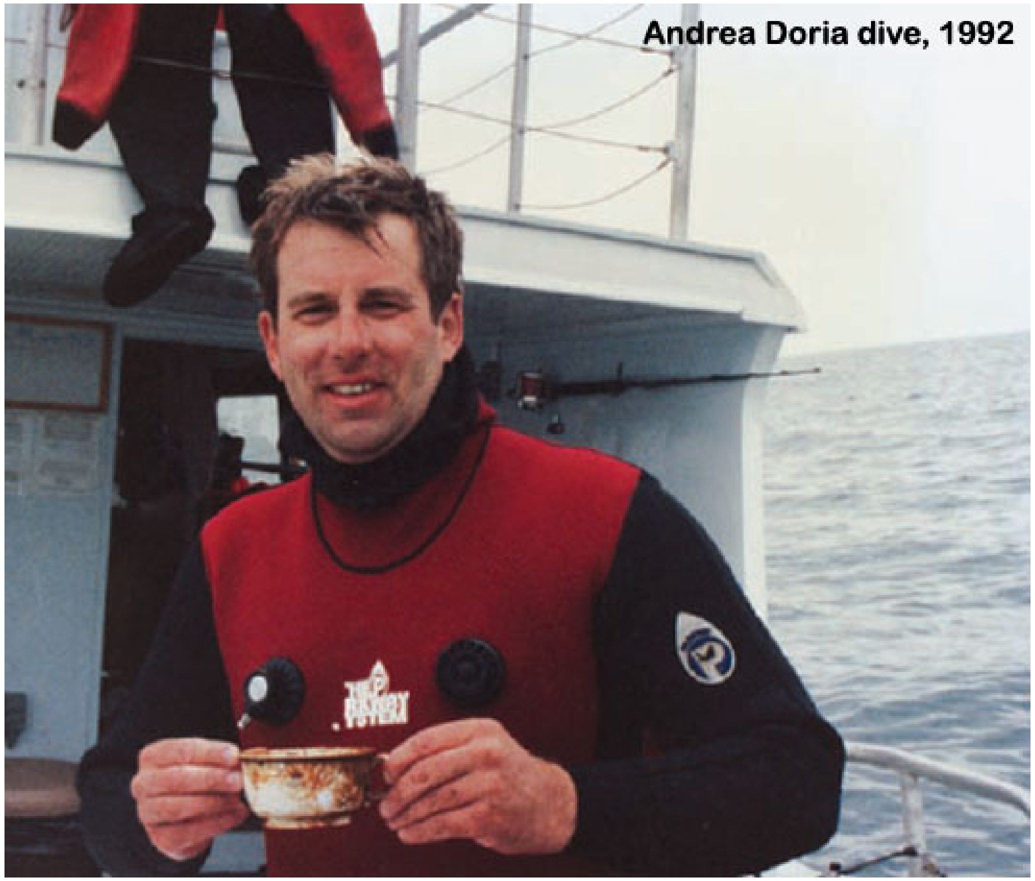
Eventually we were using lines, but not like they used them in caves. We were running vertical lines on the interior of the wreck, usually very short spaces, maybe 60 or 75 feet of line, something high visibility to denote a particular location of something above. Divers were using strobe lights inside, regular lights to hand carry, bringing other divers to leave them staggered along a particularly deep penetration. By the early 1990s, there was a lot more to technique, especially relating to progressive penetration.

I remember speaking about technical diving at one of the dive shows in 1991, when I happened to suggest that the wreck diving community – which was getting bolder and moving deeper – might want to consider stopping by the main exhibits and checking out the reels that the cave divers use. I suggested that these reels might provide the safety edge when you're inside a wreck that's on its side and suffering some breakdown from age, and all of a sudden silts up and you can't see, maybe that would bring you back out. And I remember that a particularly vocal guy in the back basically shouted me down and told me to mind my own business and not tell the wreck divers how to do things. I found it interesting when I came back to speak the next year and someone came up to me and said, "Remember that guy that was giving you so much crap about the penetration reels?" And I said, "Yeah. I apologize, maybe I was out of line." The guy says, "Well, maybe you weren't, because he got lost inside the *Andrea Doria* and died." When did you start to think that maybe we could take some of the technology from caving and commercial diving or even military stuff, and how can we best apply it to make it safe?» I was grabbing it even in the late 1980s. But what I wasn't willing to do was take something that I was doing, and hold it up to the world and say, "I have the answers. This is the way to dive these deep shipwrecks." I fully understood how dangerous these wrecks were and how far out on the limb I was going. I also had a pretty good handle on my abilities. Just as you discovered in your pioneering deep diving work, I did not feel that what I was doing was suitable for everyone. And therefore, the last thing I wanted to do was encourage someone to do something. At this time, there's no technical diving training, there's no TDI, there's no structure out there to certify, to instruct, to educate anybody. The last thing I wanted to do was to offer tidbits of potentially lethal information. I spent more than half my time by myself and I would experiment with things that I felt would give me insight that would be something that I would learn from. But I also understood that the public could misunderstand what I was talking about. So I did not feel that I was in a position to become an educator.

There were too many guys out there that see something to be gained by being the new messiah and at the same time there's another guy on the next boat with a completely different take on how to do things. And a lot of motivation was centered on bringing stuff up from the wrecks. I don't know whether it's financial, or just ego, or what. I've brought up some valuable things from shipwrecks, but I don't think I've ever brought up anything illegal. I don't think I've violated laws. I know there are guys who have done the wrong thing for the wrong reasons, for no apparent gain. A lot of crap has come with the "treasure" label, and some of that stuff I don't get. I don't understand. One man's trash is another man's treasure, I guess.

Sheck Exley, the infamous cave explorer who was tragically lost in 1994, once commented to me that some of these North Atlantic wreck divers were risking their lives for stuff that if it was laying by the side of the road as you drove down the highway, you wouldn't stop your car to pick it up. On the other hand, he admitted that a lot of people couldn't understand his drive to explore the back end of deep cave systems. But the primary difference was fueled by the approach to technology and technique that seemed to be lacking with the wreck divers.» Well, in many ways he was right. The artifact was the trophy. It wasn't so much the thing itself, it's what it represented. What happened on the *Andrea Doria* was there were people who felt that they needed that recognition. That's what got these guys into trouble. There wasn't a lot of long-term perspective and a lot of corners were cut. There should have been more emphasis on experience, technique, equipment methodology. Not all shipwreck divers are mature enough to approach the wreck in that way. They weren't really about the art, weren't really about the diving, weren't really about the wreck, it was about the trophy. They had to have the recognition.

If you take a bit of historical perspective and look at the earlier wreck expeditions, you'll see Bob Hollis, Peter Gimbel, Jack McKenney, and these guys that were going out on the *Doria* in 1973. They were such clinicians to a certain degree, they approached it with all the tools they could muster at the time, and then took it one step further by actually going into saturation. Now, all of a sudden in 1991, divers emerged as aggressive in some of their attacks on the *Doria*, but they're just so unbelievably less informed that it shook people up a bit.» When you're starting out that way, I don't think good things are going to happen. At the same time, there were other people jumping in the water who were interested in the art of wreck diving. They were coming back with some sort of insight into the wreck, into diving, into themselves. But they went humbly, as someone who is going to learn as opposed to someone who's gonna go there, grab some loot, and pound their chest about how great a diver they are.


Andrea Doria dive, 1992

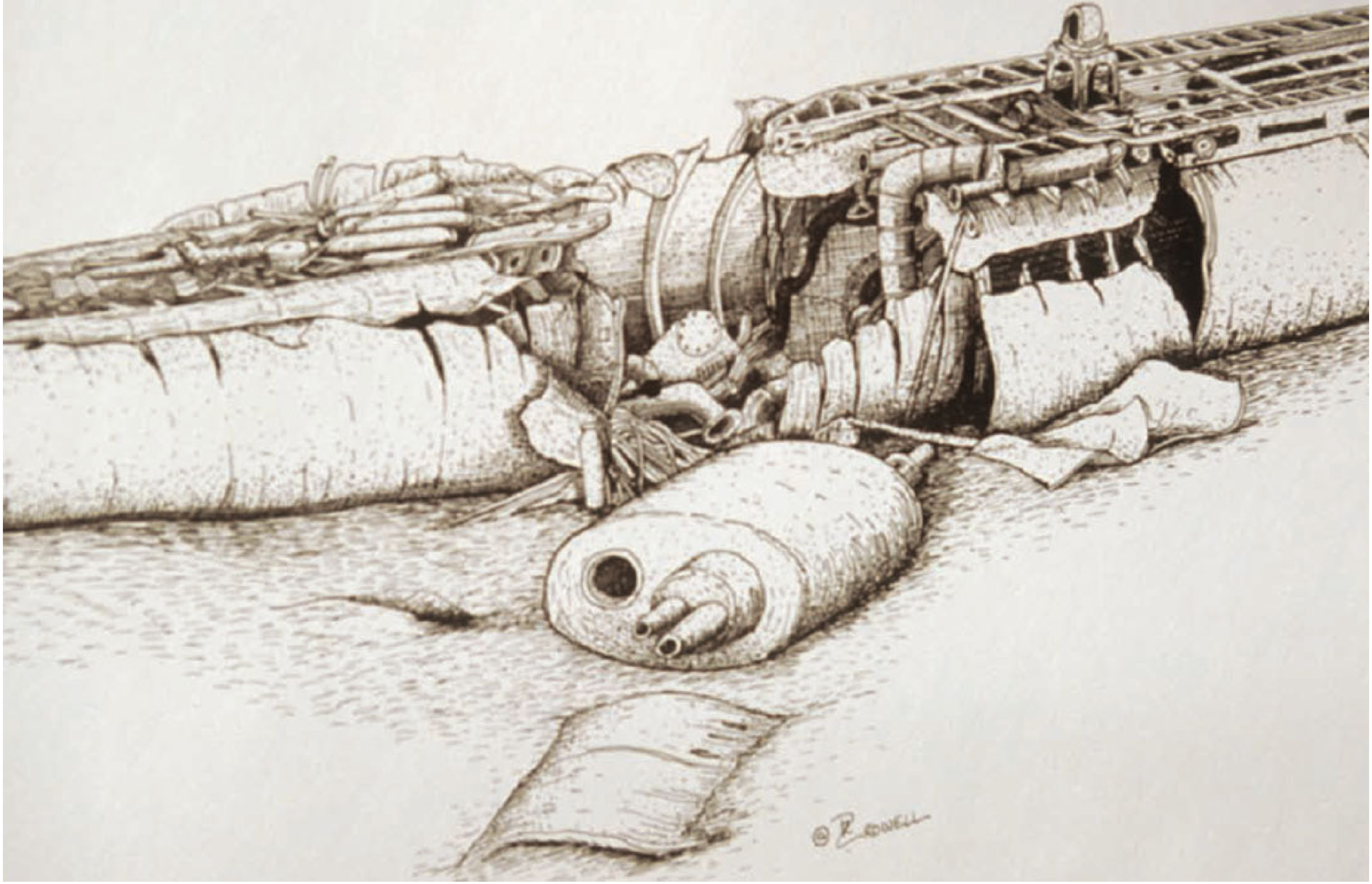
On the speaking circuit in the early 1990s, someone introduced me to Gary Gentile. At the time, Gentile was self-publishing a bunch of books: *Wreck Diver's Guide* and others in a similar theme. As I read through a lot of this stuff it seemed to me that this guy was very well experienced. But I'll never forget one day he called me up and asked me a question about managing oxygen

exposure. I presumed that I was talking to someone who was fairly switched on to the subject, so I launched off on a twenty-minute dissertation on oxygen toxicity. At the end of what I thought to be a very basic explanation of the topic, there was silence for about ten seconds, then he replied, "I have to tell you something, Bret, I don't have a clue what you're talking about." I said, "Where did I lose you?" He said, "About a minute and a half into it." At the time, I think Gary was claiming more dives on the *Andrea Doria* than anyone else, yet he didn't have a clue about what was going on with oxygen management. He was unable to even work the essential physics equations, yet he was surviving.» Gary is one of the best natural wreck divers I've ever seen. Intuitively understanding wrecks, being able to get on a wreck, figure out where you are, go to the place that you want to go, and then find your way back out. He has an exceptional gift in understanding wrecks. At the same time, he really doesn't have the technical/intellectual side to his personality. But for some guys, their diving is not about that.

In fact, Gentile published one book shortly after people started being introduced to mixed gas, where his knowledge was so fundamentally flawed that he thought all gasses had a "2" subscript. Since oxygen is O2 and nitrogen is N2, he published a book and listed helium as HE2. I look back now, with 17 years of hindsight from when I first met you, why didn't you step up to the plate and say, "I come from this other technical commercial background, what are you guys talking about here?"» Gary's primary goal was not education. His goal was promoting himself as an author; promoting his business. He still does that. He still writes books, he doesn't have a publisher, he doesn't have an editor, and he publishes his own books. He does it in a vacuum. I'm not saying there's anything wrong with that, but I never assumed he was the spokesperson for me. In the early days, I was not convinced that what we now know as "technical diving" was suitable for the mainstream.

Point well taken, because what we learned was that the more we opened the door to this closet, the more some people stepped through before they perhaps should have. It was a basic lesson in Darwinism because there were a lot of people that got killed or injured, or had unbelievably narrow escapes, that probably never belonged inside that closet door. I think a lot of people became horribly conflicted about whether we were doing the right thing by trying to disseminate the information that, for a long time, had been sealed up and only communicated in private letters. Now, all of a sudden, there was this thing called the Internet, which was beginning to get off the ground, and it was an ideal place for the deliverance of information. Why did the wreck diving community go in a different path than the cave diving community?» The wreck diving community had much more in the way of rugged individualists. The cave diving community had the ability to somewhat control the caves, to control access to the caves: who gets in, who doesn't. If you come in and you behave badly, then we're not going to let you in again. Anybody with a 50hp outboard and a rowboat can get out to a shipwreck, so you don't have that kind of control to accessing the dive sites. When you look at the individuals who were drawn to this in the early days, the divers were very private about what they were doing relative to what we now know as technical dives and experimentation. It was very much kept within the family, a very small circle of friends. Not the larger wreck diving community. You should tread softly, you go there with all humility, and what happened is some people were moving ahead at light speed with technique, technology and philosophy that were flawed. And they were doing it because they needed to draw a following. It was pure sensationalism and ego.

Capt. Dan Crowells' rendition of U-869



At the same time, there was all this other stuff going on. The controversies and the rivalries and, in some cases, the bitterness and acrimony that went on between different boats. I'm thinking now at the unbelievable rifts that developed between Steve Belinda's group on the Wahoo and Bill Nagle's group on the *Seeker*. What caused all that?» There were days when I walked around going, "I don't like any of them." It came down to issues about respect and the way they conducted themselves. I think Bill was an incredible diver, and in many ways, he was my mentor from a technical standpoint. When we start talking about the rivalries between Belinda and others, a lot of that is back to this, "I know the way" mentality. New ideas, new concepts, new technology, don't sit well in that environment.

Now you guys were in pursuit of what you were then simply calling the "*U-Who*." The notoriety that's been achieved by this pioneering search to find the damn thing and then to identify what it was and what navy it belonged to is amazing.» Yeah, it was Bill Nagel's personal interest in exploring new shipwrecks that led us to it. He traded Loran numbers with a fishing boat captain. They had a wreck offshore; Bill had a little wreck inshore. The fisherman wanted to hang inshore when the weather's crappy, because it's good for business. Bill loved the idea of a new shipwreck. This guy said, "I know there's something out there, I know it's big, I know you guys dive deep, let's trade."

At what depth?» About 200 feet, he thought.

How did this fishing guy find it?» He was running a trip out to the canyons, and quite literally stumbled upon it. At this time, I think there were only three fishing boat captains who knew about this site. But they had no idea that this was a WWII submarine, and they certainly – at this point – did not know that this could be a U-boat.

Who went out there and dove it the first time?» I crossed out a date on Labor Day weekend in 1991. Bill put five divers on, and I put five divers on it. Our deal was that we were going to go out and try to find the wreck, and if we don't find it, we keep looking. We made about five passes trying to hook into this thing, but we were having problems with the bottom recorder. One bottom recorder was saying it was up to 260 feet, and the other one said it was around 220. In reality it was about 230 feet, but there was a concern about taking a boatload of guys when we said it looked about 200 feet, and all of a sudden there's a huge difference between 200 feet and 260 feet on air. So our plan was, once we finally got grappled into the wreck, that I would go down and take a look at the wreck. If it was an old trash barge or something in 250 feet of water, that's not where we wanted to spend a day or risk the other divers.

So what did you find?» It took me six minutes to get down to the bottom. Literally hand over hand, ripping current. It was a strenuous descent, visibility was about five feet. I'm looking at this wreck and I secure the grapple to keep it from blowing away. I swam up current and saw an angled hatch, very prominent, very much a unique feature. I'm at 230 feet and my mind is racing, and I think I know what this is. I look inside the hatch and I see torpedoes. The hatch is completely blown open.

You know you are looking at a submarine, and you know you're not looking at a submarine from the 1960s.» At 230 feet on air, you're kind of stupid. But I know it's a submarine, it appears to be WWII vintage, WWII speaks U-boat, and I am absolutely astounded and mystified. I believe this is a big dive, and I'm taking a moment to appreciate how fortunate I am. During my deco, I'm working over in my mind what I saw, and knowing the history of the area I thought a German U-boat may have been 150 miles away but there's nothing nearby, and I was trying to remember the number… I'm kicking all this stuff around in my head when one of the crew members on board, comes down and gives me the " what's up" sign. I take my slate and write "SUB" and stick it in front of his face. He goes berserk. He goes back up to the boat and tells everybody what it is. Of course at this point, they don't know how deep it is, they don't know anything. Totally unbridled enthusiasm. Splash by splash, this parade of divers goes past me on the way down to the wreck. I get back on the boat, and Bill Nagel's words were, "I hear we did good."


Crew of U-869, after commissioning, January 26, 1944

At this point it's no secret that Nagel had a serious alcohol problem. Was he still diving then, or was he just essentially being a captain and having the enthusiasm that had always driven him take him out there?» I guess we all have people that we know have problems with alcoholism. Bill's case was extraordinarily severe. At 43 years old he drank himself to death. In 1991, he still had fantasies of straightening himself out. It hadn't gotten so bad that he had reached a point of no return. He was a very knowledgeable diver, and he understood that he was not capable of making the dive. At the same time, he felt this was the inspiration he needed to turn his life around. So thought the discovery of the submarine was going to save his life. He wanted to dive it, he wanted to turn his life around.

This wreck turned a lot of people's lives around. How long from the time that this wreck was initially discovered on Labor Day weekend in 1991 did it manage to kill the first diver?» The second trip, two weeks later.

How did it happen?» Everyone on that first trip signed up for the second trip. Everyone on the first trip got at least one dive, some got two. They all understood how deep the wreck was, and they understood the conditions down there. There wasn't anybody who was not just completely overwhelmed with enthusiasm at the possibilities this wreck offered. So everyone felt they had a shot at identifying the wreck.

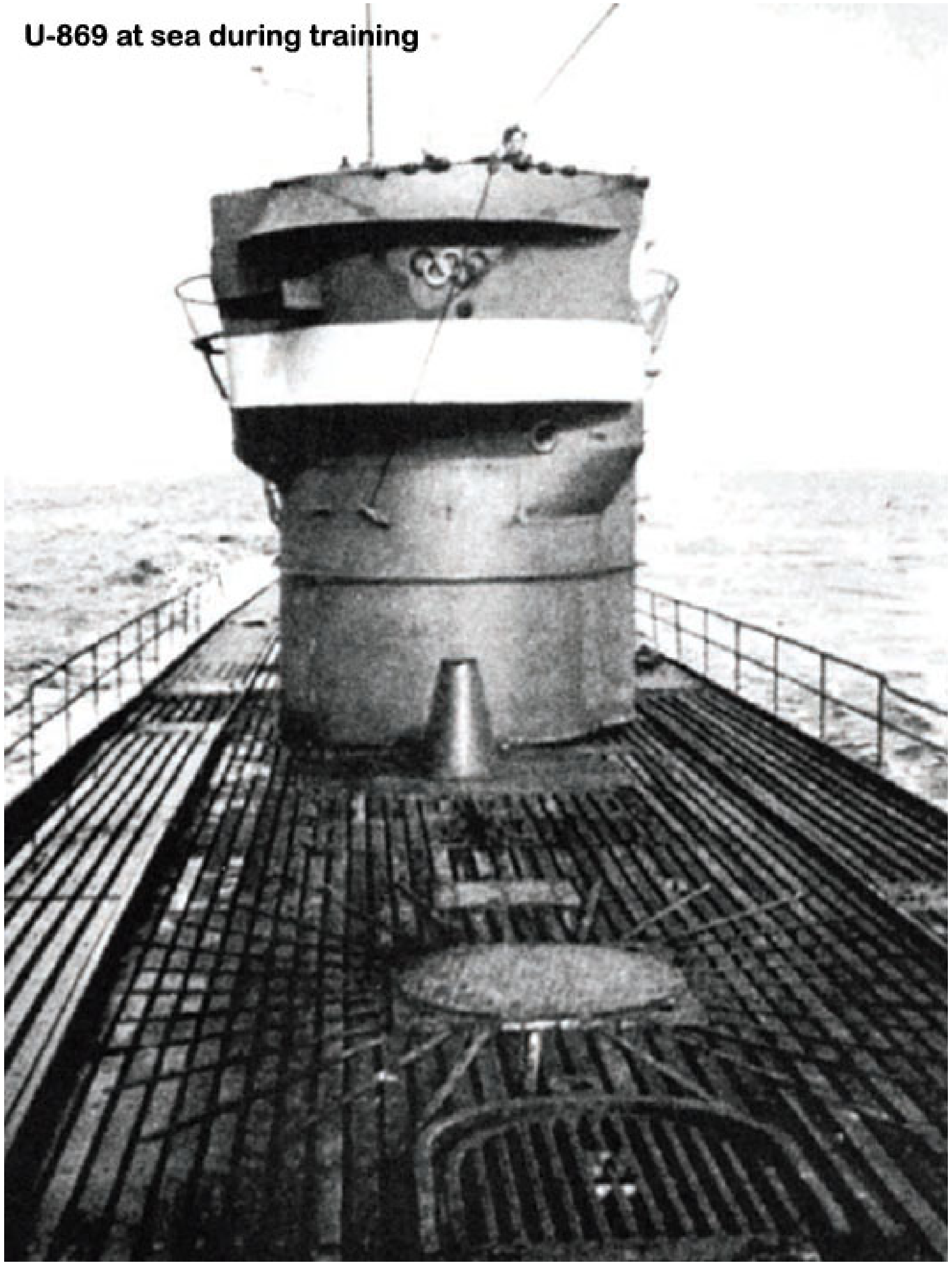
We had a buddy team with Steve Feldman, an instructor from Manhattan, with Paul Skibinski. These two guys had a lot of experience diving together. Their plan called for thirteen minutes on the bottom. Pretty conservative, by my standards. They get down on the wreck, do some exploration, get their thirteen minutes, and Paul heads up the line. He turns, and sees Steve is not following. So he stops and waits. He notices there are no bubbles coming up so he swims back down, and finds him on the bottom. He turns Steve over and sees he's wide-eyed and unresponsive. Paul is absolutely shattered. He's over 200 feet deep, his friend and dive buddy could not be in a more severe predicament, and he has to get him to the surface. He starts hauling him up the anchor line. They get up to the point where they see another pair of divers coming down.

Remember, there's a strong current. This means anchor line in one hand, diver in the other. You've got no hand for your BC, nothing for anything. You are at the limit of your ability. He thinks he's running out of gas. It was physically and emotionally demanding, it couldn't have been more stressful. The other divers come down. He grabs the regulator from one and at the same time he lets go of the body. So one stays with Paul while the other one chases the body to the bottom. He's now at 230 feet in the sand with an unconscious, non-breathing diver, and he's not even linked to the anchor line. He doesn't believe there's anything he can do to help Steve. So he ties a line on him, starts up, and miraculously runs back into the anchor line. He ties off the line he'd fixed to Steve's head. But when we went down to try to recover the body, all we found at the end of the line was a mask and a snorkel. Feldman's body was recovered five months later by a commercial fishing vessel. According to their track, they picked up the body at some point greater than a mile away from the wreck. He came up in a net.

We spent the rest of that day trying to recover his body. We used up the bottom time of everyone on board who we felt was capable of going down to search. There were guys that were emotionally distraught and you couldn't ask them to go in the water, and had they volunteered you wouldn't have wanted them to. The last thing you want is someone else getting hurt or killed trying to recover a body.

Later, the diving continued with a different lineup. Not everyone who was on the boat with Feldman wanted to continue. There were guys who gave up diving, there were guys who gave up deep diving, there were guys who gave up diving on that U-boat. And then there were others that wanted to continue.

I credit the Boston Sea Rovers and the Beneath the Seas guys for sponsoring forums and symposiums that made a real effort to bring these groups together, to put together seminars which talked about the new technologies, and it also was a process where a lot of the leading members of different dive communities got introduced to the public for the first time. Sometimes, that was a sobering experience. Back in 1991, I had spoken at the same program with Rob Palmer who'd come over from England. Exley was up from central Florida, Billy Deans from Key West, Jim Bowden flew up from Mexico. We were all introduced to two guys that quite literally scared us to death. It was Chris Rouse and Chrissy Rouse. They babbled in our faces for about ten minutes and then disappeared. The last thing that Chrissy said to Sheck was, "I want to be just like you, but I'm going to be better than you, and I'm going to go deeper than you, and I'm going to be the next Sheck Exley." When they walked away, Rob Palmer turned to me and said, "Those guys are going to kill themselves." And before I ever saw them again, that's exactly what happened.» I can understand the reaction of you guys. It was tragic and there were a lot of lessons to be learned. It was the first real public focus on the *U-869*. In 1992, the Rouses had come out and done some *Andrea Doria* trips. They were different, they were unique since they came from the cave diving community. In many ways, they were perhaps better suited for diving on the submarine. Bill kind of liked the Rouses; they were outlandish and wild, but he also thought they were reasonably capable without fully understanding everything they were doing.



The Rouses, if nothing else, had a reputation for a bizarre father-son relationship. It was competitive; it was characterized in some ways as immature. Were they good divers?» They seemed to be disciplined; they seemed knowledgeable; and if you pulled out the personality, they were capable. This was Columbus Day weekend 1992, thirteen months after Feldman's death. This was a two day trip; they had been to the U-boat a couple times previously. Chrissy had a spot he was working inside the sub that had German writing on it. He was convinced that he was going to be the guy to identify the sub, much the same way he spoke to Sheck Exley. He had a very high level of confidence and was very vocal about it. He was going to be the one to identify the U-boat.

What happened?» Chrissy, the son, was running a reel inside the wreck to a location around the galley where he was trying to dig out this artifact that had German writing on it to bring it to the surface. The father was waiting outside. Chrissy apparently undermined some heavier steel components within the wreck trying to extricate this artifact that turned out to be a rubber life raft. He's trying to pull this thing out, he's digging around, and the next thing you know a large, heavy piece of wreckage lands on him and pins him. He is essentially buried in the wreck, alone, at the end of a line. His father, Chris, was waiting outside. Chrissy does not show up, and he is not going to surface without Chrissy, so he says to himself "I gotta go get the boy."

At this point, we have the elder Rouse – the father – with the horrible realization that his son is trapped inside the wreck, the dive is way behind schedule, what happens next?» The added complexity is that both these guys are on air. Father goes in, finds his son, uncovers him, takes the reel, and heads out, but not the way they came in. So the supposition is that as they exited the wreck, they were disoriented as to which direction they were facing. They were only about forty feet from the anchor line.

This is significant because they didn't come up on the anchor line, but free ascending. They had spent more time on the wreck searching for the anchor line. They couldn't find it, they got to the point where they were over 40 minutes into their bottle time, and they had to surface. At this point, they have a huge decompression obligation and they don't have enough gas to do it. They're not coming up on the anchor line or tag line or anything, so this whole scenario is about as bad as it can get before they even leave the bottom.

It's essentially a case of making bad choices, and when things go wrong, you have inadvertently painted yourself into a corner, and that's exactly what happened here. They brought only one of their four stage bottles with them, they did not mark the anchor line with the strobe light, they ran a line inside the wreck, but they didn't run it from their start point, the anchor line. So they found themselves lost with no up-line. After another series of attempts to share the one cylinder of nitrox they had dragged up with them, everything went to hell.

If I remember correctly, they ended up on the surface with explosive decompression sickness.» Right. But all of this stuff was compounded by the fact that they were hammered with narcosis and they had to deal with almost unbelievable psychological stress. Chris, with his son not coming out of the wreck, being buried and having to extricate him… and for Chrissy, the fact that he was buried inside this thing for a long time before his father even showed up. So you have this psychological state that is created here, and the straw that breaks the camel's back is Chrissy breathing off of that nitrox regulator and getting water into the mouthpiece. He bolts for the surface. Chris was not going to let his son go anywhere without him. So he comes up, too. The weather was starting to get shitty. I was looking at the water as the two Rouses popped to the surface in front of us. The immediate realization is that they weren't on the anchor line, and they were not on the surface according to the schedule they left with us. We knew there was more than likely a serious problem.

Now you're faced with a bad situation because you're so remotely located offshore, you have to get the guys onboard, and even that is proving difficult.» We're trying to talk to them to get basic information as we're throwing them lines and trying to get them to the ladder on the boat. We're asking if they had a decompression obligation. They indicated they had come directly to the surface and they both looked really scared.

At this point, was any consideration given to trying to adopt some kind of omitted decompression procedure and put them back in?» Yes, but they were not fully responsive, and our policy and procedure has always been if you can talk to someone, you can fix it. But if it's a psychological problem, you can't take someone who is desperate to get out of the water, and put them back down for decompression.

So now you have to extract them. And that means you have to get the equipment off them and get them up on the deck. You're trained as a medic and as a commercial diver, and right away you must have known that the prognosis was very, very grim.» I knew it was grim, but I didn't think it was as bad as it was. We got Chris to the back of the boat. He said, "Take Chrissy first." The son was right behind him. We put a man on either side of the ladder to help him and he said, "I can't make my legs work." We quite literally dragged him up and turned our attention to Chris Sr. He very calmly and specifically said, "I'm not going to make it. Tell Sue I'm sorry." He slumped unconscious with his face in the water. I jumped in, took his knife, cut him out of his rig, and basically did a fireman’s carry to get him onto the deck.

At this point, the only tools you had out there were oxygen and basic CPR. How quickly, from the time you got both the guys out of the water onto the deck, did it take them to go from being able to have coherent speech to becoming irrational and passing out? Obviously we’re dealing with massive CNS decompression hits here, and it’s going to come on pretty quickly.» Chrissy was young and relatively resilient. He was very verbal, expressing his discomfort, he was almost hallucinatory. With very serious CNS, it mimics a stroke. We were not entirely sure how much of what he had to say was true and accurate and how much was delusion. The key was trying to get him calmed down, on oxygen, and trying to maintain as best we could until we could get him air-lifted out by the Coast Guard. Chris Sr. never did have spontaneous respirations. He had a pulse for maybe a minute. We were doing CPR on him and we had a pharyngeal airway that we put in, but you could feel resistance within his body building up. There were so many gas bubbles in his body that, quite literally, his blood was coagulating as we were trying to do CPR. From the time that we pulled him to the stern, Chris Sr. never had a viable chance.

You are faced with what can you do and who can you save, and then you get into an argument with the Coast Guard helicopter during the evacuation?» The Coast Guard swimmer comes down with the rescue basket and said they were going to take the son first. I said, “Take the son. Don’t take the father.” At this point, we had done CPR on Chris for something close to two hours. I was adamant, “The son has a chance. I know this family. If the father could sit up and have one thing to say to you, he’d say, ‘Take my boy.’ Chris is not going to make it. The only chance we have is to get the son treated as fast as possible.”


Chatterton on rebreather diving NOAA’s saturation habitat Aquarius

And the time element here is absolutely crucial.» We are as under the gun as you can be and we've already kind of resolved on ourselves to the fact that Chris Sr. is not going to make it. We're still doing CPR, but all of our hopes were really with Chrissy.

So how did you reconcile this triage?» I understand the Coast Guard's position that Chris is not dead until he's pronounced dead by a doctor, so we're doing what is procedure, which is to keep doing CPR. But from a practical standpoint, the father was dead and we should expend no further effort in trying to resuscitate him. We should try to focus our efforts on the son. But that's not the way the system works.

Ultimately, the decision was made that both were to go up in the basket and all of you were left behind. The chopper took off with the Rouses to deliver them to the chamber. This presented other treatment issues: the depth capability of the chamber, not to mention the delay.» And you're talking about a significant time lapse now, between four or five hours.

Both of the Rouses succumbed and passed away due to the explosive decompression they suffered. You're left out there on the boat rocking away with your own horrible psychological trauma, and you're facing a long ride back in. This turned off a lot of guys from going back out to this wreck again.» We were absolutely positively traumatized by the accident. Having a fatality is terrible, but having two fatalities is about as much as anyone can imagine dealing with. Having it be a father and son is worse still. There was also a lot of noise from both the cave diving community and the rival wreck divers. This really caused me, Richie Kohler, and others to question what we were doing. Is deep diving worth these two guys' lives? At the same time, there's multiple fatalities on the *Doria*, there's the Feldman fatality… it's a lot. We had been relatively low key, going out and doing the deep thing under the radar. Now we're not under the radar. We've got a big target painted on our backs.

You never really seemed to waver in your own personal interest in trying to determine the identity of this vessel. You guys called it the *U-Who*. It wasn't where it was supposed to be, nobody could come up with an explanation for why it was there, it had claimed three people's lives in a very short time. How long after the Rouse incident did you resume diving it again?» That was the last dive of that year, end of October. We were back out there first thing the next summer.

You seemed to react to this with a determination that is almost unfathomable for some outside observers. To think that you dove this first in 1991, and how many years until you identified it?» Six years, almost to the day.

This was a journey not only for you personally, but also for Richie Kohler. You two didn't get along earlier in your dive careers, Richie dropped out of diving for awhile after the fatalities, then you guys came back in and pursued this common interest. It ended up not only producing an enduring friendship and identifying the wreck through your astounding research, but at some point you were finally able to re-enter the engine room, recover the tag that identified the boat as *U-869*, and put this matter to bed against everybody that had been telling you that you were wrong. Three people have died, unbelievable amounts of finger pointing has gone on, nasty fighting, wild accusations, and you finally unveil the secret.» We were focused on what we were doing. Kohler and I weren't looking over our shoulders to see if anyone was watching. Richie really felt this was the right thing to do, for the sailors who had lost their lives and were lying in anonymous graves. Being a German-American, he felt a certain empathy to the predicament the families were in. You don't stop doing what it is you intended to do simply because it became difficult. The more difficult it became, the greater our personal resolve.


Chatterton and Kohler, U-869 dive , 1997

You spent six years of detective work. You've gone through an emotional rollercoaster, your first marriage breaks up, your career is changing, there's a bunch of things going on. In 1997, you unlock the mystery. Now your efforts start to attract some attention.» We had been involved with PBS and NOVA was doing a documentary on the wreck.

Was this *Hitler's Lost Sub*?» Yes. And PBS had partners in Germany and the U.K., so while they're building a two hour program in the United States, they put out a half hour program in Germany to find one of the veterans from the wreck. The documentary comes out in 2000, and it is seen and reported. Someone comes to Rob Kurson and tells him about the story that they have seen in the NOVA documentary.

What attracted him to the story?» I think it was the personalities; he probably was attracted to Richie and me on a very basic level. He went to an agent in New York City, and she made contact with us and asked if we would be willing to talk to him.

Why did Kurson think that it needed to go beyond the documentary, and what was your reaction to meeting with an unpublished author who was not a diver? What made you think he could tell your story?» Richie and I had been involved with several attempts at writing a book. In every instance, it just didn't pan out. They didn't quite get it. So when we sat down with Rob Kurson, we felt there was some kind of challenge involved. What we were trying to get across was that this submarine had left homeport in WWII with these 57 young boys on a mission that was doomed. They're in Norway, and they're watching all these U-boats leave, and none of them are coming back. That was the story that interested us: to die anonymously off the coast of New Jersey. That was what we envisioned as the story, that's what we spoke to Rob about.

Rob spent all day with us. He brought his pregnant wife, and all of a sudden he said he wanted to leave and start writing. We offered him dinner, and he said no, that he had to write. He's a nut. He has no social grace. He has no concept of anything other than what he's focused on. He made his wife drive home because he didn't want to lose anything in his head. And we're thinking this guy is out of his mind, but at the same time thinking he was perfect for us. He was not a diver; he still isn't a diver. I think that's why the book turned out so well. He had to learn everything about diving from us, and he was in a much better position to then present that information to the reader.

In my case, as both an author and diver, I found that to be true as well. I had read earlier accounts of the Rouse tragedy, and Feldman, and all the other elements that made up the other tragedies like the *Doria* expeditions. Kurson managed to come in and tell the story so well that I wonder whether anybody could have written it from within the dive community.» The same kind of dedication and focus that we had for our diving, he had for his writing. We understood each other right from the get go. He said, “Trust me. I can make this story a bestseller.” And I believed him.

Didn’t you also have to tell him that he couldn’t go out and dive the wreck himself?» Yeah. You’ll love this. He went to his agent and told her he had to go out and dive the wreck with us. She called us up, “Listen, Rob is talking about diving the wreck. You can’t kill this guy.” We agreed, and when he came to us we told him it was a really bad idea. He said he absolutely couldn’t write the book without diving the wreck. We then told him to go to his local dive shop and get certified thinking that would buy us a little time. That once he realized what diving was all about, he would back off. The obvious reality here is that the wreck had claimed the lives of three guys who were experienced divers with many years of diving behind them, and now he wanted to do it in a couple months.

So he went to dive class in Chicago. He had to be the instructor’s worst nightmare. When it comes time for the pool session, Rob eases himself into the pool and dogpaddles a little bit, and the instructor goes, “You can’t swim.” And Rob says, “Yeah, you’re telling me.”

So he asks him what he’s doing, and he explains that he just has to make one dive and then he’s done. Just one dive to this U-boat sixty miles off the coast of New Jersey, 230 feet down, and then he’s done. And the instructor tells him to get the hell out of the pool.

So Rob is now a broken man. He’s been thrown out of dive school, and he says that he simply cannot go on writing this book. So we sit down with him and ask him what happened. He explains that if he gets water on his face, he gets all panicky. And Ritchie and I look at each other and just shake our heads. This nut who can’t swim and panics when water gets on his face wants to do a deep technical wreck dive? Yeah, right…

So, let me take a wild guess; you don’t let him dive the wreck?» Come on, Bret, hell no! He’s still a non-diver, a non-swimmer, for that matter.

The book became such an elaborate project, because now the whole thing must be brought to life based on the narrative that you and Richie can supply to him. It is a fabulous book, a runaway bestseller. One thing that is interesting is that you and Richie were smart enough at the outset to know how much work you would be putting into it that you actually negotiated that the royalty be split three ways?» What happened was Rob’s agent took Richie and I on as clients of ICM. Like any good agent, they laid everything out. There was no subjectivity. When we signed a contract with them, it was very specific about who was going to get what, who was going to supply what, what would happen if it became a movie, etc. Rob certainly was very generous in sharing with us, and now it’s moved on into the movie phase.

You not only secured a movie deal but you originally brought in an A-list director in Ridley Scott.» Actually, FOX and Ridley Scott parted company on this. FOX was adamant that they wanted to shoot this in 2006, but Scott wasn’t available in that time frame, so they went looking for a new director. Now they’ve settled on the great Australian director, Peter Weir. His last film was the epic

Russell Crowe movie *Master and Commander*. He also did *Witness* with Harrison Ford. He knows how to tell a story. Our meetings with him have gone extremely well. He really gets the story and we all like each other.

How you've come from book to movie is interesting. Especially when you compare it to Peter Benchley, who was practically eating cat food when he wrote *Jaws*, and nobody could figure out how that book could possibly be brought to the screen. Peter was the first to admit even he wasn't sure how it could be done because, as you know, sharks don't take very good direction. Do you envision a hands-on role when this thing goes into production?» I think Richie and I will be consulting more on the diving end of things. Bill Broyles has written the screenplay; in fact he's working on the fourth take right now. I saw the second swipe that he took at this, and I have to say it literally made the hair on my neck stand up. I was moved by his script. If nobody screws it up between now and the big screen, it's going to be huge.

Do you have any idea who they might want to cast to play you guys?» They want A-list actors. When I look around at the very talented people they have drawn into this and hear them shooting numbers like a hundred million dollars around, I have the utmost confidence that they will find the right people for the job.

Well, I guess it's safe to say we're not going to see Paulie Shore or Adam Sandler in the parts.» If we're lucky!

How many copies of *Shadow Divers* have been sold?» So far, somewhere just south of a million copies in hard bound and paperback.

It's interesting that divers didn't make this a bestseller… the public made this a bestseller and it was ultimately because this is a human story so well told.» The credit really belongs on Rob's plate. I can't tell you how many people have come up to me and said, "I'm not a diver, I know nothing about diving, but I was moved by that book." The way that Rob wrote it was for the reader, and that's the mark of a really good book. People feel like Rob is talking to them. You and I could both read the book and take away completely different things, and that's why people love it.


Chatterton inside the wreck

You guys also parlayed yourselves into television?» While we're working with Rob Kurson and he's researching the book, The History Channel comes to us and asks to do a television series about divers and shipwrecks. It's something nobody is doing. *Deep Sea Detectives* they want to call it and initially they wanted eight shows. We figure we can squeeze in two shows before they realize we don't know what the hell we're doing and fire us.

Chatterton at 12,000 feet in Russian submersible,
Titanic dive, 2005

I remember the first day we went to shoot the show, the director of photography asked us what else we had done. We said we had worked on some documentaries. He asked us about dramatic things, and we sort of just sat there. We're at the dinner table when he finally figures out we're not actors. He freaks out.

But now, we've done 57 episodes and we're putting together candidates for the next slate of shows. They're seen all over the world. I get mail from friends in the UK and Yucatan saying, "I saw you on TV last night!"


Bret Gilliam, Chatterton and Titanic director, Jim Cameron, 2006

Any other projects on the horizon?» This past summer Richie and I put together a project on the *Titanic*. We went out, we chartered the Russian support ship *Keldysh*, took the submersibles, we did the whole thing on our own dime, made our own preparations, and then went to The History Channel and sold it as the executive producers. We're still working on *Deep Sea Detectives*, we're producing specials for The History Channel, we're still promoting the book. Twentieth Century Fox and the *Shadow Divers* movie has got us busy and we're consulting with Paramount Pictures on a dramatic television series. The only thing we don't see in our futures is unemployment.

Editor's note: There are about 40 copies of the original book still in Bret Gilliam's personal inventory. They are available as a Signed/Numbered Limited Edition personalized to each buyer by Gilliam at $200 each, including shipping. He can be contacted for purchase at bretgilliam@gmail.com.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June 2013
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