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When Necessity is Really the Mother of Invention

We've all heard the expression "necessity is the mother of invention." As commonly used, it is little more than an apt way of expressing the obvious fact that need is most often the motivating force which prompts someone to develop or improve a product or machine. Very often such inventions are made in the comfortable and supporting atmosphere of a laboratory or workshop with ready access to assistants and needed equipment. "Necessity" in the true sense really doesn't have much of a place in this equation.

But what about when necessity really means necessity? Necessity as in life-and-death. Necessity as in "invent and live, don't invent and die."

The centerpiece of this issue is the story of Steven Callahan, a sailor who spent 76 days, alone, adrift in an inflatable raft, and lived. When Callahan's small sloop, *Napoleon Solo*, sank near the Canary Islands in 1982, it happened so quickly that he escaped in his raft with only three pounds of food and eight pints of water. He spotted nine ships over the next few weeks, all of which passed him by. Out of flares and out of the shipping lanes, his only hope was to float to the Caribbean. His story is one of innovation, imagination and guts. He made makeshift spears to hunt fish, jury-rigged stills to make drinking water from seawater and traps to catch rainwater, designed patches for punctures in his raft, made a sextant out of pencils with which he navigated across the Atlantic ocean to within 60 miles of his original destination—Barbados. He made these things with a scanty supply of materials as common as string and plastic food containers. When picked up by fishermen on the seventy-sixth day, he had drifted eighteen hundred miles, the only man in history to have survived more than a month alone at sea in an inflatable raft.

Mr. Callahan graciously consented to an exclusive interview with *Asymptote Review*, in which he discusses his adventure and the role that "invention" played in his survival.

In keeping with the theme of this issue, on page 7 we feature the fascinating story of the invention of the marine chronometer — the basic timekeeping device which made it possible for sailors to determine longitude and thus, in combination with a sextant for determining latitude, learn their position and navigate the oceans.

On the Back Page, The Lighter Side offers several less practical ideas for rescue at sea, as patented in the United States Patent Office.

Innovation and Survival

Stranded-at-sea survivor and author Steve Callahan recently spoke in depth with Adams Law Firm president W. Thad Adams, III, about ingenuity and resourcefulness. We think you'll enjoy the insights he shared with us.

Adams: Steve, give us a little bit of background on where you grew up and how you got interested in sailing?

Callahan: I grew up outside of Boston, in the suburbs. My family really had no sailing experience at all. My folks are from coal mining territory in Virginia and had never sailed. I was given the opportunity to start sailing with my Boy Scout master, who had a little day-sailor and would invite different people to go out sailing with him. When I started sailing with him, I fell in love with it and ended up crewing with him for many, many years, even into my college years. He's the one who really introduced me to sailing and we would take trips together. We moved through a series of boats, from the day-sailer to something called an Oday mariner, which is a little overnight-camper type of boat, and into a Cal 25. We started with day trips, then made longer trips until we were doing two-plus week cruises, mostly along the Maine coast. We shared everything — navigation, helming, planning. He started letting me take the boat out on my own. From the age of 16 or so I was taking the boat, single-handing it for a day or two at a time. He was a great teacher, allowing me to take as

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much responsibility as I felt like I could handle.

Adams: When did you first own your own boat?

Callahan: In 1974 or thereabouts. After I got out of school, I built a boat. I'd helped a guy in town build a boat when I was still in high school. When I got out of college, I built a 28-footer, which I ended up living aboard for a while, then stumbled into helping other people build boats, which I did for about five years.

Adams: When you were doing this, were you occupied in some other occupation or was this the way you made your living?

Callahan: Well that turned into my occupation for about five years.

Adams: So, where were you living then?

Callahan: We moved around because projects would be at different places. For the most part, I was on the north shore of Massachusetts, Marblehead-Salem area, and often was living on the boat and working on other people's boats that were in the area. I also went down to Philadelphia for a year to build a boat down there. So, we were just moving around, and then moved to Maine in 1977. I'd been stumbling from building into design work at that point. My father was an architect, so I grew up drawing and so forth. I also took courses in designing. When I got to Maine, there was a designer nearby who had written me a letter because a design I had done had ended up in a sailing magazine, *Cruising World*, which is where I've been working the last four years. And he said, "welcome to the neighborhood and come down and see me sometime." So, I did. I ended up working with him in his design office and helped him to further develop a design schedule.

Adams: When was the first time you seriously considered making a solo trip across the Atlantic?

Callahan: Well, probably when I was still in high school. I had read a book called *Tinkerbell*, by a man named Robert Manley. He had taken this little 13-footer, what was originally a day sailor, and put a cabin on it and sailed it across the Atlantic Ocean. That really captured my imagination. And then, when I was in high school, Robin Lee Graham sailed around the world. He was the first teenager to sail around the world. He wrote a number of articles for *National Geographic*. I was very envious of him because we were about the same age and, while he's out rowing in the ocean, I was going to physics classes. I was very interested in sailing, certainly, by that time. So, I'd always thought, from the time I was about 12, I guess, that someday I would go off and venture across an ocean, either by myself or maybe with one other person, in a small boat.

Adams: It was obvious to me from reading your book that you were far better prepared to cope with emergencies than the average sailor would have been, but had you considered how dangerous a trip like that might really be before you actually undertook your first solo?

Callahan: Yes. First of all, I got into sailing in a number of steps, from day sailing to doing weekend cruising, from overnights to long cruises. A lot of people these days seem to have little experience on boats before they just hop on and think that they can just go off and sail around the world. They seem to think that, if they get into trouble, they can just park and wait for help, but going to sea isn't like that. You have total freedom, but you must take responsibility for yourself. But, I think because I had progressed through so many stages for such a long time that I'd come across a lot of little problems and got used to dealing with a lot of little problems first. Plus, by the time I took off in '81, I'd either been building boats or designing boats for eight years and I had a lot of friends in the boating business — people who'd done deliveries, or professional racers, and so on. A number of these sailors I knew personally. They had been in very dicey situations before. I'd also read all the survival books — tales like Bailey's *119 Days Adrift*, and Dougal Robertson's *Survive The Savage Sea*, which told how people had lost their boats and spent long times in life rafts. I was well aware of the possibilities — and I'd always been safety conscious — so I did have some fairly good gear.

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Recent Technological Developments in Rescue and Lifesaving

A recent search in the files of the United States Patent and Trademark Office disclosed many recent patents directed toward various sea rescue and lifesaving devices. These include:

- a parafoil-borne distress signal;
- a T-bar and crane man-overboard rescue device;
- a collapsible sailing rescue watercraft;
- an emergency paddle kit;
- a rescue fin for repairing a broken skeg box on a sailboard;
- a combination portable sun-shield and emergency sail;
- a self-inflating convertible life raft intended for launching from a distressed ship or a downed aircraft — including anti-capsize water ballast bags which are retractable to allow for life raft maneuverability;
- an emergency propulsion system for motor powered and sailing vessels which have a single propeller shaft; and
- a rescue signal balloon.

The unavailability of some of these devices in the marketplace, as explained by Steve Callahan in his interview, highlights the problem sometimes encountered by inventors in getting obviously worthwhile inventions into the hands of those who need them. Adams Law Firm, P.A., has substantial experience in advising inventors and patent owners at all stages of development and marketing.

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Adams: Your boat seemed very well equipped for emergencies. Did some of the equipment on your boat come from having read some of these other books that you mentioned?

Callahan: Yea, they did. I also had a survival manual written by Robertson that gave good advice. Reading other people's stories makes you aware of what might happen, and even in terms of basic boat design, I always have divided up my approach to a design in categories. Cost is one consideration, but there's also performance, accommodations and safety, and you come up with certain balances between them all. The boat that I designed had watertight compartments in it, and I had assessed the major risks to a boat offshore. The smaller the boat is, the more it's going to get kicked around, so my boat was designed to be self-righting. To protect the crew I had an inside steering position so that in bad weather I could stay below and still have control of the boat.

Adams: Your boat was called the *Napoleon Solo;* the one that you were sailing back across the Atlantic from Spain, correct?

Callahan: That's right.

Adams: What do you think collided with *Napoleon Solo* that caused it to sink?

Callahan: I think it was probably a whale or some other large sea creature. My experience at sea has brought me very close to whales on a frequent basis. I'd hit a whale in 1977 in broad daylight. I was at the helm and just didn't see it until I was right up on top of it. I hit a basking shark, which is quite large — they get up to 20-30 feet or so — in a big aluminum boat, in 1986. There's a lot of stuff out there that you can hit — containers and logs — but whatever hit *Napoleon Solo,* I believe came into the boat from the side. If it had been a log or a container, it would have hit more toward the bow, because I was sailing fairly fast forward. My recollection is that this was something that came into the side of the boat and actually pushed the boat a bit sideways. So, I presume it was just a collision with a whale. Of course, in any type of sea a sailboat makes very little noise, especially in comparison to toppling waves, and a whale might just be swimming along, minding his own business, and there you go, you've got a collision.

Adams: Before your experience, had you ever tried to imagine what it would be like to be adrift at sea for a long period of time?

Callahan: Oh yea. Ever since I can remember, actually. Even before I started sailing, I think I had a survivalist concept. I always pictured myself surviving something one way or another, because I grew up as a kid through the Cuban missile crisis and all of that and, you know, the duck-and-cover stuff as a kid. Survivalist scenarios were ingrained in me from my very earliest memories. I was in the Boy Scouts. I grew up in an area outside of Boston where there were a lot of woods. I spent a lot of time running around through the woods, camping, climbing mountains. Sailing is like that. You're faced with dealing with whatever problems you come across with a limited number of resources. When mountain climbing, you live off of what you can scavenge from the environment and what you can fashion using the tools you can pack on your back. A boat is not a whole lot different, especially a small boat like *Napoleon Solo* . So, I was used to doing these kinds of things and, in fact, enjoyed it. I often thought when I was sailing, even before *Napoleon Solo,* that when I was racing and a problem cropped up, it was actually more satisfying to solve the problems than to win the race. *Napoleon Solo* had been dismasted early on, so I had to jury-rig it at sea and get it back to port under its own steam. People were very impressed by the quality of the jury-rigging, and couldn't tell anything was wrong with the boat until I showed them the spreader sockets about a foot off the deck instead of halfway up the mast where they should have been. Although I failed at completing that particular passage, it was very satisfying to rig up something people thought was a normal rig on the boat. I always took a lot of pride in creating something out of nothing, if you will, or using limited resources in creative ways to solve problems. Writing, design and art all fit this mold — start with a blank piece of paper and create something.

Adams: I want to come back to this problem-solving issue in a minute, but looking back on your ordeal, are you glad you were alone, or do you think you would have fared better if someone else had been with you?

Callahan: It's really hard to say. Generally speaking, one thing I found heavily underscored by the experience is that life is so full of paradoxes and dilemmas. If I had had a companion maybe I would have seen a ship that I missed by being alone. There were certainly a lot of times when it would have been nice to have had somebody to bounce ideas off of, or to help solve a particular problem or whatever. On the other hand, there really wouldn't have been enough water for two people; there was barely enough for me, so I think that if I'd been with somebody else, at least one of us and, probably, both of us would have died. Also, the other person would have introduced a whole host of new problems. When dealing with other personalities a huge amount of stress can build between survivors who are faced with very minimal resources — food and water and that kind of thing. So, overall, I'm glad I was by myself. I've known a lot of other survivors who have said that the problems of being with other people are greater than the problems of being alone.

Adams: In hindsight, what do you think the most valuable item you had aboard your life raft was?

Callahan: I can name a handful of items, but it's difficult to name just one. Obviously, the life raft; if I hadn't had a life raft, I wouldn't have survived. Also critical were my solar stills which gave me a way of producing water.

Adams: Was it common to have more than one water still aboard, or did you just think ahead, providing for a backup?

Callahan: Well, it wasn't common. I ended up with several because I'd bought one previously and then, when I got the raft, it was one which somebody else had already voyaged with and, in its kit were a couple of solar stills. So I ended up with three of them and I'm glad I did because each had a fixed life and the last one broke down before I made landfall. As far as I know, I'm the only person who has ever gotten any of these things to work in the real environment. I ended up having to cut one up and try to figure out how it was put together and how it was designed to work so I could figure out how to use it, which was *not* according to the directions. Using it according to the directions, it would not work.

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In fact, it would fall apart. So to a certain degree, having three stills was happenstance, though I always like to carry backups. The solar stills were key to my survival, because water is much more critical even than food. I was also fortunate to be able to provide most of my food with a speargun that I bought in the Canary Islands just before I left. That was also a bit of good luck. Finally, I think that the pencils and paper that I had were critical in a psychological sense by allowing me to keep a "normal" shipboard routine; keeping a log; being able to separate myself from the situation and look at it in a more dispassionate way and note that there were good things that were happening as well as bad; and keeping navigational notes and similar things. So, from both a pragmatic and a morale standpoint, they were very important.

Adams: One of the things which originally interested me in the book was that it seemed you were in a situation where, if necessity was ever the mother of invention, that was it. You made excellent use of the things you had on the boat. Have you ever given any thought to solving problems on a boat as they come along in a formal sense, or is this something that becomes instinctive as you gain experience?

Callahan: I'm not sure exactly what you mean by giving formal thought to it, but first of all, I'd been in the boat design process. I was used to problem solving. I was used to doing that from experience. From the time I was 11- or 12- years old, I was used to building this and that out of rope and sticks. I carried that into my adult life by building boats. You know, a lot of times when you're building a boat, you're faced with "How do I solve this problem?" Somehow you've got to figure out how to match this shape with this curve. You often have to make special tools and jigs, especially with boat building even more so than with building a home. I'd rebuilt a house. I'd built a shop. I was used to constructing things and solving lots of problems. I think that a lot of people who've spent their lives sailing get used to sitting on deck, always looking for the next problem that might occur. You're always considering what might happen next. So when the mast came down on the boat, I not only had read about what other people might have done to re-rig a boat, and had kept that knowledge tucked away in my mind, I was also prepared with plans to suit my particular situation. But, as I sail along I wonder "What happens if the mast goes down this way, what happens if it goes down that way? What would I do if I lost a stay?" You know, normally while things are good, a sailor thinks of what could go wrong, because inevitably, something *will* go wrong and it's just a natural course of events to run through all the major problems. In designing the boat, I tried to assess what the major risks to the boat were so that I know beforehand and plan for those, because in addition to those problems you're going to run across other ones that you haven't even thought about yet. Often they happen simultaneously, and if you don't begin with a leg up you may be doomed.

Steve Callahan

Adams: Sure. I noticed in particular as you were describing the various ways you went about trying to patch the hole that the speargun made, you explained how you hit upon the idea of using a fork to secure the lashings to the raft material, and at that point, it struck me more than any place else, how you were very formal about the way you said, "Well now, what's the problem and what are the possible solutions? Well, if that doesn't work then I'll try this," and so forth.

Callahan: Well, I was a philosophy major in college. I have a very poor memory, but if I have a strong point, it's in concepts. So, what I try to do is to strip things down to basic concepts. What is the basic conceptual problem? In some ways, being too formalized about problem-solving can be a problem because you end up with fixed and narrow solutions.

You end up with "I can only do A, B, C or D." You get too tunnel-visioned down one road or another rather than being able to back-off and say, "conceptually, what is the problem here?" and then, "conceptually, what do I have that can attack that problem?" in a totally different way that I haven't even thought about yet. You just try to approach it from a totally different angle. I found often in my interviews with other survivors that they had been incredibly inventive while under stress. I often tell people that survivors look at objects outside their "normalized context." You know, we're used to an object being just what it is, but its actually much more than that. A perfect example of this — which has nothing to do with me — is a group of survivors whose airplane crashed off the Bahamas and the plane sank out from under them. They went drifting off, wearing only life jackets and what they had in their pockets. They were fishing around, looking at what they had. They were drifting into the open Atlantic Ocean. A guy got his wallet out of his pocket and was going through itwhen he found that he had a gold credit card. He saw that it was reflecting the moonlight quite strongly and he got his buddy to pull one out. The next day they got out everything they could find that had a reflective surface and they were successful in drawing the attention of an aircraft overhead. So the credit card was no longer a credit card; it was a hard, shiny, waterproof surface. That's what I tried to do in the raft. I tried to save everything I could because no longer was it a man-overboard pole or piece of rope or whatever. It had base qualities to it. So I tried to look at things for what the base quality was--was it hard, shiny, sharp, what were those qualities and how might I employ them to solve a problem? That's what a lot of survivors do to, as you say, spawn that mother of invention.

Adams: I was particularly interested in the navigational aspects of your survival. Had you ever made a sextant out of pencils before?

Callahan: No.

Adams: If you had discovered, for example, by using this pencil and rubber band sextant that you appeared to be drifting too

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far north and would miss the Caribbean Islands, was there anything you could have done to steer yourself further south?

Callahan: The short answer is I don't know really, but, in fact, I tried to influence my drift. I trailed a line from the back of the raft tied to a man-overboard pole and that, I theorized, improved my visibility because while the raft might be down in a wave trough, the pole would be up on top of a wave and vice versa. I tied mirrors to it, also for visibility. In addition, the line and pole gave the raft some directional stability. Left to its own devices, the raft will just spin around, drifting with the wind. So I needed something to give the raft some directional stability, but I also wanted to improve the drift rate of the raft. I pulled up the sea anchor, which would give it directional stability, but which also slowed it down. I set this pole out the back and I tied the line to it off-center to encourage the raft to drift southward, or what I thought would encourage the raft to drift southward and so I had a little bit of control. In addition, I had these paddles and I felt like I was drifting about in the right direction. I tried to be conservative in my calculations. Had I thought I was even right on the line, then I probably would have tried to encourage the raft to drift even more southward. The additional plan that I had was to take these paddles and tie them on the side of the raft and make little centerboards to give the raft a little bit more control in water, but it still would have been very, very limited. I've looked at a lot of survival drifts since that time and, even if you can control your drift within 10 or 15 degrees of the wind, most survivors would have very greatly shortened their survival drift — often by as much as 60 to 80 percent.

I always took a lot of pride in creating something out of nothing, if you will, or using limited resources in creative ways to solve problems.

— Steve Callahan

Adams: How long has it been?

Callahan: It was 16 years ago, as of February 4th, when I lost my boat.

Adams: I know that reverse osmosis water purifiers and GPS [Editor's note: GPS stands for Global Positioning System, which utilizes signals from multiple military satellites to give very accurate position information] and many other emergency tools are now available. Are these things now commonly found on sailboats?

Callahan: Yes, Well, many are, but some are certainly far from universally found. GPS is extremely common now. I would say that within the next 5 years virtually all offshore boats will have it. There's really only a handful of people that don't have GPS at this point. The reverse osmosis water makers are another story. They are not as common because it's still hard to get people to buy safety gear that is specifically made for safety. People don't want to spend money on something they hope they'll never use. People are always very good at denial. One of the most common instincts among people is that accidents happen, but, at least deep down, they feel it's not going to happen to them. The safety business is a tough business because you're trying to get people to spend money on things they really don't want to hear about.

Adams: How about the life rafts themselves? Have they changed a lot in the past 15 or 16 years?

Callahan: They really haven't changed a lot. When I got back, I had, of course, numerous ideas about improving rafts. The business is quite tough to change because the major part of the life raft/lifeboat business is commercial, for shipping and offshore oil rigs. The market is so small for sailors and offshore voyagers that it is difficult to justify economically producing a raft specifically for them. In addition, because of the commercial focus and the regulations recognized by most countries and international organizations — you're dealing, in essence, with international bureaucracy which is very slow to change. And so rafts are regulated to be best designed for those applications. Like when an airplane crashes, search and rescue (SAR) personnel usually know fairly quickly and they want the survivors to stay put so that they're easier to find. But a raft that sits still isn't necessarily the best design for someone voyaging across an ocean. Even if SAR knows a sailor is in trouble, rescue may be days or even weeks away. It may be better for the survivors in many cases to take more control over their own destiny and navigate the life raft or the lifeboat in one direction or another. I had all these ideas, but what I ran into was a bureaucratic brick wall in actually making changes. I don't think it's impossible, and I think rafts may change in the future, but it's a very slow, cumbersome process to make it happen. However, I'm talking with a life raft company now about doing some more testing on shapes, ballast systems and other details.

Adams: So, you're saying life rafts are the same as they have always been — rubber inflated by compressed CO_2?

Callahan: Yea, that's right. One thing that's changed is that the water ballast on life rafts, which makes them more stable in heavy seas, has steadily increased. Personally, I think they're going in the wrong direction. By regulation, the ballast has to be evenly spread around the raft, which doesn't make any sense to me. It makes sense to me to have it more on one side than the other in order to make it more effective, and to give the raft more directional stability, which is better for survivors. But that's what I mean by things moving very, very slowly. In fact, these changes were inspired by the last significant testing of life rafts, which was done between the years of 1977 and 1981. The tests are extremely difficult to accomplish because you're dealing with a real-world environment. For instance, how can you test a raft in hurricane-force winds? It's very difficult to go out and actually test them in those conditions. So it's just a tough problem all around to try to make improvements that work in the real world. Conceptually, rafts have remained almost the same since the Second World War. There have been improvements; placing canopies over the top and dividing the tubes up so that, if you lose one tube, the other tubes stay inflated, but, there have been very few changes to the general shapes and other key basics.

Adams: What about survival clothing?

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Callahan: That's actually improved a lot. We now have immersion suits, which are great. Of course, one of the biggest problems with the survival scenario in the ocean is losing body heat. Even in 60 or 70 degree water temperatures you can die of hypothermia, so retaining body heat is a primary goal. We now have what we call survival or immersion suits. They are like a wet suit, being made of neoprene, but they're usually thicker and they're dry. Once you're zipped up in one of these things, no water should get inside. People have survived even floating in near-freezing water for hours and hours, and getting out and running around on the land in subzero weather for a day or more and still survived. They're a really big plus. Just regular clothing for wearing on board has gotten a lot better; keeping people dryer and permitting layering and so forth.

Adams: Steve, have you made any long solo trips since your experience?

Callahan: I've sailed from the States to Bermuda, that sort of thing, single-handed. But, generally speaking, I often sail short-handed. A boat seems to get crowded with more than one or two others aboard. I've not done any other single-handed ocean crossings. I do quite a lot of double-handed sailing and I prefer to sail with others. I think it's safer, and it usually is a lot more fun.

Adams: Have you been back to the island where you were rescued?

Callahan: Yes. My wife and I went back there in about 1990. We took our boat down to the islands and spent a year down there. We stopped in at the island where I landed. Most of the people I had interacted with had left the island. We did locate several of the people I had met and with whom I'd become friends. Those reunions were wonderful.

Adams: What was the one thing that you did or didn't do, looking back on it, that you think made the difference between living and dying? Are there one or two things you could put your finger on?

Callahan: The answer is that there are probably millions of things, if not billions of things, that had to have happened just as they did in order for me to survive. It's very difficult to separate out one thing because even a small, seemingly insignificant thing can become critically important. That said, one big thing that was very critical to my survival was putting watertight compartments in my boat, because if they hadn't been there, the boat wouldn't have stayed afloat long enough for me to get back aboard to get all my survival equipment and I definitely would have died. Buying the speargun, which was a happenstance thing, and finding there was no real good place to store it in the boat, then thinking "oh well, that might come in handy in a survival situation," and having it just fit in the survival bag, was a very fortunate circumstance. There were lots of things like that. I remained just warm enough, just cool enough; I had *just* enough water, the environment which tested me also provided me with just enough sustenance. Had anything changed, I probably wouldn't have survived. I know that I probably made a lot of dumb mistakes, as well; things that cost me — trying to make my water drinkable by mixing it with a little sea water ended up making me really sick. Things like that were probably pretty stupid. So what allowed me to survive? I don't know, dumb luck? The gracious nature of the environment, lucky to have the fish out there, all those things...

Adams: One last thing. You mentioned in the epilogue of the book that you really didn't think you had been changed dramatically in any way by your experience. I think you mentioned that your appetite seemed to be different. But, looking back on it from a much longer perspective, are you really substantially different in any way than you were before all this happened?

Callahan: Yes and no. I think that is probably the answer for most survivors. I don't think I'm essentially a different person. I think that I'm still relatively analytical and I approach problems in the same kind of way. I'm probably as stubborn as ever and I carp and moan and groan about the same kind of things I did before the event. In the short term of course, life was very, very easy after something like that. Anything that might be considered a problem seemed like no big deal. Miss a meal? Who cares! So in a way, maybe I survived because of who I was and how I saw myself linked to the environment. I don't think the experience really changed me in that way. On the other hand, some things are different. You never forget what it feels like to starve. You can't physically recall the pain of it or the anguish of it, but there is a place inside of me that knows what it's like to starve, to not have enough to drink and to be critically dehydrated. I know true desperation. That touches me still, much in a way I can't describe. Sometimes it surfaces at very unexpected times. It could be while watching a schlocky, melodramatic movie or seeing two people touch hands, but there's something in me that moves me to tears at times, not just from *not* being in pain or not starving but the capacity we have for seeing human kindness and things like that. That certainly never would have occurred before because I had distanced myself from people. In an ironic sense, I think it made me more impatient in the long run. In the short run, I was more patient than I ever was before, but in the long run, I think it may have made me more impatient because I'm so aware of how tenuous life is. I don't want to squander it. If something seems a waste of time, I think, "who's got time for this?"

Adams: Thank you very much, Steve.

Steve Callahan is author of Adrift, published by Houghton, Mifflin & Co., New York, 1986, and is co-author with James Nalepka of Capsized!, Harper Paperbacks, New York 1992. Steve currently resides in Newport, Rhode Island, with his wife.

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Unresolved need to measure longitude fueled fascinating series of inventions

Any sailor who left sight of land in the eighteenth century took his life in his hands simply because he didn't know where he was. The "longitude problem" was the major scientific dilemma confronting navigation and world commerce. Simply put, sailors at sea had no way of knowing exactly how far east or west they were. They could tell how far north or south they were—sextants had been known for ages and latitude could easily be determined.

Many world-renowned scientists, including Newton and Galileo, had been searching for a solution for over two centuries. Many solutions had been proposed. Complicated mechanical devices were invented, but either didn't work at all or relied on clear skies, daylight, calm seas or other conditions which could not be counted on at sea. Mathematical and astronomical solutions were proposed, such as complicated tables of star and moon locations. These tables required lengthy and precise calculations which were beyond the skill of many sailors. Some solutions worked sometimes — for example, splitting the difference between true and magnetic north to find a line along which the ship was located. And, of course, there were the completely bogus proposals, including schemes that depended on barking dogs or cannon blasts or some other event.

In 1714, the English Parliament offered a prize equivalent of $12 million in today's dollars for a solution, and established a commission of scientists to judge the proposals. One man, John Harrison, dared believe a practical mechanical solution could be found, and he spent 40 years doing it. He invented a clock—the marine chronometer—which revolutionized not only navigation but timekeeping itself. Along the way he made other inventions, including the bimetallic strip, grasshopper escapement, caged ball bearing and jewelled watch movement. His is a story of an obsession with precision and a belief that nothing could ultimately prevent success if enough effort was exerted on the problem. In an era when the very best clocks lost a minute *a day,* Harrison built clocks which lost less than one second *a month.*

What is longitude? Longitude is a purely arbitrary value based upon imaginary lines which loop around the earth from pole to pole. Since the earth takes twenty-four hours to complete one full 360 degree revolution, one hour marks one twenty-fourth of a revolution—15 degrees. Each day at sea, a navigator resets his ship's clock to local noon when the sun reaches its highest point, and then consults a home port clock. Each hour's discrepancy between them represents 15 degrees of longitude. These degrees translate into distance traveled, based upon the latitude of the ship, since the distance between each degree of longitude is greatest at the equator and least at the poles. The navigator then measures off the distance on his map and with the known latitude has a precise position.

Precise knowledge of the time at two different places at once—something that can be determined today from any two cheap watches, was utterly impossible until the invention of the marine chronometer — by Harrison. Pendulum clocks would speed up or slow down or stop altogether in a rolling sea. Changes in temperature, barometric pressure and gravity introduced further errors.

Clockmaker John Harrison, an Englishman with no formal education or apprenticeship to any watchmaker, accomplished what Galileo, Newton, Halley and Huygens could not. Harrison defied convention by first eliminating the pendulum. He then constructed a series of virtually friction-free clocks which required no lubrication or cleaning, were rust-free and were impervious to the roll of the waves. He combined different metals in such a way that when one part contracted, other parts counteracted the change by expanding, thus keeping the clock's rate constant.

Each of Harrison's successes was opposed by jealous rivals, petty bureaucrats and charlatans. It took Harrison five years to build his first marine chronometer. It was met with a mixture of praise and ridicule. However, the Longitude Commission gave him a small financial award, and Harrison created a new and somewhat smaller clock which was even more accurate. However, Harrison was not satisfied, and spent another *19 years* developing another, smaller timepiece. This third clock, which Harrison called "H-3," was much smaller and lighter than the earlier ones — it was only two feet high and one foot wide, weighed 60 pounds and had 753 parts. It was the first timepiece to use jewels — diamonds and rubies — as bearing surfaces.

Harrison was still not satisfied, and spent more years developing "H-4." This revolutionary device was only five inches in diameter and weighed only three pounds! It came to be known as the "The Watch," and thereby named the device which we now call by that name. Harrison was finally ready for a full sea trial, and traveled by ship from Teneriffe to Jamaica with "The Watch." The crossing took 81 days, and when the calculations were completed, Harrison's device had lost five seconds!

The full story of Harrison and his creation of the marine chronometer is too long to repeat in full here. However, he was finally rewarded with the credit he deserved and an apprentice, Larcum Kendall, built a chronometer on Harrison's principles. The second of these, known as "K-2," was sent with William Bligh and his ship, the Bounty, on the famous expedition to Tahiti to acquire breadfruit plants for shipment and transplant in the West Indies. The K-2 chronometer was taken with Fletcher Christian and his mutineers to Pitcairn Island in 1789, and was bought by an American sea caption in 1808.

Many of the inventions made by Harrison in his development of the chronometer are still in use today in jeweled watches and are lasting tributes to the devotion of one man to the idea that longitude could be determined in any weather or sea conditions. He deserves to be recognized along with other famous inventors as one who made a lasting contribution to science, and thus to the improvement of man's life on earth.

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Note: The full story of John Harrison and the solution of the "longitude problem" may be found in Longitude by Dava Sobel, published 1995, Walker and Company, New York.

On the lighter side

Imagine leaving your home in a landlocked country like Austria-Hungary. Imagine having never even seen the ocean before. Imagine traveling all the way across the Atlantic Ocean to America at the turn of the century and seeing for the first time the huge waves and high winds of an ocean crossing. Imagine being scared to death that the ship you were on would sink.

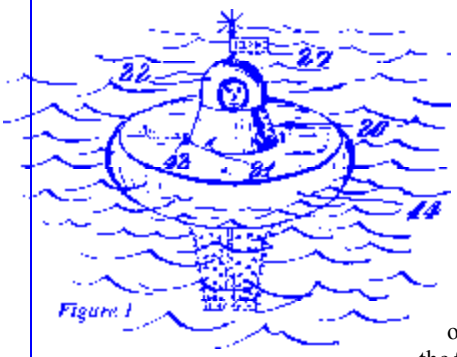
Figure 1

As shown in Figures 1, 2 and 3, immigrants to America went to the Patent Office with their ideas for live-saving suits. All three of these patents were obtained before 1920 by immigrants who were still subjects of the Emperor of Austria-Hungary. From the features of these lifesaving suits it is easy to see how vividly these inventors must have imagined the horrors of being lost at sea.

The Niemiec Patent (Figure 1) provides a means of inflating the rescue suit and "spurs 17 adapted to discourage the attacks of fish and the like." (Steve Callahan describes at length the almost constant butting of the bottom of his raft by fish and sharks. Is there a way of "spiking" the bottom of a rubber life raft to prevent this?) Note the "Help Me" sign on the top.

The problem of biting fish was solved in a different way by Mr. Vukosav (Figure 2). Here, the wearer walks on the water, and an American flag on the helmet informs the rescuer of the wearer's nationality.

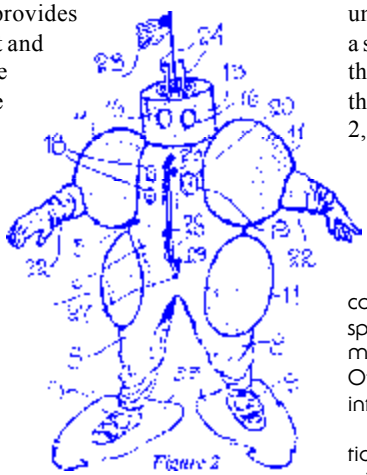
Figure 2

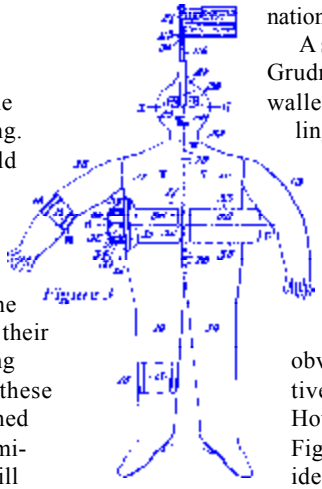
Figure 3

A similar lifesaving suit is shown in the Grudnienski Patent (Figure 3) where a double-walled suit with an inflatable belt and a signalling flag protects the wearer from the elements and provides floatation while awaiting rescue.

Of course, it's easy now to have a laugh at the innocent impracticality of these devices. But try to imagine how the inventors felt at the time.

These ideas from almost a century ago are obviously impractical, and from our perspective more amusing than anything else. However, take a look at Figure 4, an idea patented in 1987 whereby a motorcycle rider wears an inflatable suit which inflates in the event of a crash by means of an umbilical cord connected to a supply of compressed gas. Is this really all that different that the devices shown in Figures 1, 2, and 3?"

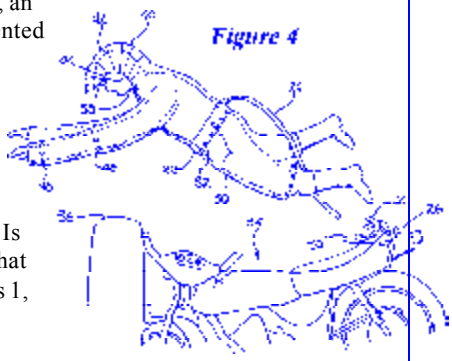
Figure 4

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