

## FORENSIC NAVAL ARCHITECTURE

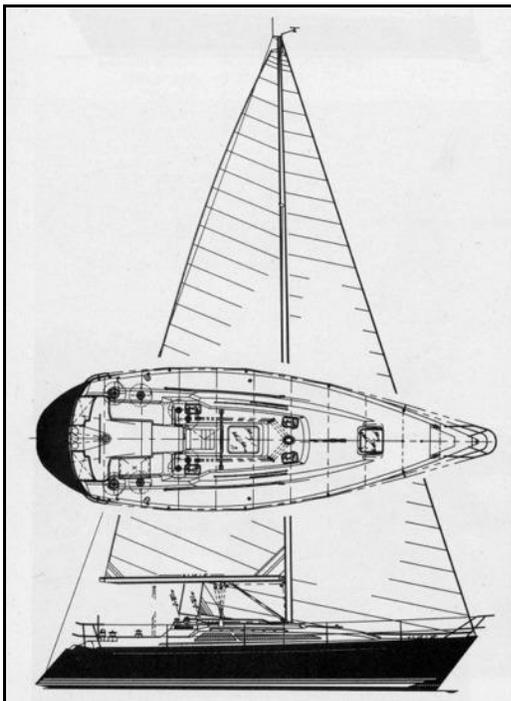
### Sleuthing Boat Accidents

by Eric W. Sponberg

**Author's note:** *The following article is the original manuscript that I wrote for Professional Boatbuilder magazine. The final version of the article appeared in PBB #50, December/January, 1998 as Forensic Engineering and Expert Witnessing. People and builders in the following article are referred to by initials to protect their identities. The initials have no correlation to their actual names.*

Forensic naval architecture is naval architecture to figure out what happened in an accident or event for the benefit of the court. When a forensic naval architect testifies in court, he or she is called an expert witness. Courts need expert witnesses to explain complex technical issues in layman's terms so that judges, juries and attorneys can understand them.

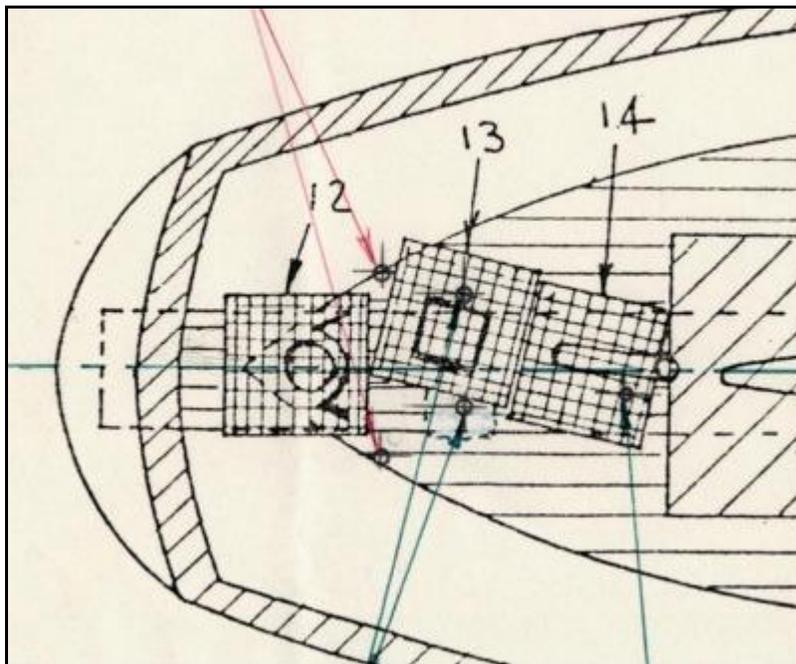
In my very first case, in 1985, Mr. C bought a 34' fiberglass sailboat from Boatbuilder D for \$61,500.00. Due to the press of production, the cockpit drains were left to the broker to install. Afterwards, Mr. C complained to the broker that he installed the through-hull fittings too far forward and too far below the waterline. So the broker removed the fittings, patched the holes with nicely done fiberglass patches, and reinstalled them further aft and higher up.



**Fig. 1.** *The boat design in question in my very first case.*

Mr. C, however, became enraged because the patches necessarily had to rely on secondary bonding. Well, he was lucky to be alive, he said later in court, because secondary bonding is no good, and it is damn lucky the boat didn't sink leaving him to drown! Mr. C filed a lawsuit against Boatbuilder D and the broker claiming he incurred \$46,500 in damages, which he demanded trebled, plus attorney's fees, interest, and the cost of the suit. Mr. C did not hire a fiberglass expert to back up his claim, but relied only on what he had read about fiberglass in boating magazines.

The attorney for Boatbuilder D, Robert Compton, with whom I have worked on a number of cases since, called on reference from someone else to say he needed a naval architect expert witness who could talk from shop floor experience on fiberglass boat manufacturing. I have a degree in naval architecture, and I had been chief engineer at a major boatbuilder, so I seemed to fit the bill. I explained, though, that I had never testified in court before. "Don't worry," Mr. Compton said, "I'll prepare you with the pertinent facts, and you just explain your opinions."



**Fig. 2.** The green arrows point to the original through-hull locations, and the red arrows to the new locations.

### **Trial by fire**

In court a few months later on a steamy hot June day, using fiberglass boat sections from Boatbuilder D as demonstration models--one with a molded-in through-hull, the other with a secondary-bonded patch--I explained to the jury the basics of fiberglass boatbuilding.

Since this was my first time ever testifying in court, my hands were sweating considerably. I mangled a white paper napkin to keep them dry. My mouth was thick

with saliva, and I quickly downed all the water from the glass on the witness stand. Relief was fleeting. Mr. Compton finished his direct examination, and Mr. C's attorney started his cross examination. Oh boy, the Spanish Inquisition, I thought. The air conditioning was on, but you could have fooled me. After what seemed like six hours under hot lamps like in old mystery movies, Mr. Compton did a short redirect, Mr. C's attorney a short re-cross, and I was through.

With legs of limp spaghetti, I rose to go, but the judge placed his hand on my shoulder and told me to remain seated for a moment while he called a recess. Crap, I thought, I guess I really blew it! Now they're going to arrest me! My gaze caught Mr. Compton's in return, and in a flash I knew he was worried. Something was about to happen, and we waited for the courtroom to clear. My dark blue sport coat was sinking in sweat. I was drowning. Finally, the judge leaned over and handed me his card. "You did a fine job, young man," he said. "You know your field well, and you explained your opinions very clearly to the jury. Good work!" He even allowed me to use his name as a reference in future cases, and he would be happy to vouch for my expertise and credibility. Wow!

The jury gave us a very favorable judgment. Boatbuilder D was assessed zero damages, and the broker about \$3,300 damages, equal to the cost of moving the through-hull fittings. I never had a chance to take up the judge on his offer as a reference, however. His secretary, with whom he'd had a long-running affair, wanted to break off the relationship and she hit him with a sexual harassment suit. He got kicked off the bench.

## **Freedom of speech**

I have probably watched too many lawyer-type TV shows because I find dealing with the law and the legal process very interesting, although real-life court is not as clever or glamorous. I'm glad I'm not a lawyer; I'd get ulcers. However, sometimes interesting points of law are at issue, like freedom of speech (believe it or not), and a builder's rights of warranty, as in the case of Mr. M vs. Boatbuilder S.

Mr. M bought a 34' sedan cruiser from Boatbuilder S through a dealer in New York. From the very first cruise, the starboard gasoline engine vibrated excessively, but not the port engine. Believing the propeller shaft was bent, the dealer replaced it, but the cure was temporary.

Unfortunately, the dealer soon went out of business, leaving the owner to deal directly with the builder. Over the course of two summers, the problem persisted, and the owner sought a number of repairs and solutions through various boatyards. Boatbuilder S declined to pay for any of the repairs because propeller shaft and engine vibrations were specifically excluded from its warranty. The owner was on his fourth starboard propeller shaft and second set of propellers, and now, not only the engine, but the whole starboard side of the boat was shaking violently.



**Fig. 3.** *Mr. M's 34' sedan cruiser.*

Frustrated, Mr. M made up some T-shirts that stated, in very foul language, Boatbuilder S built s----y boats. At a New England boat show, he walked up and down the dock in front of Boatbuilder S's boats wearing this T-shirt. Naturally, this sparked discussions between Mr. M and the boat show attendees, much to the distress of Boatbuilder S.

It gets better. At a Florida boat show, Mr. M hired an airplane to tow a banner over the show that said, in the same foul language, that Boatbuilder S built f-----g bad boats. Boatbuilder S filed a lawsuit to get Mr. M to desist. The court found that Mr. M had first amendment rights to free speech regarding his shirts and airplane banner, and there wasn't anything Boatbuilder S could do about it.

Finally, Mr. M filed a lawsuit against Boatbuilder S to rescind the purchase of the boat and demand damages of \$180,000. That's when I was called. Boatbuilder S had learned of the hull vibrating only a short time before Mr. M filed his suit. They were concerned about this because of their 10-year hull warranty. A sister vessel in Michigan was known to have excessive hull vibration because the solid fiberglass hull laminate was too thin. Boatbuilder S's attorney asked me to attend a sea trial on Long Island Sound with the boatbuilder's chief engineer to determine the extent of the vibration and take hull thickness measurements.

At the sea trial, I set up a telescoping wand directly over and touching the hull panels and engine bearers. As the boat moved through the water, the vibrating structure pushed up on the wand. When we stopped, I measured the gap between the wand and the structure. Thus knowing the deflection, I worked back the engineering calculations to determine if the hull laminate and girder structures were within acceptable

engineering stiffness limits. The longitudinal girders were fine, but the outboard hull panels deflected excessively.

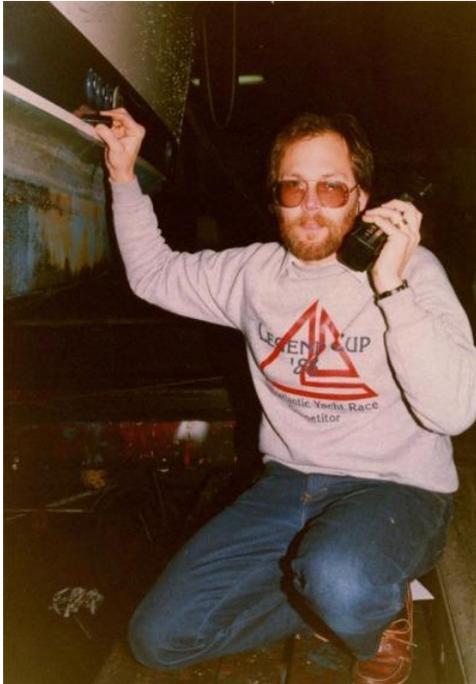


**Fig. 4.** *The telescoping wand touching on an outboard hull panel gave us an indication of how much the bottom moved.*

After the sea trials, we lifted the boat out of the water to measure the thickness of the hull laminate in various places with a magnetic thickness gauge. The bottom hull panels were thick enough when compared to the laminate schedule, but the sides of the hull immediately above the chines were very thin, barely within manufacturing limits of the laminate schedule.

For comparison, we found a sister vessel in Oregon that was built at about the same time and equipped with the same engines. I flew out west to conduct the same deflection and hull thickness measurements. The hull was thicker and the vibration much less. I concluded in my written report that Mr. M's hull should be repaired by laminating more fiberglass onto the inside of the hull at the chines in the engine room, for a cost of about \$15,000.

At trial, Mr. M sought to deny Boatbuilder S from repairing the hull under the warranty claiming that any repair would be obvious and therefore detract from the value of the boat. The court found that not only does a boatbuilder have an obligation to honor its own express warranty, it has a right to do so. Mr. M had no grounds to say that my repair specification would not work. Boatbuilder S won the opportunity to repair the boat.



**Fig. 5.** Eric Sponberg with half of the magnetic thickness gauge equipment and a walkie-talkie, talking to the other half of the expert team inside the boat.

After the trial, Boatbuilder S hired me to design and engineer the repair, solicit bids, monitor the work, and conduct a final sea trial to prove that the problem was cured. The new fiberglass was laminated so that you could not tell the boat had been repaired. This included finishing the interior with the builder's production line gelcoat.



**Fig. 6.** When we lifted the 34' sedan cruiser in the Travelift, we found the bent propeller.

Just after Mr. M got his boat back, he called me to say it was still vibrating, but this time on the port side! Huh?! When the repair yard and I went down for the final sea trial, the first thing we did was haul the boat. Bingo! One blade on the port propeller was badly bent. Mr. M went home to get his spare propellers which were installed, and during the sea trial we did not see any vibration anywhere. Afterwards, Mr. M sent me a very nice letter saying how much he appreciated my efforts toward fixing his boat.

### **Design defect**

You have to be a little masochistic to be an expert witness, because the other side's job is to discredit you and your opinions. This is not a gentle process--they try to get you really riled by insulting your intelligence and your work so that you start yelling and arguing. Judges and juries do not like yelling, so you have to keep your cool. You lose your cool and you lose your case. In the case of Miss J vs. Boatbuilder C, I had one of my worst experiences with the other side's attorney. On top of that, it was a grisly case. I testified as Miss J's expert against Boatbuilder C.

Miss J was 8 years old. She, her mother, and half-brother were guests on an 18' sailboat belonging to the mother's friend. The mother was baby-sitting two other boys who also came along, and the owner had a male friend with them. It was Labor Day weekend on one of Michigan's Great Lakes. Seven people were on board with four life jackets and no signal kit. They headed about 45 degrees off the shore with the wind behind them for about two and a half hours, then headed back. The wind was strong but declining.



*Fig. 7. The actual sailboat involved, complete with bent mast, two years later.*

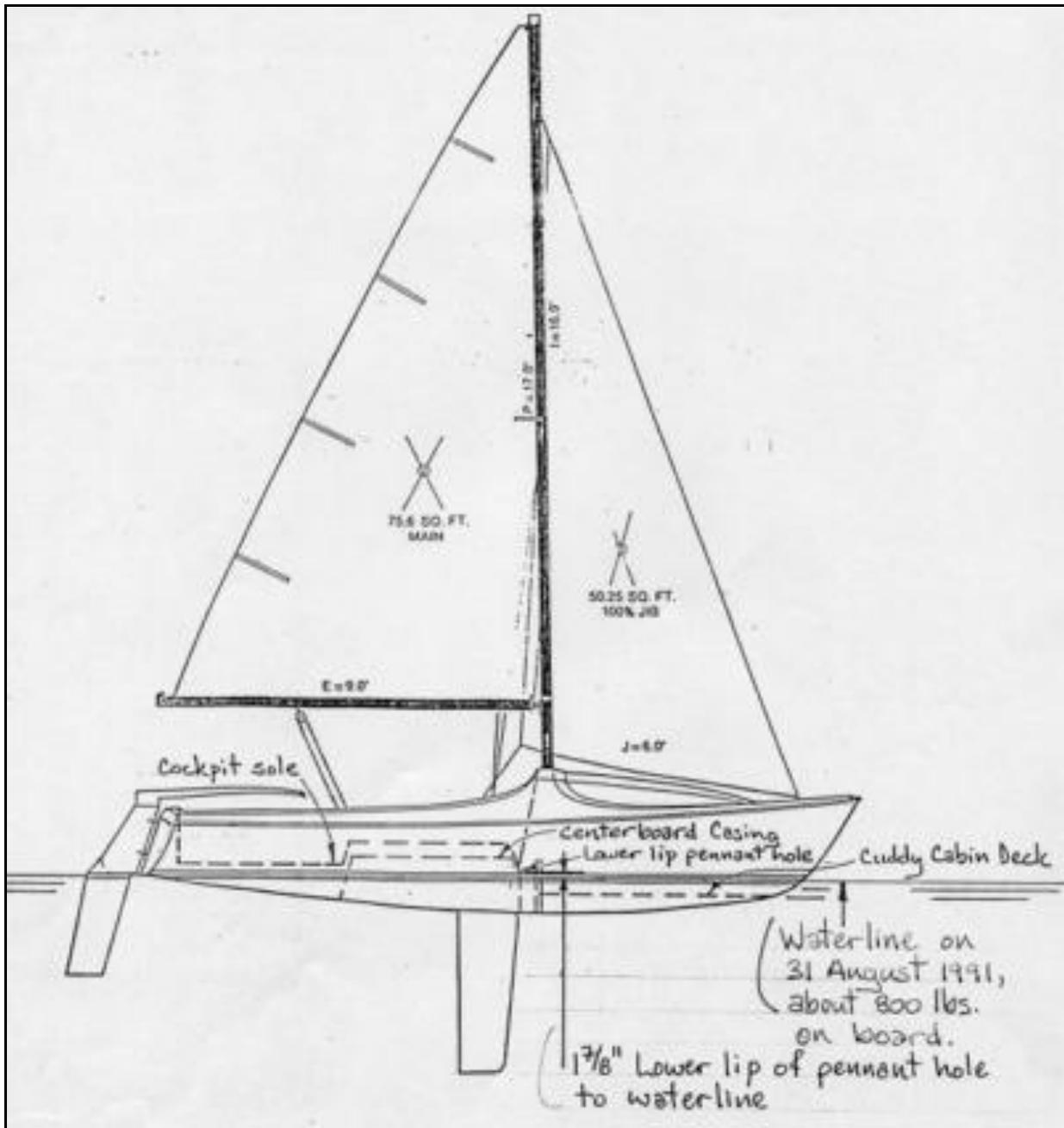
About a mile from shore, the boat capsized and turned turtle. All the children had been sleeping in the cuddy cabin and were trapped. The owner dove underneath and pulled them all out, and everyone clung to the overturned boat as best they could, although the 4'-6' waves kept washing them off. The children donned the lifejackets in the water. The wind was still offshore, and it was getting dark. There was no way to signal. After about a half hour, the owner's male guest started to swim for shore. He was not seen again until his body washed ashore about two weeks later. Then one of the boys the mother was baby-sitting succumbed to hypothermia and died. He was washed away. His body was recovered by helicopter the following day.

The mother became distressed and decided to swim to shore. She didn't make it, and her body washed ashore two months later. The second of the two baby-sit boys and Miss J's half-brother also succumbed to hypothermia and died. Miss J's half-brother was recovered by a boat the next day, and the other boy washed ashore the following February, by which time only a backbone, collar bone, pelvis, and femur were left. He was identified in part by the underwear waistband strung around the spine. I had to read all the autopsy reports and police reports in preparing the case. They were real tear-jerkers.

That left Miss J and the owner clinging to the hull. By daybreak, they decided to swim for it. They'd removed the lifejackets from the dead children as they had succumbed, but soon they became separated in the waves. Miraculously, Miss J was found alive that morning by helicopter, the owner a few miles away by boat. Ultimately, the owner was found guilty of negligent homicide for not having enough life jackets or a distress signal kit on board, both federal requirements. Fair enough. He spent a year in jail.

But what caused the boat to capsize in the first place? The sailboat had a centerboard housed in a casing that was molded right with the hull. The upper forward corner of the casing was cut off to allow the centerboard pennant to pass through. On virtually all centerboard sailboat designs (at least every one of the twenty or so that I looked at in preparing for this case) water comes through the pennant hole, overflows into the cockpit, and drains overboard through the transom scuppers.

On this design, however, the casing was totally below the cockpit sole which was part of the deck molding. When the boat left on its afternoon sail, the bottom lip of the pennant hole was only 1-7/8" above the waterline. As the boat sailed, gallons of water began splashing into the bottom of the boat where it remained trapped. I was able to calculate and prove by actual tests on the actual boat, all photographed and videotaped by a professional film crew, that after the five-hour sail, about 168 gallons of water (1400 lbs.!) came on board. That much water caused the boat to lose all stability and capsize. I concluded that the boat was defectively designed and built because it could downflood without clear knowledge of the operators. In my opinion, the hull was inherently unsafe and unseaworthy. Miss J filed suit against Boatbuilder C for defective design and construction which put her life in jeopardy.



**Fig. 8.** The flotation condition of the boat when it left for the afternoon sail, was already overloaded and close to downflooding.

After I issued my report, Boatbuilder C requested to take my deposition. I had been given a list of things to bring, like examples of all the advertising I had ever done, all of the documentation of all of the legal cases I had ever testified in, and all of the books documents, papers, articles, notes and sources I use in designing boats--virtually my whole library. Boatbuilder C's attorneys (three of them) flew into Newport, RI, where I lived, from southern California, the Pacific Northwest, and Michigan.



**Fig. 9.** Eric Sponberg on the boat during a test sail, from a video shot for the trial.



**Fig. 10.** Eric Sponberg and a helper draining water from the boat that came through the centerboard pennant hole during the test sail. All the water was captured in jugs and weighed.

Mr. L from southern California immediately went into a tirade, at the top of his lungs, when I said I had only some of the requested documentation with me. "I'll have you know, Mr. Sponberg," he screamed, "that Newport is not the easiest place to get to. I spent a lot of time and trouble to get here, and I expected you to cooperate!" All this

was recorded by the court recorder taking notes verbatim. I sat silently while my attorney sternly replied that it was not our problem on how difficult it was for Mr. L to travel to Newport, and the exorbitant request for documentation was unreasonable. Mr. L went on in acid-rock volume to accuse me of not following proper business practices because I discarded a lot of the paperwork from my previous cases. If I kept copies of all the depositions and evidence of all the cases I have ever been in, which is mountains of paper, I wouldn't have any room left in my office for myself and my furniture. I am convinced lawyers are stockholders in paper companies.

Well, the yelling and screaming went on for six hours, after which I felt like I had been drug through a knothole. Fortunately, the attorneys paid me then and there for my time at the deposition, which is the proper practice. But a year later, at the trial, Mr. L resumed his loud tactics in front of the judge. You could hear him way out in the hall through two sets of closed doors!

Besides being bombastic, Mr. L was also very shrewd. I had prepared photographs of many other boat designs, mounted on foamboard, to show how they were all designed and built to drain flooding water overboard. During cross-examination, Mr. L demanded I reply with only "yes, no, or I don't know." My attorney objected, but the judge overruled. Did I have anything to do with the design of these boats? Had I sailed them? Did I prove by calculation or test how water might come in through the centerboard pennant hole? Well, of course, the questions were designed so that most of my answers would be negative--no or I don't know--so I looked like I didn't know what I was talking about, and my attorney could not well counter the damage. We lost the case. The jury decided that Miss J had no grounds for damages against Boatbuilder C for defective design and construction.

## **Subrogation**

A very common practice is subrogating the claim. If your insurance company pays to repair damage to your boat, it may have the right to recover its costs by going after whomever it thinks is responsible for the damage. And, it can use your name as the name on the case by your acceptance of that provision on signing the insurance policy. A large part of the legal traffic in this country is insurance companies suing each other on the basis of subrogation, as in the case of Mr. T vs. Mast Builder X.

Mr. T owned a 3-year-old, 80' sailing yacht that was cruising in the Caribbean, although Mr. T. was not on board at the time. Enroute from St. Thomas to Martinique, the crew heard "an explosive noise", and the mast broke at the first spreader and crashed down over the starboard side. This is typical of the vast majority of dismastings--the sound of an explosion is a rigging part breaking suddenly under extreme tension, and once broken, the mast is almost assured to collapse. The boat was towed to Tortola where the damage was assessed. Fortunately, almost all of the rigging parts and mast were recovered, which is unusual in a dismasting. Mr. T ordered a new, duplicate mast and rigging for about \$200,000 plus shipping expenses, all covered by his insurance. The boat underwent complete repairs to rig and hull in Florida.

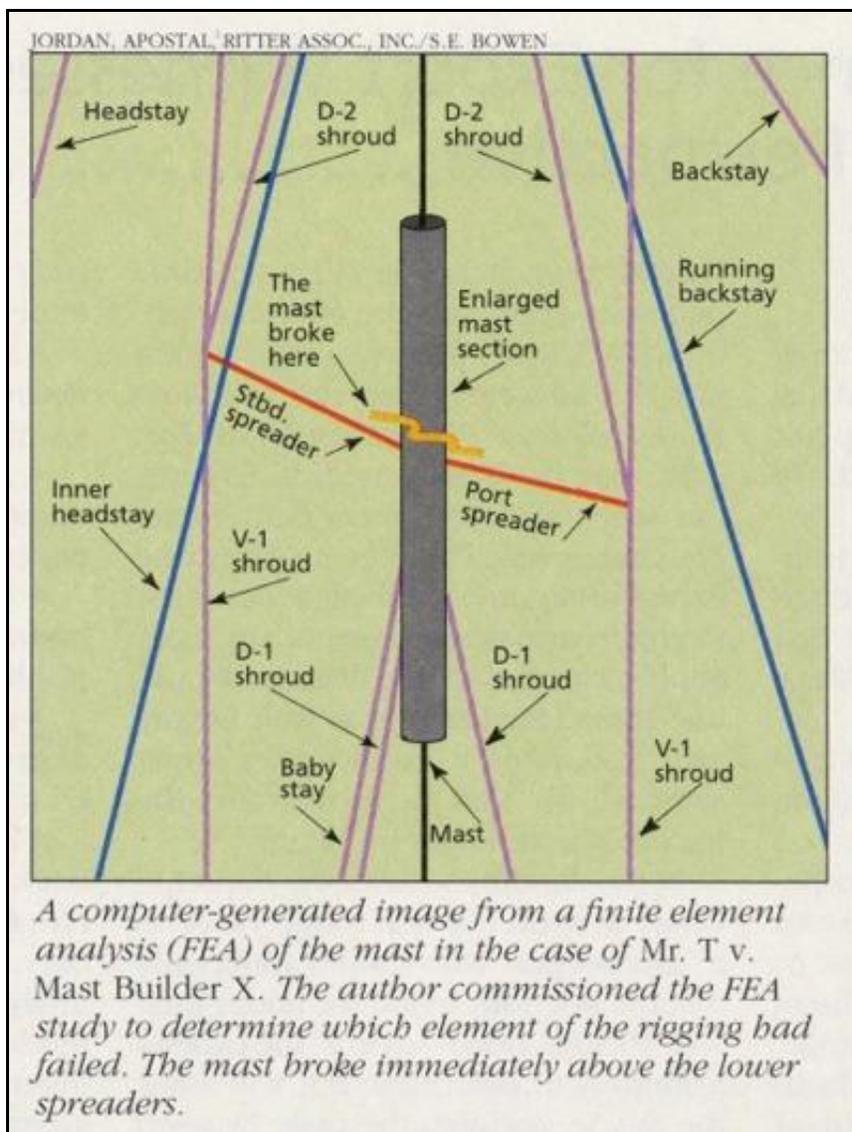
Mr. T simply wanted to get his boat running again, but his insurance company filed a lawsuit in Mr. T's name against Mast Builder X, the aluminum company that provided the mast extrusion, and the rigging company that rigged the boat, all covered by product liability insurance, to recover its money. Mr. T's insurance company based their claim on a faulty marine survey report of the damage which said that the mast had failed, not the rigging, and a metallurgical study of the mast extrusion conducted afterwards. They hired a metallurgical expert to assist with the case, but they did not have a naval architect expert at that time.

The case simmered for about three years when low and behold, the second mast came crashing down. This time, while enroute from St. Thomas to Baltimore, the boat hit two large waves in succession, the second of which precipitated another "loud bang". The mast broke at deck level and fell to starboard. As is usual in dismastings this time, the wreckage was cast to the murky depths for the safety of the vessel. Most of the evidence was lost. Letting the rig go, the crew accounted for every piece of rigging except the port running backstay which was never found. We think it broke at the deck padeye. Shortly after the boat arrived in New England under power, I received a call from Mast Builder X to survey the damage. A second lawsuit was likely.

Over the course of another three years (cases always drag out during the discovery process), I analyzed both dismasting cases. This involved rather extensive engineering calculations of each incident. Almost immediately after the second dismasting, Mast Builder X weighed the boat and discovered that instead of weighing 113,000 lbs., as originally thought, it weighed 157,000 lbs., 39% more! This makes the righting moment of the boat correspondingly higher, and righting moment is the single most important load factor in designing and engineering a mast and its rigging. The new third mast and rigging were built appropriately stronger, and so far have been standing for more than six years (touch wood!).

The low displacement value came from the designer and builder of the boat who was long out of business, so Mr. T's insurance company had no recourse back to them. Mast Builder X, realizing that they probably should have weighed the boat or reassessed the design loads after the first dismasting, eventually settled the second lawsuit.

In my engineering studies, I found it curious that three years passed from when the boat was built until the first dismasting, and another three years until the next dismasting. I was able to make a strong case for fatigue failure in the rigging. But we still did not know precisely which piece of rigging failed. Simplified engineering calculations could not provide the detailed results we needed. I proposed hiring Charles Anastasia of the engineering firm Jordan, Apostol, Ritter Associates Inc. in North Kingstown, RI, to conduct a finite element analysis (FEA) of the first dismasting to see what possibly could have failed. While not 100% conclusive, it did point out that the mast could not have failed by itself, but only by a rigging failure--the inner headstay or the port D-2 shroud being the most likely culprits.

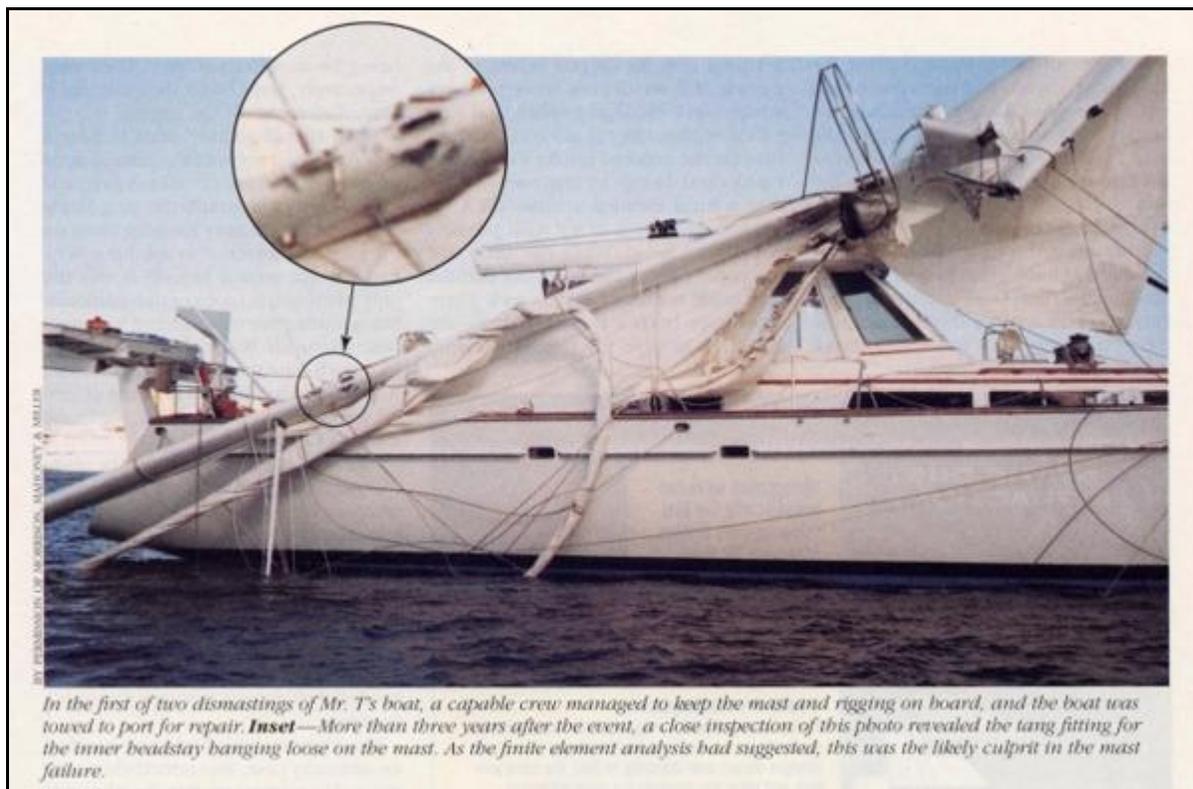


**Fig. 11.** The results from the finite element analysis.

Knowing this, shortly thereafter, Mast Builder X was reviewing some of the photographs taken soon after the first dismasting, and saw in one photograph the tang fitting for the inner headstay hanging loose on the mast, not attached to anything. Bingo! Why had we not seen it before? It was the one and only photograph taken of that particular fitting during the entire incident and aftermath. Never mind, because with that one photo, the FEA study, and the fact that Mast Builder X was given too low an estimate of vessel weight by the boatbuilder, we found a very strong defense.

At this point, the lawyering for the other side became a parody of the Keystone Cops. Mr. T's insurance company hired the foremost admiralty lawyer in New England who let his intern handle the assembly of evidence and witnesses. They had relied on a naval architect and metallurgist in the handling of the second dismasting case, the one

that had settled. But a few days before the trial for this first dismasting incident, they recalled their experts to review its evidence.



**Fig. 12.** The "smoking gun" photo that showed the broken headstay fitting.

Our attorney, who had never handled an admiralty case in his life, was nonetheless very astute and quickly saw that the other side was using their expert testimony and some facts of the second dismasting to argue points of the first. Our attorney was able to get their expert metallurgist taken off the witness stand because he obviously knew nothing about the first dismasting. Our attorney moved for a directed verdict, which means that if the plaintiff did not prove his case, then the judge has a right to stop it right there in favor of the defendant. We got the directed verdict, and went out to lunch afterwards for lobster bisque.

One year later, the other side did better homework and appealed the case, but it was settled in short order. So for all the insurance company's 9-year effort of subrogation, they received very little money.

Why do I do forensic naval architecture? I enjoy the mystery. I get to apply my naval architecture knowledge and experience to solve intriguing puzzles. It also makes me a better naval architect, because I can see what can go wrong. And, if I am defending a boat builder, maybe I can help them make better boats.

[ END ]