Conversation segment about S/S Edmund Fitzgerald

The following is a transcript of a conversation between myself and Taylor Award naval architect Joe Fischer. Recorded in Sturgeon Bay in June, 2017, for his memoir, this segment discussed Joe's knowledge of the vibration issue on the *Edmund Fitzgerald*, which he has published through SNAME, as well as other memories from the launching of the vessel to thoughts on its demise. On the 50th anniversary of the loss of the *Edmund Fitzgerad* I share this portion of the interview. (November 9, 2025)

Joe: You mentioned the *Fitzgerald*. When I was a senior, "Cap" Baier was a consultant to Great Lakes Engineering Works, the shipbuilder, on the stern design, and he had written a recent paper about stern designs for fat vessels and he and professor Ormondroyd gave a paper to the SNAME in the early 50s about the, [note: January 01, 1952, L.A. Baier, J. Ormondroyd] they put a Baier flow control fin over the propeller to keep air from being sucked in. The propeller has such a big, fat ship ahead of it that when it pulls the water back the water isn't getting there fast enough and a rope of air would come down from the surface into the propeller and make it vibrate, make it cavitate and shake and so Baier developed a flow control fin stop that. He was also a consultant to Great Lakes Engineering Works on the design of the stern lines and at the launching of the *Fitzgerald* all the senior class were invited to attend the launching, all courtesy of Cap Baier.

Pat: When you say Cap, is that like captain?

Joe: Yeah, he was a captain. Besides being a professor, he had a master's license. He had gone to the university and gotten his degree in naval architecture, went out into the world and got his masters license and then came back and became professor again and became department chairman while I was there, and so we referred to him as "cap," meaning captain, and he had a master's license and as consultant he invited the senior class to the launching and there were only about twelve of us in the senior class. We had a party the day before the launching and we had the Quarterdeck Society, which is a student society at Michigan, had their annual banquet and I was commodore of the Quarterdeck Society and master of ceremonies and we honored Cap Baier as retiring department chairman and the incoming chairman was professor Dick Couch. He was there and he was now the department head and we had an honorary commodore, was the naval architect from Bethlehem Steel at Quincy, James Robertson, and I was the emcee for all that and we had our banquet I think in the Michigan union, then after the banquet we went to a private residence and partied and they ended up at my place and I think the last dog was hung at like four o'clock in the morning. I was married that last semester. My wife and I got up about eight, hung-over and drove to Ecorse, the Detroit suburb and got in, we had passes and all that, and to protect the observers from getting swamped from the launching wave they had an open gondola railroad car parked there on the tracks with wooden steps leading up to it and so forth and they directed you into this railroad car and we're sitting there and this hot sun is baking down on and we're hung over and they didn't have water bottles those days, you couldn't buy it – you could I imagine but it wasn't common. There was a shipyard bubbler about thirty feet from the car and each time I tried to get out and down the steps to the bubbler some rent-a-cop would "Get back in there" you know, and the side-launching was late. I later found out that most side-launchings are late and I'll get into that in a minute. So, it didn't go out on time and we're under this hot sun and a big hangover and about an hour late, you know, close to noon or one, it finally was side-launched. And, very spectacular.

So, I go to work for Stearn. One of our big clients is Oglebay Norton, who are the operators of the *Fitzgerald*, and we do lots of work for Oglebay Norton. We repower the *Sensibar*, we lengthen the boom on the *Sensibar*, we repower the *Frantz,* we take those AmShip river boats and extend the side slopes out to the side shell because they were built with longitudinal bulkheads inside of the hull and didn't have no cubic capacity, so the *Fitzgerald* in the Oglebay Norton's management had the center vertical keel crack where it attached to the bottom shell. We were not aware of it at the time but they finally came to us and said every winter we got to go in and re-weld and gouge out the weld to the center vertical keel to the bottom shell and re-weld it and during the course of the year it cracks again, and we've done this year after year after year. Why is it doing this, you know? So, they hired Stearn. And I took a, well, the ship looked something like this [note: draws on paper] – has a deck with hatches, it's got a tunnel here, comes down like so. Here's the center vertical keel. This is a ballast tank and this is a ballast tank.

Pat: So, what is this, about a foot this keel – one or two feet high?

Joe: This distance here on the *Fitzgerald*, it's normally five feet. On the *Fitzgerald,* it was probably six. It was deeper than most ships. I could stand in here with no problem. And there's a manhole here and a ladder comes down and there's a keelson here, and a keelson here and got holes in them, so you come down here and you go through these keelsons to get into here. Well, I boarded the ship at the Soo Locks. I had a vibration instrument with me and a recording device and I'm going to see if it's vibrating anyplace. So, we're going down Lake Huron. I'm sitting in the galley having coffee like everybody else is and the ship started to spring. Now, springing is a phenomenon [looks for a book] you see, two-noded vertical hull vibration and by that, I mean, if you take a floating box and you hit it with a hammer it acts like a tuning fork. It vibrates because it's elastic steel. Steel is springy. And in the first node of vibration it'll twist. The bow will twist one way and the stern will twist the other way and then it'll go back and forth, it'll oscillate and the first natural mode of this box hull is a torsional twist.

The second mode is a two-noded vertical hull vibration and there's a node, a node is a place where there's no movement, at about the quarter points and the ends will go up and the middle go down and then it'll go back to neutral, it'll bend the other way, it flexes. It's very stiff torsionally and you don't see any torsional movement, but longitudinally, its length to depth ratio of Great Lakes vessels is bigger than saltwater vessels and they tend to spring. This phenomenon is called springing where the ends go up and the middle goes down, middle goes up and the ends go down. It does this. You see it, you can see it. You stand back aft and watch the forward deck house, the spar's vibrating, see it go up and down. Seagulls will sit at the nodes. There's no movement of the deck. They like a smooth ride. And so this movement and the frequency depends upon the length of the hull, the stiffness of the hull girder and the displacement of the hull is all involved. So, I'm sitting there and the curtains start to sway in the messroom. That's your first indication that we're springing and the curtains spring at the same frequency as the hull is moving and you can see the curtains sway, so I grab my instruments and run down, I get a deckhand to stand up here on this manhole, we're full of iron ore. I go down and tell him stand up here and make sure I come back out. And I got a drop cord I plug in up here on the walkway so I got a cord with me with a lightbulb and I go down through and crawl through here and crawl through here and I get over here to CVK. Above is the tank top, over my head and below me is the bottom shell.

Pat: CVK is the…?

Joe: Center vertical keel. This is a center vertical keel common to most vessels and in most vessels its water tight and it separates the port ballast tank from the starboard ballast tank. So I'm standing right here [shows on his drawing…in front of the CVT at the aft end of the ship], and this bulkhead, this plate here, the web frames that are the transverse webs in the hull are spaced eight feet. The CVK is about six feet high, so I have this 8-foot by 6-foot steel panel which I'm looking at and its oil canning. When the ship bends, [draws again] and the deck goes into tension and the bottoms in compression, the bottom plate buckles. When it goes this way, the bottom plate goes into tension and straightens out, and this way here it buckles again. You're taking this long beam –

Pat: And this runs the entire length of the vessel, right?

Joe: This runs the entire length of – take this long beam and you're bending the ship like so and when it's doing this the deck is in tension and the bottom is, you look at this eraser. If I bend it the deck is stretching, the bottom is being pushed together, okay. When the bottom plate is being pushed together without stiffeners it'll buckle sideways. If I push on this piece of paper it'll buckle. I can pull on it and it's stronger than hell but if I push on it, it buckles. Okay, steel plate is just like this piece of paper, it's buckling but it's restrained on the top and the bottom where it meets the frame on the two sides…

Pat: So, it shouldn't be buckling

Joe: No, it shouldn't be…but its oil canning. Take the bottom of an oil can and you push on it, it goes boing, you're buckling that bottom plate right. Well, that's what this CVK is doing, its oil canning, and, if you look down from the top of the ship it has the CVK and every eight feet it has a frame. This one would buckle this way and this one would buckle that way and this one that way. I'm standing here [note: refers to drawing] I can only see this one but I can see it go this way and I can see it go that way and this is occurring about once every second, about 60 times a minute and you can see the bulkhead moving. Well, when it buckles sideways like that it's cracking this weld down here and it would crack every year and they would weld it up and it would crack the next year. So, I got measurements sitting in the file over here that the lawyers forgot to take out of our files that show the movement of that bulkhead, and what we did is, that winter we went in where the steel panel, I got [inaudible] so every six feet and eight feet we put two flat bars, like so, they don't even touch the top and bottom, just welded them to the bulkhead to stiffen the bulkhead so it can't buckle sideways. And they put that in and the following winter of 74, I measured it in the summer of 74 and they put it in the winter of 74 and the ship sank in 75, and so, whether or not it would have cracked now with the new stiffeners in nobody's ever going to know.

Pat: And that's the only place you put the stiffeners?

Joe: On the CVK.

Pat: So, it was probably doing that all the way down the length of the hull, or not?

Joe: Yeah, yeah. I'm sure it was. Well, at the nodes you don't get much movement. In the middle you get a lot of movement and it disappears at the ends again. And so, it's a classical, in engineering terms, two-noded vertical vibration.

Pat: And is that a design flaw?

Joe: No, it's just a phenomenon that happens.

Pat: So, it happens on all ships?

Joe: Well, unless you made them stiff enough or that panel's small enough where it won't buckle. The buckling phenomena is because you have this large panel without stiffeners on it that's bigger than it should be. If you put smaller panels in, with closer frames it won't buckle. In the days of the *Fitzgerald's* construction the American Bureau of Shipping had no rules to check for buckling. It's only since 1969 that the new rules came into effect that they were aware of the springing phenomena.

When we came to design the vessels for the new lock, which could be a thousand feet long, the biggest ships to that date had been 730, ala *Fitzgerald*, and we didn't have rules for this buckling. And the longer, the bigger the depth to length ratio, if a thousand-foot divided by fifty-foot is a number of twenty, okay, ocean vessels don't go over fourteen and Great Lakes ships you have 600-foot ships divided by 30, they're 20, and they're know to spring. And you can see them spring in the time and the springing can be predicted but there was no, it was just a, accepted ship springs, so what. Well in this case it happened to crack the weld of the CVK to the bottom…

Pat: I know I've heard the theory it had a loose keel or something…

Joe: Yup, that's the loose keel theory. One of the cooks told his family that he was the ship keeper in Superior one year and they had to jack the keel up inches. Well, when I was at – it was just a crack. You couldn't get a feeling gauge in there at all, it was just so tight and I think that inches is an exaggeration. I don't believe that's true and I also believe the theory that it grounded on the bottom at that shoal and cracked the bottom and water got in and they even cracked the tank top and water got up into the cargo hold and was filling the boat with water and the captain reported that waves were getting bigger. The waves weren't getting bigger, the ship was sinking.

Pat: Yeah, it was getting lower in the water.

Joe: It was getting lower in the water. The freeboard was going. And so, I was invited to the anniversary of the launching down at a park on the Detroit River, oh, she was launched in, oh, it's the 50-year anniversary, it was launched in 58 and in 2008 we had this party which I was invited to and I met all these people. And they were all relatives of the crew that sank and one of the guys there was a engineer at Great Lakes Engineering Works when it was built and he give me that book.

Pat: I've never seen that anywhere before.

Joe: This is by a mate. This is not by the engineer. The mate wrote a paper and he has his own theory. He was a substitute mate on it. The engineer wrote another paper and he said it had design flaws and I don't believe in that, his theory. Ships were built to a certain design draft that was established by the designer and there were no U.S. regulations for how deep you could load the vessel. There were ocean regulations saying how deep you could load the vessel but not Great Lakes.

In 1935, Congress directed the Coast Guard to establish load lines for the Great Lakes. The load line regulations were based on somewhat of a offshoot of a false assumption. They were based on the assumption that the deeper you loaded the vessel the more the bending was in the hull. So the deeper the draft was, the greater the hull strength had to be, and when this happened in 1935 when the regulation was passed and one of my jobs at Stearn, we would take these old ships built in the twenties and the 06 and 08 and so forth that were assigned a load line with penalties because the hatch coamings weren't high enough, because the deck-house wasn't strong enough, and the ABS would assign a three inch penalty to the summer draft and one would get a four-inch penalty for this and a two-inch penalty for that, and I asked the man at the ABS, Irv Paulo, who died in the 50s, died in the 60s I would get, how he determined this, what rules they got for this penalty thing. He just - seat of the pants in his head. There was no written rule, which I objected to. I said "How can you do that?" He says because I can.

Pat: So, it was not on any science or engineering?

Joe: No. no, it was just that ah, they had new rules now for the front of deckhouses and the old deckhouses didn't meet it so he'd give you a three-inch penalty. Why not two-inch? Cause I said three, it's my…I said what makes you think three is the magic number? Cause I just think so. I said there's nothing published that the owner can go to look and see how much he can get if he corrects this. He just knows he's got a penalty. So, at Stearn we did a lot of hull modifications on old ships to reduce the - and load them deeper and the deeper you loaded the higher the draft was obviously and the more the bending moment was and the stronger the hull girder had to be. And the *Fitzgerald* was built to that same theory.

Now the theory has some rationale to it and background. If you have a vessel so wide and so long, so high in the cargo hold and if you fill it with iron ore, if you uniformly load it, it'll sag in the middle and you get hull bending. So to reduce this bending you load higher in the ends and less in the middle so it doesn't sag in the middle. Well, if it doesn't sag with a load at 25-feet you're fine. Now if I want to add more cargo to it and load to 26-feet, all of a sudden I got no more space in the ends to add this cargo. I gotta put it more in the middle and the bending moment goes up. The bending moment goes up because of the cargo distribution, not because it's deeper loaded. It's because I gotta put the more cargo someplace and the only place I can put it is in the middle which will cause more to bend. So, the deeper it's loaded the more the bending, but it isn't the draft that's causing it, it's the cargo space limitation that's causing it. So the 1969 development of the rules for larger bulk carriers recognized that draft is not the critical dimension, it's cargo space, it's cargo distribution and so all those ships built for the thousand-footer are much deeper cargo so you can distribute the cargo, and it isn't the draft, it's the cargo space that you can

Pat: It gives you the room…

Joe: Yeah, you don't have the space to put it in the ends. Well, during World War II they decided that the summer load line for the war effort we could carry more iron ore so they made a mid-summer draft, which is deeper, and allows you to load deeper at a certain mid-summer season which is defined in the rules. Well, when you're carrying iron ore you've got space in the ends to go to a deeper draft but the man who proposed the theory says oh, the loaded deeper drafts and therefore they increase the bending. That'd be true if they were carrying coal. They fill them up and they sag, and limestone gets filled up faster, but iron ore you never fill the cargo hold up so deeper draft doesn't mean more bending like it does on some cargoes. So, this theory that they overloaded her from her designed draft, she should have been draft of a certain spot but they added this midsummer additional cargo and that's what caused the deeper bending is partially true if you're carrying a light-density cargo. If you're carrying iron ore it's not true. It doesn't make any difference. If you can control the bending moment by cargo distribution – it's when you run out of cargo space that the deeper draft is inherently a more bending cause you got to put the cargo in the middle. You've got people standing on a plank and if a guy stands in the middle of it between two horses, he's gonna bend the plank. If you put two of them on they're going to bend more. When you put two of them towards the ends it don't bend near as much and one in the middle. Well if you add more people and you add them towards the ends you're alright. When you gotta start adding more people in the middle the planks gonna bend more. And so the guy says, therefore the deeper the draft the more bending. Not necessarily true. It's cargo distribution.

Pat: But it would with coal because ….

Joe: with coal you're going to fill it all up its gonna have bending.

Pat: So, grain would probably be the same as well.

Joe: Yeah, yeah. You can't control the bending by cargo distribution, but you can on iron ore. So this guy who was an engineer during the construction of the *Fitz* claimed that they overloaded it to a deeper draft and therefore they overloaded the vessel. I don't subscribe to that.

Pat: I kind of think they hit bottom.

Joe: I subscribe. If you say it hit bottom all the answers, all the situations are answerable. If you claim it's too deep a draft you can't answer some of the phenomena that happened. So anyway, there's a book here and I wrote a paper for that meeting. I got it here someplace, of my experience on the *Fitzgerald* measuring the quote "loose keel."

Pat: so that loose keel could have caused, if they hit…

Joe: Well, when they it, the loose keel is due to it not having enough buckling capability. It should be able to be in compression. If I push on this piece of paper it should bend, but I can pull on it all I want, tension doesn't bother it and when I push on it, it buckles and so, looking down from the top, each eight feet is a frame and this side would go in and this would go out, in and out because the next cycle would reverse, this would do like that and this happens every second.

Pat: So the stiffeners would prevent that.

Joe: Stiffeners prevent that.

Pat: But just on the after end. You have no control over what's in the middle of the ship, if it was loose.

Joe: well, when you add this stiffener to the panels, they don't buckle and therefore the weld is not fatigued. If the weld is going like this all the time the weld cracks and the keel would crack from the keelson to the bottom shell.

Pat: Now, they would winter in Superior all the time.

Joe: Well, they run from Superior to Toledo.

Pat: So, at Superior, Fraser would do all the repairs, they spent ten winters in a row there; they didn't realize this was happening?

Joe: I don't know what they realized, but after a few years of it, she was put in service in '58, I saw the launching, and it wasn't until '74 that they called in Stearn to figure out why this keel is cracking all the time. So, they ran for years…

Pat: Knowing it was happening and not knowing why…

Joe: Not knowing why. So, I looked at it and said I know why it's happening – the center vertical keel is buckling and so I designed two flat bar stiffeners to place on it. If you take your oil can and put two stiffeners on it you can't make it pop. So, it's the same theory. I gave that theory at the 50-year launching celebration and the guy that was there, they all want to believe that the ship was overloaded and not designed properly and they all want to blame the owner for the death of their loved ones.

Pat: Sure. Then it's not an act of God, it's a culpable event.

Joe: Right. So, I don't want to get involved in that, but if the vessel ran aground, loose keel or no loose keel, it makes no difference if you crack the hull girder and water gets into the vessel and it starts to sink. It's doomed.

I personally believe that where he sank he made a turn and when he made the turn the vessel had all this loose water in the cargo hold and it shifted to one side and he went underneath the water on the leeward side of the turn and he filled with water and that was his demise. If he'd never made the turn he'd probably have made it if he could go straight, but he'd be up on the rocks on the Canadian shore. He's got to make a turn to stop running into Canada.

Pat: Exactly, to get into the bay, yeah. [Whitefish Bay]

Joe: And so that's where I think that it happened. I've been on ships where we're on sea trial, and one that comes to mind explicitly is we built the, Christy Corporation built the *Tustumena* for the Alaska State Highway Department, and it was a passenger – freight vessel, and we were running sea trials and I was naval architect in charge of sea trials and stability and we're going full power and make a hard turn and we make the turn and the vessel starts to heel and it keeps heeling and it keeps heeling, stuff is sliding off the desks on the tables on the floor, everybody's grabbing hold of something to keep from sliding down the deck and it goes over about 12-15 degrees and stops and makes the rest of the turn. And everybody says "Hmm, I knew it was going to stop." I thought, hell, I'm in charge of stability and I didn't know it was going to stop.

So I can see McSorley up in the bow and ah, making this turn and with all this free surface in the cargo hold and the water it shifts and the vessel heels and they're waiting for it to stop and it doesn't stop, it keeps on heeling and first thing you know they're sliding down the deck and the radio's up there in the center window and they can't get to it and that's why there's no S.O.S. That's why they didn't get to broadcast any radio alarm because the microphone's hanging in the center window where the captain usually has it and he's sliding down transversely to the outside wings of the deckhouse. That's my explanation of the *Fitzgerald*.

Anyway, I've got the graphs here showing the frequency of the springing. When she sank the Oglebay Norton lawyers came in and cleaned out R. A. Stearn's files, which is normal. They're working for the owner, but I forgot that we had those springing investigation files in a separate file, they were a different file so when, they were always in the stern files in a different place and when I bought the company from McMullen's, who then owned Stearn I didn't know I got those files and I was looking for something else one day and ran across them by accident. "Holy mackerel, here's the files from the *Fitzgerald* springing," and I thought Oglebay Norton had all those.

Pat: Did they investigate that during the…

Joe: No.

Pat: They weren't aware of it.

Joe: No. Being at this 50^{th} reunion of the launching, I'll give you a situation. There's a bunch of people standing around at a funeral looking at a dead body and they're all telling you why he died and none of them are doctors. Nobody did an autopsy, but they all got a theory of how he died but none of them are medically trained.

Pat: There are a lot of Fitzgerald theories.

Joe: Oh, lots of them. As many as there are people. Oh, she had a loose keel and she should never have done this, should've done that. If you subscribe to the theory that she ran aground all the situations can be logically answered.

Pat: It's the only one, I've been wrestling with for years trying to figure it out, and that's the only one that makes any sense to me is that they had to have hit bottom somewhere. They didn't have any list or big issues until after that shoal

Joe: After that shoal…

Pat …all of a sudden they're taking on water, they got a list, they got issues and…

Joe: I knew McSorley personally.

Pat: Oh, you did?

Joe: Yes. In 1959 Stearn repowered the, I think it's 59, I can look it up, 60 – 59, the *J. R. Sensibar* and we put new diesel engines in and we lengthened the boom. We put a longer boom on and Oglebay Norton didn't want to change the topping lift structure so we made it out of aluminum so the longer boom wouldn't weigh any more than a shorter steel one and we left Christy Corporation in the spring of the year on sea trials and I was in charge of sea trials and McSorley was the captain for the owner, so I got to meet him. Then a few years later we repowered the *Joseph H. Frantz*, and put a new boom on it and went out on sea trials. I was in charge of sea trials and McSorley was the captain. And the *Frantz* was the start of a new boom design and new slewing and topping design, which I was in charge of and I would, she made a run from South Chicago, Rail to Water Transfer Dock, to Oak Creek Power Plant in Oak Creek, and she had that run of coal and I would go down and get on in Oak Creek and make a round trip quite often with McSorley.

Oak Creek is South Milwaukee. It's a big power plant there that they enlarged and it was a coal burning plant and in those days the Interstate Commerce Commission regulated interstate commerce and it ruled, by their regulations, that you had to charge per ton mile, so if you brought coal up from southern Illinois, which they did, at that time high sulfur, and they brought it to Chicago by train or whatever, they would dump it at this Water to Rail Transfer dock, load it on a ship and take it to Oak Creek…