

Joe McGonegal: This is the MIT Alumni books podcast. I'm Joe McGonegal, writer for the MIT Alumni Association. Standing on a pristine sand beach on a gorgeous summer day, you can feel the grains of sand beneath your feet. The balmy wind cools you down at midday as you hope for the blistering sun to take a break behind some clouds.

But the best sensation of all for many is the sound of breaking waves. In his new book, *Waves*, our guest, Frederick Raichlen, who earned a masters and doctorate in engineering from MIT in 1955 and 1962, breaks each of these elements that influences how, and when, and why waves arrive at your beach on a summer day. The book is must reading for anyone who stakes a claim on any coastline.

Waves is a primer of the way sand, stone, air, and wind, and even the planets all influence that pleasant lapping sound of waves, and a breakdown of exactly what happens when waves act up, from dangerous rip currents to devastating hurricanes and tsunamis. Upon reading it, a day at the beach may never be the same.

Raichlen, who lives near the sea in California, is a professor of civil and mechanical engineering, emeritus, for the division of Engineering and Applied Science at the California Institute of Technology. Frederick, thanks for joining us. Why write this book now?

Frederick Raichlen: Well, I guess there are two reasons. One, it's something that I think would be of interest to the layman, but someone who has a perhaps a technical, an interest in technical-type literature. And I think that although there are some books written in the past, this was really one that kind of fills in between a basic book and a more of a textbook. And actually, the reason I, one of the reasons I wrote it, I felt that in retirement, it would be something interesting to pursue.

McGonegal: Your children seem to factor into it from the very beginning-- begin with a picture of you walking on the beach with your children and them asking you lots of questions. As you raised your children, I'm sure you had many conflicts between being a father and being a scientist.

Raichlen: Well, I think they were sick and tired of some of my comments at times. Especially, we used to vacation quite a bit on Maui. And every time we'd go down to the beach, I would tell them that, you know, to just never turn your back on the waves, because you never know what's going to happen. And this was a-- the area we stayed was a particularly steep beach. And so we had waves that kind of sneaked up and broke without you really realizing it, would always tell the

kids and until they got sick and tired of it

McGonegal: You've got some good experiments for kids to do in this book. More can be done in the bathtub than I realized to learn about waves.

Raichlen: Well for some specific things, I think, things like putting a bath tub into resonance, which like might be a little sloppy. And then also just some basic things, such as how earthquake-generated sea waves, tsunamis are generated. How waves propagate if you kind of pound your fists to the water and just look at the waves as they propagate outward from that point.

McGonegal: And then there's the more technical holding a vacuum cleaner over the water to simulate a hurricane, key core.

Raichlen: Well, yeah, that's something that I guess you have to be a little careful about. But one of the effects, that is a potential for damage, is the fact that you have low pressures near the center of a hurricane. And so you tend to increase the elevation in the water, but or water surface rather. But that's not really the real problem that occurs in say like Hurricane Sandy and all. It's not, that's sort of a, generally a minor effect. But it's something that perhaps you can see in a bathtub.

McGonegal: Talk about some of the obstacles in writing this book. Retirement made it easier, I'm sure. But what about other obstacles in putting it together?

Raichlen: This was published by MIT Press. And generally, it was a pretty good relation. They did a good job on the figures. I think. One of the things was, I started writing the book, I figured I'd write it in a very folksy manner. And I'd never really done anything like that, since anything that I had written was really on a technical basis. And the interesting thing was, the editor at MIT Press really wanted it to be more technical. So I kind of started with a method that I wasn't familiar with, and ended up with a method of writing that I was more familiar with.

McGonegal: Well, as you say early on, you can skip all the math and still get a lot out of this book.

Raichlen: Well, I think so. I think what I wanted to do was, in the first part of the book, was to really lay down some of the basics of waves, of ocean waves, in a simple fashion. And then in the latter part of the book, talking about areas that I had become involved in, both in research and in engineering consulting.

McGonegal: It seems to be a very subtle, cautionary tale for people who live by the sea. But you seem to

hold back from editorializing or making any claims about global warming and so forth. Was that a challenge in writing it?

Raichlen: No. I just-- I really wanted to avoid that-- that is, talking about climate change and all. Things are really not that definite in terms of quantitative estimates of sea level rise. And there's just a wide range of ideas of the magnitude of sea level rise or the rate of sea level rise. So I wanted to just talk about things that are more definite than.

McGonegal: I learned about a frustration for civil engineers and those who study the ocean in creating tide pools or wave pools indoors. And is it easier to do now than when you started?

Raichlen: Well, that's an interesting question. Actually, sometimes it's difficult to find facilities that you can use in this country. In Europe, I think the reverse is true. And they have increased and they have some very large wave facilities there. You can test structures at very large scales, which doesn't exist in this country anymore.

McGonegal: We know how well the Dutch are at creating seawalls, right?

Raichlen: Well, yeah, that's their existence, really. And they have been at the forefront of coastal engineering for many, many years.

McGonegal: Well, you came to MIT in the 1950s. How was your MIT education put to good use in this book?

Raichlen: Well, I guess I'd say that my MIT education was put to good use in my profession. I did research at the hydrodynamics lab, which is now the Parsons Lab at MIT in the '50s in the area of turbulence and turbulence measurements. And then coming back in 1959, I worked on wave problems.

My education really led to my job. And I came to Caltech in 1962 and retired in 2001. So I stayed in one place for 40 some-odd years. My students and I sort of ran the gamut of research from the reaction of harbors to waves, resonance in harbors, to breaking waves and movement of material on the bottom, and various aspects of the generation and propagation and coastal effects of tsunamis.

McGonegal: And what books on the subject of waves or of protecting coastlines have yet to be written or would you like to see written?

Raichlen: It's quite interesting. I think that the area of coastal engineering developed over the past 20 or 30 years, and with interesting books, both in the United States as well as overseas. And I think there still is room for a book which is more technical than mine, but not quite as technical as some of the existing textbooks. And that's something that I'm sure someone will find time to do.

McGonegal: And what's on your nightstand right now? What books are you reading right now?

Raichlen: Well, they run the gamut from *Bully Pulpit* by Doris Goodwin, and then John Grisham and Michael Connelly. And there's an interesting book, "*Medical Lives of Famous Writers.*" So I kind of run the gamut of when I get tired of things that are biographical, I'll go back to my mysteries.

McGonegal: Frederick Raichlen is the author *Waves*, available now through MIT Press, on amazon.com, or at your favorite local bookstore. Frederick Raichlen, thanks for joining us.

Raichlen: OK. Right, Joe. Thank you very much.