Curtis Mobley's Jerlov Award Acceptance Speech

Ocean Optics XXIII 27 October 2016

I now have the opportunity to thank my friends, tell you my life story, give advice to graduate students, and predict the future—all in less than 20 minutes.

Let me begin with my sincere thanks to my colleague and friend of many years, Emmanuel Boss, who expended the considerable effort of nominating me for this year's Jerlov Award. Emmanuel is an exceptionally enthusiastic and competent oceanographer, and it has been a great pleasure to work with him over the years. Likewise, I wish to thank Ray Smith, George Kattawar, Dariusz Stramski, Stewart Bernard, Roland Doerffer, and ZhongPing Lee, all of whom wrote supporting letters. I am humbled that these colleagues, and the members of the selection committee, consider me worthy of this honor.

I of course thank Ann Kruse, my wife to almost 40 years, who has stuck with me through the times of uncertain funding, years of a career-induced bi-coastal marriage, and so many weekends lost because I was sitting at the dining room table working on some pile of equations when we should have been climbing mountains or sea kayaking. She has been wonderfully supportive of my career, and her love is much appreciated.

Thanks also go to the US Office of Naval Research, and to Joan Cleveland and Steve Ackleson in particular; and to NASA, and Paula Bontempi in particular, for the many years of funding that allowed me to have a career in optical oceanography. Science requires money, and without funding agencies and highly dedicated and competent program managers like these, we are all out of a job. I hope the taxpayers have received a good return on their investment.

Finally, I thank Yogi Agrawal and Chuck Pottsmith for starting Sequoia Scientific, where I have now worked for over 20 years. Sequoia has been the perfect place for me.

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I came to optical oceanography by a very indirect route, which makes an amusing story. I started out as a physics major, and made it through the first year of graduate school at the University of Maryland before I decided that I simply wasn't smart enough to be a physicist. (I now realize that I perhaps was smart enough, but the error in my reasoning was believing that I was actually supposed to understand quantum mechanics. No one understands quantum mechanics; at best, you just learn to do the calculations.) Anyway, I dropped out of grad school in physics in a rather dramatic way—by simply walking out half-way through a final exam in statistical mechanics. That made me something of a folk hero among my fellow grad students.

I eventually found a job as a computer programmer at the Chesapeake Biological Lab. As luck would have it, Hurricane Agnes hit Chesapeake Bay the next week. A few days later I was on a small boat sailing down the Bay making CTD measurements to see what the hurricane had done to the Bay (there was as much as half a meter of rain, and the runoff turned much of the Bay into a fresh-water lake). That was my introduction to oceanography.

I eventually decided to go back to grad school, but the University of Maryland at that time did not have an oceanography program. However, one of the professors in the Meteorology Department was doing ocean numerical modeling, so I enrolled in the Meteorology program to work with him. My dissertation was a numerical model of Langmuir circulations, which at that time were not well understood. I didn't learn anything about what causes Langmuir cells, but I did learn that you can't study a second-order problem with a computational fluid dynamics model that is only first-order accurate. My simulations were total garbage, but fortunately we didn't realize that until after I had received my Ph.D.

Because of my ocean modeling background, I then got a post-doc at the NOAA Pacific Marine Environmental Lab in Seattle. My proposed research project was to develop a numerical hydrodynamics model to predict the movement of spilled oil in Puget Sound. Tankers were (and still are) bringing oil from Alaska to a refinery in the northern Sound, and it is just a matter of time before there is a major spill. At the time, the model for predicting where an oil spill will go was simply "three percent of the wind velocity." That is, oil will move in the direction the wind is blowing at a speed of 3% of the wind speed. Such a rule would be totally useless in Puget Sound, which has very complex circulation dominated by strong tidal currents and irregular geometry.

PMEL's charter at that time was to study the "meteorology and oceanography of the Pacific Northwest." My proposed oil spill model would combine both meteorology and oceanography as the winds and currents move the oil from its spill location to the nearest pristine beach. However, in one of my first encounters with government bureaucracy, the day after I arrived at PMEL, I was literally forbidden to work on an oil spill model. NOAA senior managers had gotten wind of my proposed research and decided that oil spill modeling was "fluid dynamics," which has to be done at the NOAA Geophysical Fluid Dynamics Lab in Princeton, New Jersey. My advisor told me to find something else to work on and disappeared, never to be seen again. The bureaucrats never explained how you can study meteorology and oceanography without doing fluid dynamics. BTW, as far as I can tell from a Google search, there is still no predictive oil spill model for Puget Sound. The tankers are still coming and, fortunately, the expected spill hasn't yet occurred, but someday it will. When it does, the predictive model probably will still be "3% of the wind velocity."

I then sat in my office for a few unhappy months trying to figure out what to do with the rest of my life. Then one day, Rudy Preisendorfer appeared at my office door. Preisendorfer had heard that the new kid was looking for a project. He simply walked into my office one day in early 1978 and said, "I hear you like numerical modeling and that you're looking for something to work on. You should consider hydrologic optics." I had never heard of either Preisendorfer or hydrologic optics, and little did I realize that I had just changed careers.

Rudolph W. Preisendorfer

Anyway, Rudy laid several hundred pages of hand-written notes on my desk and said, “Turn these equations into a computer program.” That was the beginning of HydroLight. For the next few years I was basically Rudy’s programmer. It was a pleasant job. He was a very humble and gentle person who guided me through the process of learning radiative transfer theory, and we worked together on the numerical analysis problems that inevitably arise when continuous mathematics must be discretized for solution on a computer. He took care of my funding by carving out my modest salary from his internal NOAA funding for climate prediction research, which is what he was supposed to be working on as a PMEL scientist. I kept a low profile within PMEL and worked mostly on developing the code for solving the RTE. We never received a penny of funding for hydrologic optics research, which in theory we were not doing. After several years of work, we finally had a computer program that could compute underwater radiance distributions with great accuracy and computational speed. That was 35 years ago. You can read more about this in my *History of HydroLight* handout.

Just as things were getting scientifically interesting as regards applying the computer model to problems in optical oceanography, Preisendorfer died unexpectedly of a heart attack in 1986 at age 58. Rudy was the most senior scientist in NOAA who still did science full time, and as a tenured civil servant he was somewhat immune to various political pressures. However, he was never able to get me a civil service position at PMEL, and I lived from year to year. The PMEL lab director had no use for either hydrologic optics or me, and he contemptuously called my computer programming “blue-collar science,” which was “inherently unworthy of a Ph.D.” Without Preisendorfer's protection and funding, my days at PMEL were numbered. I tried to obtain funding from the U.S. Office of Naval Research to continue Preisendorfer's work. One ONR program manager, who admitted that he hadn't even looked at the proposal I sent him, told me, “Who cares what he was working on, he's dead.” Another one told me, “Trying to live off of a dead person is a poor way to make a living.”

I then sent letters to several scientists (all now Jerlov Award winners) who had worked with Rudy and knew the importance of his work. I asked for suggestions on how to find funding to complete our various half-finished projects. Fortunately—another almost divine intervention—Ray Smith knew that ONR was in the process of establishing a new program in Ocean Optics, to be run by Richard Spinrad. Smith realized that a lot of unpublished work by the preeminent theoretician of the field was about to disappear along with me. To make a long story short, Smith called Spinrad who called ONR and told them to give me a year of funding. I was two weeks away from unemployment when I got a phone call from the ONR Ocean Biology program saying they would give me a year of funding. The old-boys' network had saved the day! Rudy had been working on another book, which at his death was just a six-inch-high stack of handwritten notes. I used my year of ONR funding to compile those notes and get published Rudy's text *Principal Component Analysis in Meteorology and Oceanography*. I also published several papers that we had underway. Finally, I wrote a long technical report that documented the mathematical algorithms used in HydroLight.

After that year of ONR funding I found a temporary job for 18 months as a sabbatical replacement physics professor at a small liberal arts college. I had no funding and did no science, but I loved the teaching. Spinrad was then moving up a notch at ONR and encouraged me to apply for his soon-to-be-vacated job as the Ocean Optics Program Manager. Since I had no funding and only a temporary teaching job, I had no choice but to apply. Fortunately, I was selected and became the second manager of that program beginning in 1989. My wife and I then began a bi-coastal marriage. That wasn't fun, but it was a necessary compromise for our two careers.

Well, enough said. By this time I was well down the road of optical oceanography, and I've never looked back. It has been a great career.

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If I have just one piece of advice for graduate students it is this: Don't worry, something always works out. I didn't make it as a physicist, but I ended up as an oceanographer, which is much more fun. I wasn't allowed to do my planned postdoc on oil spill modeling, but I ended up working with Rudy Preisendorfer. I never got a job at NOAA, but the old-boys network saved the day with a year of funding. After that year, I found a temporary job teaching physics. By the time that was over, the position at ONR came along. And so it went for another 25 years. Now, after the last to my ONR and NASA funding has ended, I can live on HydroLight revenues until next year, when I can start collecting Social Security (that's the US old-age pension system). Something always worked out.

So, you may not get the post doc you want, or the job you want, and your proposal may not be funded, and you may even have to move to another country where things are better. But don't worry. You won't starve, and with a bit of luck, everything will turn out even better than originally planned.

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I would now like to give you some thoughts on what being a scientist has meant to me. Of course, science helps the world, which makes me feel good, and the pay is adequate (if you can get funded). But the real joy of science, for me at least, is both intellectual and personal.

On the intellectual side, this equation

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\begin{aligned}
\cos\theta \, \frac{dL(z,\theta,\phi,\lambda)}{dz} =& \; -c(z,\lambda)\, L(z,\theta,\phi,\lambda) \\
&+ \iint_{\Xi} \beta(z;\theta',\phi' \to \theta,\phi;\lambda)\, L(z,\theta',\phi',\lambda)\, d\Omega(\theta',\phi') \\
&+ S(z,\theta,\phi,\lambda)
\end{aligned}
$$

is just symbols on a piece of paper, which would seem to have absolutely nothing to do with light in the ocean. I can then program a computer to manipulate the symbols and solve the equation. This amounts to moving electrons through copper wires and pieces of silicon, which has absolutely nothing to do with light in the ocean. Yet the output of that computer program tells me with good accuracy what light I will do on the ocean. If I have ever had any feeling that might be described as religious, or sensing the divine, it is in contemplation of the deep connection between mathematics and the physical world. Of course, I am not the first to be in awe of that almost mystical connection and the idea that mathematics may be the fundamental language of the universe.

On the personal side, we have in this room tonight most of the world's optical oceanographers. We come from 30 or 40 different countries and from a wide variety of historical and cultural backgrounds, political and economic philosophies, religions (and lack thereof), world views, and ways of doing things. Yet, in spite of these many differences, we all work together year after year in pursuit of knowledge. In my forty years as a scientist, I've never once heard someone say, "I won't work with so-and-so because he or she is a __fill in the blank with some group name__." We share our data, we help each other with ideas. We argue about things, but only in the sense that "Truth springs from argument among friends," as the philosopher David Hume put it.

If this were a meeting of the world's political or military or business or religious leaders, I would not be able to talk about how we all get along together and work unselfishly for the betterment of mankind. Science really is a noble pursuit that rises above individual or national or cultural self-interest. We should all congratulate ourselves for having created such a community, and I am honored and privileged to have spent my life as part of the global community of scientists.

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As regards predicting the future, well, that's easy. I predict that the world's so-called leaders will continue to start wars, rob the poor, exploit the weak, and deny the reality of scientific discoveries, unless, of course, those discoveries put money in their pockets. But those leaders and their supporters have no future; they just have more of the past. We scientists DO have a future! We can continue to work together and be friends, even when our governments can't. We will continue to discover new things and explain old ones. Slowly but surely, we will add to our understanding of nature and in so doing, make the world a better place. Certainly, there will be good times and bad, and successes and failures, and unexpected things will happen and expected things won't happen, and there will never be enough funding, but it will all work out.

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Again, I thank those who have chosen me for this year's Jerlov Award. I acknowledge once again that I would not be here if it were not for my wife's support, for Rudy Preisendorfer's mathematics, and for many others along the way who have helped in my journey. The Jerlov is very gratifying recognition for a lifetime of work, and encouragement (perhaps unintentional) to continue playing the game as I begin my eighth decade. There are many more pages to create for the Ocean Optics Web Book, and many more tutorials to write.

However, too much math and too many meetings are not healthy. My wife and I therefore planned leave next week for a sea kayaking expedition in the very remote Raja Ampat area of Indonesia, just off the northwest tip of the island of New Guinea. However, last week she tripped on a broken sidewalk and fractured her knee. So…no trip to Raja Ampat for us this year. But, not to worry, experience shows that it will all work out OK.

Thank you all again.

Raja Ampat, Indonesia