# 1999 Timoshenko Medal Acceptance Speech

**Anatol Roshko**

## SMALL IS GOOD

Dave Belden's letter announcing the award was really a surprise, almost a shock. At first I wondered whether it was another example of a story which you may have heard and which, I believe, originated in the FSU. Two friends are at a grand reception sipping cocktails when one notices a man with his chest almost completely covered with medals. Says one to the other, "Do you have any idea what those medals are for?" and the other replies, "Well, you see that one at the top left? That one was a mistake; and the others followed automatically." I humored myself out of that thought but not out of a feeling of guilt. You see, I suddenly felt terrible that I was not a member of the ASME. There had been opportunities but somehow I had let them go by. One reason is that I was concerned about another onslaught of communications, information and other paper that always results and requires attention. Fortunately, ASME lost no time in relieving my guilt. In a few weeks I received a nice invitation and forms to fill out, and now I am Member No. 6143358. And sure enough, information has begun to roll in: a beautiful, glossy magazine, notices of various meetings, etc.

I sincerely thank those who put my name forward and the Division of Applied Mechanics for this honor. I want to assure you that, though not a joiner, my destiny has always been in Applied Mechanics, as you will see as my talk progresses.

Other medalists have had some acquaintance or connection with Professor Timoshenko. Mine is mainly through the ending "-ko." I understand that there are some who think that Tim O'Shenko was an Irishman but, as most of you know, he was Ukrainian. The "-ko" is almost certain identification. So even though I did not have the good fortune to meet Stephen Timoshenko I feel some connection.

Originally, when informed by Dr. Belden about the award and tonight's dinner, I assumed that it was going to be appropriate to make a few acceptance remarks and that something like what I just said would do it. Not being a member, I was not familiar with the rituals of the Applied Mechanics Division. So when, a few months later, Professor Needleman informed me of the custom, I again had a bit of shock, especially when he told me it should be a NON technical talk; and no blackboard, no overhead projector! And a written copy would be needed for the Newsletter! Well, I have here my illegible handwritten notes which I hope to have in printable form before the due date.

What do you want to hear in a non technical talk? Humor? Advice? An appraisal of the field and projections for the future? Views on public policy for Applied Mechanics? I'm not very good at any of that. So I've modelled my talk somewhat on that of Professor Willis, the 1997 Medallist, whose acceptance speech I read in the AM Newsletter and liked very much. Some back copies were kindly provided by Professor Needleman and Mr. Majewski.

The theme is "how to pursue a satisfying career in Applied Mechanics," and I feel very satisfied with mine. I discovered the generalized formula only at the end of my career, but perhaps someone else can use it. Simply stated it is this: "Be in the right place at the right time." But there's an important caveat: the places should be small. I use the term "places" as a generalization for various entities, as you will see. Hence the title of this talk.

My career started in a small high school in a small coal mining town in the Canadian Rockies. There were 15 in the graduating class. Bellevue High School provided me with an excellent education in the basics, up to introductory calculus. The town was an ethnic pot, it was poor, everyone in it was poor, but the three high school teachers had University degrees! I still don't know how that worked and why it doesn't seem to work so well now, but I think one clue may be in the word "small."

From there I went to the University of Alberta, which at that time had a total enrollment of about 2500. I was in the Civil Engineering class, some 15 in all, but on a special track called Engineering Physics, which allowed me to substitute extra Math and Physics for courses like Concrete Mixing. The Eng. Phys. option was the brainchild of Applied Mechanics professors in the Civil Engineering Department (there was no M. E. Department at that time); they were mainly in Structures and Soil Mechanics. Many of them had gone to the University of Illinois for graduate work. One of them, my good friend George Ford, an Applied Mechaniker at heart, went to Stanford to work with Goodier, the son-in-law of Timoshenko who was still very active then. So I got to know a bit about Timoshenko from George Ford, who went back to Alberta and was instrumental in establishing an M. E. Department there.

From Alberta, after some diversions, I came to Caltech for graduate work in GALCIT. This is, effectively, the department of Aeronautics, but the Division of Engineering and Applied Science does not have Departments. I guess each department would be TOO small. Lucky for me; I got to teach some of the Applied Mechanics courses that George Housner and Don Hudson had established.

In 1946 the enrollment at Caltech was about 1500, half undergrad and half graduate. After half a century it has grown to about 2000, still half and half. Bigness is not big at Caltech. You probably noticed that *U.S. News and World Report* recently ranked Caltech at the top of Universities in the U.S. (even though it's not a University!). You may have also heard, at about the same time, another education story from LA County, namely the crisis in the Los Angeles Unified School District. It's difficult to avoid comparisons—no, not with Caltech but with Bellevue High School. In fact, one of the proposals being suggested is to break up LAUSD into smaller units. About the size of the old Bellevue School District should be about right. (This ends my venture into Public Policy.)

I was fortunate to come into the orbit of Hans Liepmann the first day I arrived at Caltech. Much of my way of seeing and doing things has been influenced by

  

him. Hans was wary of bigness. He liked to keep things lean: big funding brings big baggage with it; you should seek funding for research you want to do, not the other way around; research must be enjoyable to be productive; "smaller" makes it easier to recover from setbacks, even crashes, and so on.

Echoing Professor Willis' observations, I believe that a productive career in research in Academia is helped by three elements, all related to the fact that research is nurtured by questions and questioning. An ideal mix is the combination of teaching, consulting and research; the elements of this triangle feed each other constructively.

To teach technical material convincingly it is necessary to understand it, and students encourage you to do so. Digging deeply often reveals gaps not only in your own understanding but often in the subject itself. When interacting with students at the research level we teach each other. Liepmann delighted in asserting that even before a Ph.D. thesis is finished the student should know more about his subject than anyone else, including his advisor.

The second element of the triangle which leads to questions and questioning is consulting, using this term in the broad meaning of interaction with the outside world, whether it be industrial companies, government laboratories or other societal entities. My own work was strongly influenced by such activities. Observing engineers solve tough technical problems, with imperfect technologies at their disposal, gave me a healthy respect and admiration for how they get their jobs done, and it often left me with feelings of inadequacy to help. I also realized how inadequate even our best students may be feeling as they stepped out into the real world. This led to the introduction, with Don Coles, of a new course in our curriculum, officially called Technical Fluid Mechanics but unofficially Dirty Fluid Mechanics, the kind you can't find in textbooks. This enabled us to pass on to our future engineers and researchers some extra help; at the same time it impacted our own research, by the feedback process I've mentioned. I suspect that there's also a place for a course in Dirty Solid Mechanics.

The third corner of the triangle, scientific research, is at the apex. Feynmann called it "the pleasure of finding things out." Exhiliration may be a better describer. I feel privileged to have experienced it. Professor Oden, in his 1996 acceptance speech, said "I have experienced this phenomenon many times. I am constantly amazed by it, but find it awkward to explain or rationalize." I had thought to give a few examples here, but there's no blackboard or overhead projector! But I have promised to write up one of them for *Applied Mechanics Reviews*.

It seems to me that it is the nature of Applied Mechanics research that it is best carried out by individual investigators or small groups. So it concerns many of us that the trend is toward large consortia of researchers who are supposed to interact with each other and across disciplines. This is inevitably directed research, about which many thoughtful people were concerned when government funding of research accelerated, continuing a process that had begun during World War II. Other thoughtful people point out that this is the only way that societal expenditures on research can continue and even increase, and that anyway there is no net loss to the undirected research that would and will otherwise flourish. Perhaps this trend toward more directed research should be viewed as a contribution to the consulting corner of the triangle which I described and that individuals may still be able to work on their creative ideas under the umbrella of a large consortium. A little moonlighting might be helpful. In fact, life could be very comfortable, except possibly for the Director. But, inevitably, creative people will be left out.

Also troubling is that bigness seems to be crowding out some of the culture that has served Applied Mechanics so well, i.e., the abstraction of well-posed scientific questions from important but messy practical ones (a phrase which I've borrowed from Garry Brown). As someone (Prandtl?) remarked, "there is nothing so practical as a sound scientific theory." It is idealized models, leading to analytical descriptions, that reveal the innermost workings of nature, and they help develop the "intuition" which engineers need to do their "dirty" work. This culture should not diminish; it is already small.

Mr. Chairman, again I thank you and the Division for the honor you have given me, the ASME for signing me up, and you the audience for the opportunity of speaking to you.