CANDU, BUILDING THE FUTURE

Some of you may have read the article in the Chicago Tribune, written by a young lady called Mary Schmich. This got wide attention on the Internet. The title is "Advice, like youth, is probably wasted on the young." As far as I can see, everybody here is young, and since I'm going to hand out some advice tonight, I'll just use, slightly altered, the first two paragraphs of Mary Schmich's article:

"Inside every adult lurks an after dinner speaker, dying to get out, some world weary pundit eager to pontificate on life to young people who would sooner be rollerblading. Most of us, alas, will never be invited to sow our words of wisdom among a learned audience, but there's no reason we can't entertain ourselves by composing a guide to life for such an audience.

I encourage anyone over 26 to try this, and thank you for indulging my attempt.

Ladies and gentlemen, wear sunscreen.

If I could only offer you one tip for the future, sunscreen would be it. The long term benefits of sunscreen have been proved by scientists, whereas the rest of my advice has no basis more reliable than my own meandering experience. I will dispense this advice now."

My advice is intended to help you to succeed in building a solid future for CANDU. If I have had a modicum of success in my life, it has mostly been by getting others to succeed. I have always used a very simple technique to achieve that, when faced with a daunting problem. Simply by suggesting solutions, sometimes off the wall or even outrageous, sometimes bordering on the practical, my colleagues were forced to think in competition with me, and a sound solution would result. I hope that my advice tonight will make a small contribution to achieving that, and it should be seen in the light of this technique.

Let us first take a look at the somewhat daunting problems that face us. Seen from the broadest perspective, we are talking about energy for the future of mankind. On our planet, energy and life are synonymous. Whenever a new source of energy is discovered by mankind, there is not only a great increase in the population, but also an increase in the general health and life-span.

Right now, most of our energy comes from recycling the carbon and hydrogen created by billions of years of photosynthesis, and locked in the outer crust of the planet. This is really in the nature of an experiment; we have little understanding of the eventual effects of turning the carbon back into CO_2, but we're doing it by billions of tons. I know that I am preaching to the converted when I say that this is a risky experiment, and we should proceed very cautiously. Of course we are not; instead we are rushing into burning more and more hydrocarbons because they are cheap. All of us here, I am sure, agree that the only really practical, benign source of energy known at this time is nuclear fission, and that CANDU is an excellent implementation. We have the solution to this problem, but will we be allowed to implement it in our lifetime on an adequate scale? That is the problem on the planetary scale; let's call it problem #1.

A little closer to home, while our fuel is excellent at meeting the performance criteria, our reactors are not ageing well. When they are new, they are quite competitive with fossil energy,

but as they age, the cost per kWh mounts. This feeds right back into problem #1, even if the populations of the western world wake up, will CANDU be part of the solution? Let's call that problem #2. There are of course many more problems, but I have considered them outside the scope of this conference.

How can we, the CANDU fuel community, help in dealing with these problems? Obviously, we cannot do it in isolation from the rest of the CANDU community. But neither can they do it without us, so we have to do our bit. Are there any problems in our area which need to be addressed? Well, my feeling is that there are, and this conference has presented the evidence that indeed you are doing a lot about them.

I know many people who want to set the world to rights in one simple step, mostly by having others do as they tell them. My answer to these folks has always been that the only effective way I have discovered to better the world is to do better one's self. If example helps to persuade anyone else, that's a bonus. So my first bit of advice is never to be satisfied with how well you are doing, you can do even better.

The theme of our conference is "Building on Excellence". The Oxford English Dictionary defines "excellence" as "the possession of chiefly good qualities in an unusual degree, surpassing merit, virtue etc." This tells me that excellence cannot be judged in isolation, but must be based on comparisons, however odious you may think comparisons are. Also, excellence tends to be temporary unless a continuous effort to improve is made. We must realize that the competition has not stood still. Joe Lau, in his presentation on the "Canadian Fuel Development Program" mentioned the danger of complacency. The president of AECL, Mr. Morden, also alluded to this in his speech at the last CNA conference. For anybody who did not hear or read Mr. Morden's speech, what I got out of it, in a nut shell, was that the future is bright as long as we work very hard to lower the cost and raise the quality of the product, and *refuse to rest on our laurels*. He also addressed problem #1, i.e. the need to change the public's perception of nuclear energy production, and I would like to say a little more about this later.

I feel strongly on the point of complacency right now because of what's happened at Ontario Hydro. Top management there has openly admitted that this was a management problem, and it may have started at the very top, so what could anyone at a lower level have done about this? Usually, complacency at the top is a communications problem. People are very pleased to hear good news, and get upset by bad news. The bearer of bad news thinks that he may become persona non grata, and sometimes the levels above tend to massage the news and act as filters.

I don't know if that was the only problem or even part of the problem; I'm sure that there were many other complications, but, supposing it was, I want to examine what you and I might have done to alleviate the situation. Obviously, the situation could not have deteriorated to an extent where seven reactors have to be shut down post haste, without some early warning signs, i.e. some very bad news, along the line.

My personal approach has always been to reward the bearer of bad news on the basis that, if the news had reached me later or not at all, the situation could have become much worse. As soon as I had ascertained the facts, I have passed them on to the next level. I always feared that filtering out the bad news might have a profound effect on my job security in the long run, and I

advise you to share the bad news with your superior at whatever level you are, as soon as you know the facts. This should be a lesson learned from the unfortunate situation at Ontario Hydro and all of us should realize that, when we are faced with such problems, we must do something about it.

Now I'm going skating on really thin ice. In order to plan our strategy for the future, we need not only to understand our present problems, but must forecast what the environment for energy producers will be in the first quarter or more of the twenty-first century. We all know that anyone who forecasts the future is usually proved wrong by actual events. One should really follow Sam Goldwyn's advice, which roughly was "Never make predictions, particularly about the future". History abounds with examples:

In the sixties, the big worry was how the banks could possibly finance the many nuclear power stations which would be required all over Canada and the world. The seventies was the decade of the "Energy Crisis", hyped in due course by President Jimmy Carter, as "The moral equivalent of war". By 1990, the price of crude was to be $90 per barrel. The price of uranium was going to hit the roof and practically bankrupt Westinghouse, but that great company found a better way to get to the brink, namely real estate investments, because, in the eighties, real estate had only one way to go, up. Yet, building a bright future for our industry requires a reading of the crystal ball.

Here, for what they're worth, are my predictions of future trends:

Competition will increase in all fields of human endeavour. Hong Kong, eventually, is going to take over the Republic of China and liberate the energies of over one billion people. This will provide many opportunities, but also fierce competition. The trend to privatise state owned enterprises will continue, and not just in China, but in the western democracies as well. I predict that there will be further reductions in the restrictions to free trade and international finance. Competition will take the place of the wars which have bedevilled mankind's past. As a result, prosperity will increase and people will have more time to indulge their fads and more fads to indulge.

I regard these trends as inevitable because, for the first time in human history, the flow of information, as well as mis-information, can no longer be controlled by governments or anyone else. If I'm right, there is great danger in resisting them. There is a natural tendency for monopolies to resist the trend towards competition, whether in the energy or any other sector, only to face wrenching adjustments when restriction on trade are removed.. To resist these trends is like resisting water rising behind a dam by raising the dam, higher and higher until it bursts. It may be better to let the water through gradually, channelling the outflow in the least destructive path.

Dr. Robin Jeffrey, Vice Chairman of British Energy, gave a talk in Toronto last week describing the gradual way in which the British nuclear energy industry has been privatized between 1989 and 1995. This is an excellent example of what I'm talking about. British energy is now a privately owned utility, operating all nuclear reactors in Britain except for the old Magnox plants which are due to be shut down shortly. Since the company went public in July of 1995, the output has increased by 64%, per unit operating cost is down 35%, output per employee is up

112%, operating profit has turned from a loss of M$628 in 1989 to a profit of M$675 in 1997. The group accident rate has been halved. The employees are mostly shareholders as well, and I bet they feel a lot happier and more secure in their jobs than they did in 1989.

Going back to the fads I mentioned, I would never have predicted the enormous popularity of sports utility vehicles in spite of the steep increases in tax on gasoline. One fad that has been thriving for a long time is anti-scientism. Most of you will have heard of the Scopes "monkey" trials in 1925, when the state of Tennessee passed a law forbidding any reference in state schools to Darwin and his theory of evolution. A similar manifestation in recent years is the resistance to cleaning our food and even our sewage by means of irradiation, in spite of the proven fact that this would save hundreds of lives annually not to mention millions of hours of suffering "stomach flu". In view of this, it seems quite irrational to me that I also predict that the concerns with public health and safety will continue to escalate, which, if I am right, will prove that logic and reason simply don't come into it at all.

Yet I believe that we all can do something about it. We have tried for the last forty years to convert the anti-nuclear lobby to our point of view by reasoning with them, and have, if anything, had the opposite effect. I predict with confidence that, if we set ourselves realistic goals and achieve them, the activists will fade away and take up different causes. Imagine how weak their case would be if all 20 OH reactors were functioning, even at only 75% capacity factor, right now. There was just as much opposition to pasteurization of milk and fluoridation of drinking water. The value of these measures has been amply proved and few activists would think of picking them for a cause now. I am sure that we can prove the value of the CANDU contribution to the Canadian and global energy pool if we all work together to show the world by the results, that our reactors are safe and economically sound.

We have a lot of hard work in front of us to demonstrate the economic soundness of CANDU. We must not only overcome the ageing problems, but greatly simplify design and construction, lowering the capital cost considerably while improving the quality and meeting increasing safety requirements. Nobody said it would be easy, but I know that we can do it. If we don't, the competition will defeat us; accepting the challenge will strengthen us.

The light water fuel industry has had strong competition in all sectors for a long time, but the fuel manufacturers appear profitable. Some are customers at Stern Labs., and never stop experimenting with new fuel assembly designs and minor improvements to older designs, thereby strengthening the competitive position of the LWR's. A couple of years ago I was at the Nureth conference in Saratoga Springs, co-presenting a joint paper with one of our BWR customers. They manufacture fuel in Europe. Their representative spoke first and got right to the crux of the matter by saying that his company had increased the critical heat flux of their BWR fuel by 25% over the last 12 years. He was talking about fully qualified fuel being sold to and in use by utilities at that time, and his CHF results were based on full scale tests in water. We know from the goods and services they buy from us that our other customers in the LWR fuel business are not standing still but are continually proof testing their design improvements. You have to compete with them.

We, at Stern Labs. have always had a competitive attitude. In order to survive, we have had to keep a tight leash on overhead costs and salaries, and look for customers wherever we could find

them. What little success we have had has been due to this and a lot of luck. There are many legends about Napoleon, but I have always liked the one about a soldier being recommended to him for promotion to General on the basis that he was very clever. As it has been told to me, he replied :"What I need is lucky Generals, not clever ones." It may be that we have helped our luck along a little by listening carefully to our customers' problems and setting out to solve them, rather than making a big profit, or offering a service which would suit our capabilities better. I think that all our employees must be interested in solving technical problems, because they will work nights and weekends to get to the solution. There is many a time I have told one or the other of them that I would charge them rent if they did not go home soon to their wives and children.

Please forgive me if this is going to sound a little self serving; I kid myself that it is true. I have always treated all my employees as professionals, and found that they all quickly develop a professional attitude. The dictionary defines this as "(1) being characterized by or conforming to the technical or ethical standards of a profession, (2) exhibiting a courteous, conscientious, and generally businesslike manner". This requires complete openness in the workplace. I am always amazed how much each individual, regardless of education or age, can contribute to the quality of our work, if given the opportunity.

Mutual respect and recognition are essential to the safe and smooth operation of a laboratory, where experiments involving many megawatts of energy and high pressures and temperatures are involved. To operate safely, we must respectfully listen to the concerns of everyone, and never dismiss them with just a shrug. Another rule we have is that if you notice something that really needs to be done, and nobody else is available to do it, then it *your* job, whether you are the chairman or floor-sweeper. I unreservedly predict that these approaches will be helpful in other work situations also.

The CANDU system has many other great resources in the private sector here in Canada. The manufacturers of major reactor components, fuel, steam generators, special valves and fittings, and instruments. Then there are the consultants. Like Stern Labs., they must be looking to broaden their bases by selling to other industries and developing export markets. The stock in trade of consultants in the nuclear industry is in the form of experience. Unfortunately, the trade unions have worked hard to shut them out, and it is a case of use them or lose them. It often simply is not good business, i.e. it's bad for our industry, to hire them as full time employees. My advice is to use them, or their experience will drift away. You can absolutely rely on my next prediction; the unions will disagree with me. But sometimes it is necessary to jettison even valuable goods to save the ship.

CANDU has been doing well in overseas markets, competing very successfully with LWR's. But quite apart from competing with each other, international nuclear reactor vendors will be faced with increasingly severe competition from other energy sources over the coming years. The strongest competitor is likely to be natural gas. New geological tools and drilling techniques seem to be able to discover and develop endless supplies of natural gas at relatively low cost. So much for the energy crisis. Gas turbine manufacturers are now able to deliver a generating station in less than three years, at about US $300 per installed kW (say roughly one billion US dollars for the Darlington station equivalent) and thermal efficiencies over 60% for combined cycle machines.

Many turbine manufacturers worldwide are competing fiercely to outdo each other in this relatively young technology; further improvements are bound to be plentiful. Obviously, the price of gas will increase with increasing demand, and eventually the price we all pay for the release of carbon dioxide and oxides of nitrogen will be collected from the user of gas in the form of a carbon tax, raising the cost of electrical energy from gas turbine generators considerably, but that won't be enough to offset the difference, we must severely sharpen our pencils to achieve that. At some locations where electrical energy is urgently required, natural gas is not readily available but the competition from LWR's will continue to be fierce there. To strengthen the position of CANDU, we must solve the ageing problems quickly.

So, let's have no illusions; Mr. Morden paraphrased Mark Twain, saying that the rumours of the demise of CANDU have been greatly exaggerated, but it *can* go the way of the Stanley Steamer, which was also an excellent product for its day. We have to face it, competition is coming at us from all sides, and the nay sayers are rubbing their hands with glee.

How then can we help to build a bright future for CANDU? First of all we have to accept that we are surrounded by great difficulties. I favour a real siege mentality, a closing of ranks; we must realise that the success or failure of the CANDU reactor depends greatly on the effort of every one of us. Some of you may ask, if energy is so cheap and plentiful, why struggle? The simple reason is that the other energy sources will get scarcer and will not be available at a reasonable price for ever and their excessive use may well endanger the environment on our planet. I believe nuclear energy to be the most benign, and therefore in the long run the least costly source of energy, and this is worth fighting for, quite apart from the pleasure I have had from spending a lifetime wrestling with the technical challenges presented by the field, and working with so many like-minded, professional people.

As Mr. Morden prescribed, we must focus on making major improvements in the cost and quality of the CANDU system. He has my best wishes in getting this going, whatever way he tackles it. It is something which has no end point. In my opinion, as long as we want to sell one more CANDU reactor, we must make improvements in cost and quality. I believe that the private sector should have a growing part in this effort. Public sector R&D is very necessary when the national interest demands work involving large investments and great risks or low returns. The private sector should be making a contribution to the highly focused effort we now need to make our products more competitive.

I think we have plenty of excellent people in our industry, and I use the word excellent advisedly, but it is again a case of use them or lose them. They must have an environment which motivates them; they must feel that they are members of the team, the winning team. They must understand where the real competition is. They need the best tools available and clear objectives, best of all objectives with which they can agree wholeheartedly, and they need direct channels of communication with top management. Let's not put them into procedural straitjackets, let's de-emphasize protocol, forget about turf battles and search for better ways of doing everything all the time. I hope that the current events at Ontario Hydro were sufficient to get our attention, because that would turn them into an advantage and may really be all we need to succeed.

Frank Stern
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