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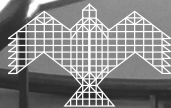
V.S. Ramamurthy



SOCIO-ECONOMICS OF TECHNOLOGY OPTIONS

TECHNOLOGY DAY LECTURE

May 11th, 2011



NATIONAL INSTITUTE OF ADVANCED STUDIES

Bangalore, India

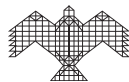


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The world recently witnessed one of the most devastating natural disasters of our times, an earthquake of magnitude 9.0 in Japan followed by a ferocious tsunami triggered by the same earthquake. The earthquake-tsunami combination, in turn, led to an unexpected crisis in Fukushima nuclear complex, the full magnitude of which is yet to be seen. While the first reaction among people across the world was sympathy for the affected population, the nuclear crisis has also triggered an intense debate worldwide on the safety of nuclear technology itself for electricity generation.

Natural disasters like earthquakes and tsunamis can neither be stopped nor predicted. We have no alternative

but to learn to live with them. The strategy across the world is to be better prepared, better prepared to minimize loss of life and loss of property. On the other hand, building nuclear power stations is a matter of choice.

The anti-nuclear lobby sees the Japan nuclear crisis as another evidence that the nuclear option is not a safe option. Some countries have already announced steps to slow down their nuclear energy programs though Japan herself has not revealed any such intentions.

The pro-nuclear lobby on the other hand argues that an accident is an accident, particularly when it is triggered by an unexpected natural disaster. There are lessons to be learnt from such accidents and one should incorporate these in retrofits and future designs. One can not do away with the nuclear option altogether, particularly in the light of the emerging energy needs of the world and the non-sustainability of fossil fuels to satisfy these needs.

In our own country, the Fukushima nuclear crisis has triggered an intense debate on our long term nuclear energy program. On one hand, we recognize that we are a country of energy shortages. Urban or rural, we are far

from electricity on demand. Our industries and commercial offices pay through their nose to get reliable power on 24X7 basis. We rely heavily on imports for our energy resources like oil and natural gas. With double digit economic growth, our population is increasingly aspiration driven. Our energy demands will continue to increase. We also recognize that if we continue to burn fossil fuels like coal and oil in the same way as we are doing now, not only we run out of these resources in the near future but we will also contribute substantially to the carbon-di-oxide load on the environment leading to global warming and serious climate changes that can put lives of a sizable fraction of the world population at risk in the next few decades. We have no option but to include nuclear in our future energy basket for a sustainable energy future.

On the other hand, the safety issues associated with nuclear technology can not be brushed off as insignificant or irrelevant. The past nuclear accidents such as the Three Mile Island accident in 1979 and the Chernobyl accident in 1986 and the more recent Fukushima crisis only send out two unambiguous messages- no design is absolutely safe and human error can never be fully ruled out. It is not surprising that we hear more and more anti-nuclear

sentiments across the country, suggestions of a moratorium on the nuclear energy program, public resistance to siting of nuclear facilities in their neighborhood etc.

I am a trained nuclear scientist. I was with the Indian nuclear establishment for nearly twenty five years. For the next twenty years of my active life, I was in the Indian S&T establishment but outside the nuclear establishment. I am often asked "what is my take on the Japan nuclear crisis?".

There is no doubt that the Fukushima nuclear crisis is a very serious event. In the light of this event and perhaps the earlier events of similar nature elsewhere, is it time for India to say NO to nuclear power? I don't believe so. First of all, nuclear technology for electricity production is a mature technology with several decades of operational experience across the world. While we are not one of the major producers of nuclear electricity in the world, we are one of the few countries having end-to-end competence in nuclear technology. We have a well defined road map for transition to the thorium cycle. We are also conscious of the safety issues associated with the nuclear technology and have systems in place to ensure that the necessary safety features are

incorporated in our programs. The unusual circumstances under which the nuclear crisis got triggered in Fukushima are very specific to Japan and very specific to the reactor site. For example, our own reactors are not subject to the same kind of vulnerabilities. Most of India is in Earthquake Zone-3 and Zone-4. Our coast lines are at least thousand kilometers away from Tsunami sites. Our reactors have been designed to withstand natural events anticipated for such conditions. More importantly, I believe and you will agree with me that safety is not a one-time exercise. It is a continuous process and we must learn all lessons that we could learn from events of the type in Fukushima but move forward. The designs of our indigenous reactors are different and we have long experience of safe operations. A blanket embargo on new nuclear plants as a reaction to the present crisis is certainly not warranted. What about the reactors from abroad? While their designs may be state-of-art, they do come with limited operational experience. Perhaps, in these cases, there is a case of re-evaluation of the safety features before the green signal. Last but not the least, our projected energy demands during the next few decades and the available options do not permit us the luxury of saying NO to any of them including the nuclear option.

Sometimes it is argued that we should move over to renewable energies like solar and wind quickly instead of relying on nuclear. I am a firm believer in solar energy as the ultimate sustainable energy resource for the human race. Unfortunately, neither the solar energy technologies are fully mature to address our energy needs today nor have we adopted "sensible" life styles in spite of decades of global consultations. Our investments on the development of solar energy technologies, globally and nationally, are miniscule as compared to what we spend even on some popular sports events. The focus is more on deployment of existing technologies rather than on development of breakthrough technologies. The solar energy sector is indeed crying for breakthroughs in energy harvesting, energy storage and energy efficiency. To say NO to nuclear on the hope that some breakthroughs will take place in renewable energy technologies with very little real effort on our part is not tenable. I will indeed be very happy if our anti-nuclear lobbyists divert part of their energies into convincing our governments and others to invest a lot more in the development and deployment of renewable energy technologies like the solar energy. These are my personal assessments. If your assessments are different from mine, it simply reflects the complexities of assessing public

needs and public risks, especially over long time periods while making technology options. Let me assure you that if I am not with you, I am certainly not against you. The relevant point here that while assessment of technologies and the associated risks may be in the domain of specialists like me, assessment of the need itself and the acceptance of the associated risks are clearly in the domain of the public. Fifty years before, when we launched our nuclear program, we had Homi Bhabha who said nuclear energy is good for us and the whole country had full faith in him. We had Pandit Nehru who also had full faith in Bhabha and went ahead with the necessary political and executive moves to put in place a robust nuclear energy programme. Today, no country including our own has a scientist or a politician of the same stature on whom the whole country has absolute faith. Who then will take the decision now and how? It is often said that in a democratic environment as we have today, the responsibility of any decision of national importance lies squarely on the shoulders of the citizens and their elected representatives. This includes technology options also. Unfortunately, the common man needs to make an option in an environment of poorly understood technical complexities. He also needs to recognize that the best technology option need not

necessarily be the best option because of its social and economic implications, also poorly understood by him. How does one ensure that the common man is technically informed when he is not technically qualified? How does one ensure that the common man appreciates the social and economic implications of the options he is making? How does one ensure that the common man understands the risks associated with the options he has chosen and the mandatory safety steps that need to be taken to minimize the risks? This is the challenge that the world faces today.

This kind of challenge is not unique to the nuclear energy option alone. Whether it is BT brinjal, human cloning, even the simple UID, the problem is the same. There are advantages, there are risks. There are lobbies, for and against, equally vocal and equally unreliable. It is a matter of making a technology option in an environment of technical complexity, multiple options, long term needs, long term risks and uncertainties. There is no aspect of human life today that is not touched by technology in some form or another. Technology options, not only at the collective level but even at the personal level have become unavoidable. How does one make the common man technically informed when he is not technically

qualified and enable him make the technology options in an informed manner?

Let me give a few illustrative examples of technology options in our day to day life. I want to buy a flat panel TV. Of course, there are multiple manufacturers. There are also multiple technology options (LED, LCD, Plasma, HD, many more). It is too risky to leave to the vendors to decide what I buy and therefore I meticulously go through the technical literature provided by the manufacturers, popular articles in the media, references from other people who have purchased them etc. Finally, when I enter the shop, I am still as confused as I was before. My wife has found out her own method of making technology options. (She makes the choice on the basis of the freebies that come with the purchase). Whether our final choice is right or wrong, the stakes are low and limited to a small group of individuals, one family. Some choices may not be as benign. One of my close relatives is a Parkinson disease patient. Some doctors suggested that he goes for a newly emerging intervention- Stem Cell therapy. I was approached by my relatives to give my opinion as a professional scientist. I consulted my biotechnology friends, who were unanimous that the intervention has not been scientifically validated. But the

doctors said "forget about scientific validation, check with people who have tried it and benefited from it". Now, how does one make the final decision? The stakes are high (not only the intervention may not be as effective as claimed but may also be counterproductive) but still limited to a small group of people. There are also cases where stakes are high and the stakeholder base is large as in the case of nuclear power or BT-brinjal. The stakeholder base is so large that there is no scope for a consensus. One therefore relies on "political decisions". Are the political system and the supportive administrative system knowledgeable enough? How vulnerable are they to vested interests? A very recent public interest decision comes to my mind, the introduction of Euro-II cars and CNG for buses and three wheelers in New Delhi. That the quality of air in New Delhi was far below acceptable norms was known for a long time and that vehicular emissions were responsible for the same was also known. In spite of this, the decisions to introduce Euro-II norms for cars and CNG for buses and three wheelers in New Delhi were not administrative/political decisions backed by sound technology advices. They were judicial interventions. Is a technology option a judicial matter? That more and more of our decisions regarding technology options end

up in courts of law is a standing proof that our political and administrative systems have not learnt how to make hard technology options when the stakes are high, the stakeholder base is large and the impact is long term.

In my view, there are three distinct steps in any technology option- the technical viability, assessment of risks, acceptability of the risks by the public and the economic viability. The first two are clearly in the domain of the relevant specialists. Acceptability of the risks is clearly in the domain of the public. All of us take risks at some time or another, but taking public risk collectively is very different. Is it a cultural issue, is it a sociological issue or is it a psychological issue, I do not know. Long term economic viability can only come from the market place. Government interventions can only be short term. In the recent years, an unfortunate trust deficit has developed between the common man and the specialists. The specialists are often seen with suspicion that they are trying protect their own territory. Lack of consensus among specialists, often displayed in public without convincing reasons, is yet another reason for the erosion of public trust in them. In areas of high technology, the non-specialists have a distinct disadvantage. The large volume of information that is often fed to the public

through the media lacks credibility and adds only more confusion. This cuts into the very fabric of democracy which presumes an informed electorate.

That prompts me to narrate a small story. A friend of mine received a communication from his office administration that being more than fifty years of age, he should go for a medical check-up. He chose the best hospital in town and submitted himself for check-up. Lo and behold, the cardiologist detected a block and suggested an immediate by-pass surgery. Panicked by this sudden discovery, my friend asked for a second opinion. The second cardiologist suggested that if indeed he is hesitant to go in for an operation, he can opt for a stent that involves a much lesser level of intervention. He then went to his family physician for yet another opinion. Considering that my friend had no complaints or symptoms of any kind, the doctor suggested that my friend go in for some simple medication and possible life style changes. The cardiologists were indeed unhappy and said that when you actually get a symptom and come to the hospital, it may be too late. My friend, totally confused, started consulting his friends and relatives who only confused him more. One thing was emerging clearly. The cardiologists may have a vested interest in suggesting a

surgical intervention. The physician may have a vested interest in suggesting medicines. There was a clear need for some one who had no vested interests and could offer unbiased advice. Who better than an astrologer? My friend is now going from one astrologer to another for advice. For contrast let me narrate another story, actually an anecdote. Once Mahatma Gandhi had to undergo a simple operation. A doctor was identified by Gandhi himself. Strangely, he was an English man. Some friends of Gandhi went to him and asked him whether it would not be safer to find an Indian doctor. Gandhiji declined saying that he has full faith in him. On the day of the operation, the doctor had a small wick lamp in one corner of the operating theatre even though there were electric lights in the room. When the operation was in progress, the lights went out but the operation was concluded with the assistance of the wick lamp. Every body was praising the doctor for his foresightedness. Gandhiji said "that is why I chose him". The message is clear. Decisions can not be built on a lack of trust. We need to erase this trust deficit and create platforms where every view has a space and is presented in a language understandable to the common man.

Evaluation and acceptance of public risk is more complex than evaluation and acceptance of the underlying

technology itself. You will agree with me that there is nothing in this world that is absolutely safe. While the assessment of the risks may be a technical decision, public acceptance is certainly not a technical issue. Search for zero risk options do not take us far. The history of jet engines for passenger travel comes to my mind. The first few years of experience with COMET engines in the fifties were disastrous with a series of accidents. We now know why but at that time the feeling was "say no to jet engines". Fortunately the world didn't. When India introduced the fly-by-wire aircrafts, A-320, in the early nineties, we opened our account with the air crash on the outskirts of Bangalore. The memory of another A-320 air crash in 1988 in Habsheim, France in the prestigious Air Show was still fresh in our memory. We grounded the entire fleet of A-320's for a long period but fortunately resumed after convincing ourselves that there was no safety issue with the aircraft. In fact, our airports were underprepared to exploit some of the safety features of the aircraft. When our airports were ready, still an accident took place in Mangalore. They said "Ah, the pilot was sleepy". When they were negotiating with the pilots, yet another aircraft landed on the nose wheel. They said "Ah, the pilot had a fake certificate". When DGCA is tightening the licensing procedures, I continue to travel by air. My wife believes

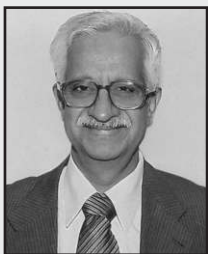
that the road journey to the airport is more risky than the air journey itself. Any time I overhear some one whispering "Solpa adjust madi", I feel a chill in my spine. Still I take the plane knowing fully well that any thing can happen but the balance of advantage lies in utilizing this technology while continuously upgrading the safety features. In contrast, one accident in the early days of air ship development led to complete denial of this technology for public use. While we are discussing a ban on the use of helicopters in the North-Eastern states, it hurts to think that the air ship could have provided a safer option. The message is clear. The answer does not lie in saying NO to any technology option in our search for an absolutely safe option. Such an absolutely safe option does not exist either. We need to continuously evaluate the advantages and the risks and prepare the public to take informed options.

Last but not the least, commercial viability plays a very important role in the choice of technologies. Frankly, I am not an expert on financial matters. But I know very well, as much as you know, that the costs we ultimately pay have not only the real costs but also opportunity costs and government subsidies, direct or hidden. In many cases, as in the case of energy costs, they completely

ignore the environment costs. The only good news is that the end user still has substantial say in the choice of technologies much more than the other players including the government. Take for example the penetration of cell phones in India. It would not be an exaggeration to say that the public at large discovered the value of the cell phone much before the government itself. For a long time, a very high powered committee in the government used to regulate the use of cell phones in the government. While I was still trying to convince the committee that some of our senior functionaries would benefit from a cell phone in their discharge of their duties, my driver went and purchased one since it would help him to discharge his duties more efficiently. I am told the ubiquitous missed call is an Indian invention. Today, scam or no scam, the market is driven by the users. It is not that the cell phone technology is risk-free. Every day I read articles that claim one or another risk of cell phone technology. The public read these articles with curiosity but continue to patronize the technology because the balance of advantage lies with the adoption of this technology.

In summary, technology options, particularly those involving global and long term implications, require not

only technical but also socio-economic assessments. An unqualified "NO" or an unqualified "YES" to any new technology is not a sensible option at all. In a democratic world, the responsibility of every option lies squarely on the shoulders of the common man or his elected representatives. Organizations like NIAS and professionals have a responsibility to equip and empower the common man to shoulder this responsibility.



Prof. V. S. Ramamurthy is a well known Indian nuclear scientist with a broad range of contributions from basic research to science administration. Prof. Ramamurthy started his career in Bhabha Atomic Research Centre, Mumbai in the year 1963. He has made important research contributions, both experimental and theoretical, in many areas of nuclear fission and heavy ion reaction mechanisms, statistical and thermodynamic properties of nuclei, physics of atomic and molecular clusters and low energy accelerator applications. During the period 1995-2006, Prof. Ramamurthy was fully involved in science promotion in India as Secretary to the Government of India, Department of Science & Technology (DST), New Delhi. He was also the Chairman of the IAEA Standing Advisory Group on Nuclear Applications for nearly a decade, Chairman, Board of Governors, Indian Institute of Technology, Delhi and Member, National Security Advisory Board. After retirement from government service, Prof. Ramamurthy, in addition to continuing research in Nuclear Physics in the Inter-University Accelerator Centre, New Delhi, has also been actively involved in human resource development in all aspects of nuclear research and applications. He is currently the Director, National Institute of Advanced Studies in Bangalore, Chairman, Recruitment & Assessment Board, Council of Scientific and Industrial Research and Chairman, Board of Governors, National Institute of Technology, Hamirpur. In recognition of his services to the growth of Science and Technology in the country, Prof. Ramamurthy was awarded one of the top civilian awards of the country, the Padma Bhushan, by the Government of India in 2005.