

SLV-3 by Dhawan some of his scientist friends wrote or spoke to him expressing their reservations. Remarkably however, neither Dhawan nor Brahm Prakash had any doubts that they had made the best choice for the job. I should add to that list Atal Bihari Vajpayee, who saw that another brahmachari like himself, who helped weaponize a nuclear device and could easily have passed for just a technology freak, would in fact make a wonderful President for the Republic – one who knew that strength respects strength but thought of missiles as ‘weapons of peace’.

The vast majority of the people of India, from every walk of life, have however been mesmerized by the tangible achievements, charisma, simplicity, humanity and dedication that characterized Kalam, and they went on to shower their affection, love and respect on him, irrespective of caste, religion, gender or political persuasion. His autobiography *Wings of Fire* (1999) became an inspiring national classic. He was honoured widely and received the *Bharat Ratna* in 1997 when he was still Scientific Adviser to the Defence Minister. He won the von Karman Wings Award of the Aerospace History Society in 2009 at the California Institute of Technology. The citation called him ‘an international leader and humanitarian who is honoured and admired by the next generation’. (Characteristically, the cash award he received at the time was donated by Kalam to Caltech, for a Kalam Prize to be awarded every year to the best student in the Master’s course.) He also won the Von Braun Award for excellence in management and leadership of space projects from the (US) National Space Society.

In summary, he was an outstanding technological manager and leader, but he was also much more than that: a sensitive human being with a big and soft heart, a karma yogi with a desi genius for understanding his countrymen, a rock star, a great Indian citizen and a true patriot – all in one.

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A. P. J. Abdul Kalam was born in 1931 in the fishing island of Rameshwaram, Tamil Nadu, India. His parents were from a middle-class family with high ethical standards. He went to vernacular schools nearby. He did his collegiate education in one of the good colleges in Tamil Nadu, St Joseph’s College in Tiruchirappalli.

While at school he was highly influenced by his teachers. That inculcated a habit of trying to ask questions to understand nature, to enjoy it and to be one with it. His quest to understand the flight of the birds gave him the *Wings of Fire*, the urge to become a pilot and to fly. This attracted him to the study of aeronautical engineering at the Madras Institute of Technology.

He learnt compassion from his mother and strict discipline from his brother, who was nearly sixteen years elder to him. His father set an example for him to follow and practice religious tolerance and societal integration. The recipe for success was well engrained in him at the very initial stage of his life through his teachers and family.

As a traditionally trained aeronautical engineer, his initial assignments were in aeronautical establishments, starting his career as a trainee and moving on to the design of a hovercraft, which was possibly one of the first flying machines designed and developed in India. The doyens of Indian science and technology at that time never failed to notice the work of a committed young man who gave all his time to his work than to any other pleasures of life, including setting up of a nest of his own. They were very impressed by his hard work, passion and knowledge and it enabled him to get a passport to work on the first Satellite Launch Vehicle programme of the country. The success of SLV-3, preceded by its own dose of failure, was perhaps the first nationally successful project wherein India’s capabilities in using science and technology base came to the fore. This was perhaps the first time the scientists gained a certain level of credibility for

their usefulness to the nation in the eyes of the public, media and the politicians.

Kalam subsequently moved over to head the Integrated Guided Missile Development Programme (IGMDP). This programme was conceived to address a large spectrum of the missile requirements of the country and was way ahead of the technological capabilities available in India and perhaps in the world. Until Kalam joined Defence Research Development Organization (DRDO), defence research was shrouded in secrecy and was mostly inward looking. He first established several design review teams with experts from the academia and the industry and ensured that everyone was exposed to and contributed to the goals of DRDO. He also established joint research centres with generous core and project-specific funding in all major educational institutions and the industry network. Thus he brought in the ISRO culture to DRDO. He was present in all the design review meetings, which often stretched well beyond dinner time. The fact that Kalam was a great listener and a learner became very evident in these review meetings. He effectively used the design review meetings to have a whole army of academics and researchers from other organizations and the industry to think and contribute to the missile development programme of DRDO. He was also singularly responsible for an enormous increase in open research leading to several doctoral degrees in IISc and IITs that directly addressed the unsolved problems in aerospace and related areas. This was almost the first experiment in India of directed and locally relevant research. He was personally in touch with every scientist and never hesitated to approach anyone who could make a contribution to his vision and mission. He was also extremely generous in acknowledging everyone’s contribution in the public. He did this by name with poise in the books that he wrote later and in his well-publicized talks. He did this attribution not only to his mentors like Vikram Sarabhai, Satish Dhawan, Brahm Prakash, Raja Ramanna and others, but also his peers and juniors. He was a great integrator and motivator of people. This art of management of large projects through inclusive participation and generous appreciation was the key ingredient in the success of all his work – a trait that he learnt from his mentors Vikram

Sarabhai and Satish Dhawan, and he was never tired of acknowledging.

The work of Kalam in the sounding rocket experiments, the development of SLV and the Integrated Missile Development Programme all had similar thread of events – first skepticism by people who never believed he was the right person to lead the initiative, failure and criticism by his detractors and the media, unconditional support from his mentors, rejuvenated team work to overcome the teething problems and followed by successful launches and the praise. This sequence of events made every success sweeter and hard earned in the eyes of the public, media and the scientific and political leadership of the country than what it would have been, had it been successful in the first attempt. It also brought out that sincerity, dedication, determination and hard work are the keys to bringing home the success. Kalam became a symbol of these in the hearts of every person, particularly the youth in India and gave them the hope that they can also do it in every walk of life.

His success propelled him to become the Scientific Adviser (SA) to Raksha Mantri (RM) to succeed V. S. Arunachalam who had by then established several initiatives in combat aircraft, radars, materials and communication to name a few. Kalam quickly expanded his knowledge horizon to take on the leadership of one of the best technology development organizations of the country. He brought in his awesome power of people and project management to further DRDO to its greater glory. He was also the originator of the most successful *BrahMos* missile development in collaboration with Russia.

Even while at DRDO, he never missed a chance to expand the impact of DRDO beyond the defence needs. His role in opening up the Internet and data services to private operators after allaying the fears of the intelligence agencies regarding the national security and simultaneously starting of a well-articulated Information Security Research centered around DRDO is something that whole nation should be thankful to him, lest India would not have seen the telecom revolution and would have been pushed to dark ages. The great trust that the intelligence agencies, the government and all the stake holders had in Kalam was so huge and acted as a glue to bring together unwilling partners to willfully agree to work for the advancement of the

society. He was able to translate the development of composite material originally done for *Agni* into a light weight and inexpensive caliper that helped several polio-affected children. The society will ever be indebted to him for many years to come for his gift of stents that made them affordable.

As the Chairman of Technology Information Forecasting and Assessment Council (TIFAC), Kalam worked with Y. S. Rajan and a group of experts to articulate for the first time in the country a national vision to make India a developed nation. Till this vision 2020 was brought out, the societal development programmes were carried out in silos of line ministries with no porosity or linkages between the programmes. Vision 2020 was the first attempt to look at the National Development in holistic way, cutting across ministries and disciplines and to be carried out in a war footing with missions in the project mode – just like IGMDP albeit at a much larger level. The Vision 2020 as a concept spread like wild fire amongst the youth and the public in general, almost like the freedom movement spearheaded by Gandhiji. It integrated the whole nation and gave a hope for everyone for a better tomorrow.

After the successful stint as SA to RM, Kalam was elevated to the position of the Principal Scientific Adviser to Government of India. His fabric had by then grown from defence research to national and societal development. Kalam initiated discussions, formulated several projects beyond territorial security to energy, water and economic security. His pet project was Providing Urban Amenities to Rural Areas (PURA). He spoke about physical, economic and knowledge connectivity and capitalized on the developments in Information and Communication Technologies to make the distance disappear. From an integrator of people, he became the integrator of ministries, and he came up with several inter-ministerial exercises in mission mode with specific time targets and measurable deliverables. With his charismatic presence and stature, he brought the DRDO and Department of Atomic Energy to conduct the nuclear test and effectively weaponized our missiles. He always believed that strength respects strength and a developed nation must also be a militarily strong nation.

Subsequently, he joined the Madras University as a professor and started to

teach and reach out to the youth, spreading his message of making India a developed nation. This was perhaps the part of his life that he enjoyed most and it fulfilled his long cherished dream of becoming a teacher. The amazing way by which he adapted his role from ‘The Missile Man’ to the messiah of national development through commitment and using Science and Technology as a vehicle for the prosperity of the nation made him the most popular household name in India. His simplicity and infectious and childlike enthusiasm for the cause at hand set him apart from the rest as an icon of the youth and their dreams and he soon became a rock star, attracting large crowd of genuine followers.

His elevation to become the President of India was rather unexpected and sudden. Once he became the President, his first task was to dismantle many of the protocols and make Rashtrapati Bhavan and Rashtrapati accessible to everyone. He met people from all walks of life many times with and without prior appointments, toured the country and met a few millions of children, igniting their minds. He used his position effectively to reach out to all the Members of Parliament and bought them into his vision of the developed nation. He and his team did a phenomenal amount of research to understand the core competencies and available talents and natural resources in every state. In fact, he produced a mock newspaper date sometime in the year 2020 for every state that highlighted the development dreams that he had for that state as ‘achieved’. This was much appreciated by the Members of Parliament and gave them a hope that they too can do it and contribute to their state’s development cutting across party lines. He also visited many State Assemblies and spoke eloquently with complete faith about what they should and could achieve for their society.

Amongst the large number of visitors to Rashtrapati Bhavan, the scientists and international leaders from industry and academia occupied a special position. Almost everyone who had ever worked with him in his long career and many times their friends and relatives were entertained by the President himself and he always offered them a sumptuous meal or at least a cup of coffee. He was extremely tech-savvy and connected the entire Rashtrapati Bhavan and parts of the Moghul Garden through Wi-Fi so that he

could work with his colleagues using his laptop. Rashtrapati Bhavan also had one of the state-of-the-art Video Conferencing (VC) facility and a well-planned E-governance initiative. He used the VC facility to deliver lectures to audiences in India and abroad.

When Bill Gates visited the Rashtrapati Bhavan, Kalam gave a power point presentation to him using a wireless keyboard and mouse and unfolded his vision in IT for India that set the business target in IT well beyond the then conservative estimates made by the industry. The fact that India did achieve Kalam's target speaks volumes about the faith that Kalam had in Indian IT industry. Bill Gates was awestruck by both the vision of the great man and the technical ambience of Rashtrapati Bhavan.

A team of leaders from US universities visited him and to them he again made a power point presentation of the road map for Indian Education System. One of the Chancellors of a well-known university in the US turned to the person sitting next to him and jokingly asked, 'can we swap our Presidents?' He won everyone's heart and projected India's image as a newly awakened nation waiting to take over the world.

Kalam was equally at home with the Indian scientists. Amongst many of the brainstorming sessions that were held at the Rashtrapati Bhavan, was the one on nanotechnology. C. N. R. Rao led the delegation of scientists and conducted the brain storming session with the participation of Kalam. In the evening, Kalam arranged for a cultural programme for scientists in the Rashtrapati Bhavan auditorium and hosted a formal dinner in the same way by which the President of India hosts the dinner for the visiting heads of state. The seating arrangement was as per the established protocol with CNR occupying the seat wherein normally the visiting head of the state would sit accompanied by his delegation. This shows the extremely high respect that Kalam had for scientists.

As a President, Kalam visited many countries. He always had a group of scientists accompanying him. Science was an integral part of the agenda of the President's visit and it was given almost the same importance as the political agenda. He ensured that he always met with group of scientists from that country and was keen to listen to technical presentation by them. He would then discuss

about what he perceived as a possible S&T cooperation agenda between the two countries. He was generous in his gesture in the co-operation with India. When he visited Africa, he noticed that there was a large disparity among the African nations in terms of the access to higher education and health care. As part of his passion for the PURA, he had already done an in-depth study of the use of satellite and other communication technologies for remote education, research and healthcare. He was in the know of Indian capability for launching any complex satellite in any orbit. He proposed that India would launch a dedicated satellite that would link all the 54 African nations and provide equitable access with equipment from India for up-linking and ground support for providing tele-education and tele-medicine support. Later he worked with the then ISRO Chairman G. Madhavan Nair and the then Prime Minister Manmohan Singh. India donated the satellite. The satellite beamed down programmes to many African countries. Just before announcing this programme in Tanzania, he wrote a beautiful poem in English that effectively said that when the rivers which originate from different places, flow through many countries in Africa and merge, why not the people merge and become friends forgetting their different origins. This poem was an instant hit and was translated into many African languages so that it could reach many people. In all of his visits, he made India proud and projected India a new emerging leader. Most of his counterparts looked at him not as a President of India, but as messiah and someone who belonged to the entire world.

All his visits always included many lectures by him to students and scientific community sprinkled amongst his otherwise busy inter-governmental meetings. His lecture at the European Union Parliament was considered by all EU leaders as visionary and thought provoking.

Kalam may have been the person who delivered most lectures and interacted with most number of people from all walks of life. Each of his visits will have at least eight to nine engagements. Personally we have seen that for every lecture, he used to prepare well, spending almost five to eight hours. Whenever he addressed technical and scientific groups or conferences, he would study the subject in depth, speak to experts known to

him and meticulously come up with a recommendation for the future of research in that area. He would stand like a scientist working for many years in the area of the conference. When it comes to the lectures to students, he was at his best and would often spend time on direct interaction with them through questions and answers. While he was a great lecturer, he was perhaps the best in his interaction and extempore answers. His lectures always had a message. He used simple and short sentences that made him resonate with the youth. He seldom used negative adjectives. Kalam never ever criticized anyone or any ideas in his talks or lectures. He was emanating positivity in thought and words.

Kalam was perhaps the most 'photographed with' individual in the world. When some of us think, we are very close to him, we soon realize that there are almost a billion people who also think so and have photographs with him to show as proof. Immediately following his death, *Facebook* witnessed the largest ever profile picture change with every one of his followers putting up photographs of theirs with Kalam. He was by far the most celebrated Indian.

On the personal side, he was a very affectionate person and always enquired about personal side of people and about their health and family. He was perhaps the most gracious of hosts. In the midst of many of his other commitments, he would always go the extra mile to show his concern for your near and dear ones.

While describing Kalam, it would be difficult for anyone to control their emotions. During one of his visits to my laboratory, he was quick to notice the sadness in my face. He asked for the reason. I told him that one of my students died in an accident and his father is injured and was in the hospital. I knew that he had a very busy schedule on that day. Nevertheless, he made it a point to visit my student's father in the hospital and spoke to him comfortingly. On another occasion, while he was in Madras University, we had planned to go to a restaurant for dinner and I had invited a few of my friends and relatives to join us. In the last minute, one of my friends called and conveyed her apologies for not coming since her husband had to be taken to hospital on an emergency. Next morning, Kalam told me that we should go and visit my friend's husband and we did. I was amazed at the humane side of a great

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person. My friend's husband recovered so rapidly and was touched by Kalam's personality. Incidences such as the ones above are neither isolated nor have been only reserved for a chosen few. I personally know of many people who have had similar experiences with Kalam.

Once, a well-known politician who was an admirer of Kalam, told me that Kalam must be the reincarnation of God. She said that 'one can be good to all the people sometime, can be good to some people all the time. How can he be good to all the people all the time if he is not God's reincarnation?'

Kalam was heavily influenced by Tamil poet Thiruvalluvar who wrote the famous Thirukkural. Thirukkural was created sometime between 3rd century BC and 1st century BC and has 1330 couplets that cover almost all aspects of our life and the philosophy behind it. Kalam had written several couplets that have motivated many a person and were original in thought. A compilation of all of these would act as a bible for everyone.

Kalam died while he was delivering a lecture to the students in Shillong. He died doing what he liked the most. In his death, most of us in the academia have

lost a colleague and a friend, every Indian had lost a guide and saviour of the country and the whole world lost a great human being. There is one in a quadrillion chances that God would create another Kalam within the next million years. He was a mother, father, brother, teacher, friend and guide, all rolled into one.

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Govindasamy Shanmugam (1938–2015)

Govindasamy Shanmugam, fondly called by colleagues and students as GS, was an internationally and nationally recognized Cancer Biologist. He did his post-graduation in Chemistry from Annamalai University. He completed his Ph D in the Regional Research Laboratory, Hyderabad working with P. M. Bhargava and carried out research on the uptake of exogenous RNA by liver slices and the effect of Actinomycin D on the synthesis of ribonucleic acid and protein in rat liver parenchymal cells in suspension and liver slices. He moved to the Institute for Molecular Virology, St Louis University School of Medicine, St Louis, Missouri, USA to work with the famous tumour virologist Maurice Green. During postdoctoral training, he worked with Giancarlo Vecchio of Italy and Nobuo Tuschida of Japan on 'transcription and translation of viral RNA in cells transformed by RNA tumour viruses'. He demonstrated the presence of virus specific messenger RNA in the polyribosomes of cells with replicating murine sarcoma-like viruses and their effective translation into viral-encoded proteins. Later he became an Assistant Professor at the same Institute and during his independent research career (1973–1978), he continued his work on viral RNAs and published two papers. He also collaborated with his post-docs in the laboratory to work on adenovirus type 2-induced early polypeptides; identified six early viral-induced polypeptides and two of those polypeptides (75 kDa and 45 kDa) were found to be associated with the DNA replication complex suggesting their role in the replication of adenovirus DNA. This work was published in *Nature* (1975).

After his independent career in US, he wanted to move to India and establish his own laboratory at Madurai Kamaraj University (MKU) during late 70s. S. Krishnasamy, then Chairman, School of



Biological Sciences invited him to join as a Reader in Biochemistry in MKU. He established the Cancer Biology Research Unit as a part of the Department of Biochemistry. His research students were known for their passion, enthusiasm and love for science, and high quality research. During early period at MKU, his group carried out research in the following areas: (1) Role for single- and double-stranded DNA binding proteins in human placenta and tumour tissues; (2) isolation and characterization of RNA processing enzymes in human placenta and plants; (3) role of intracellular and secreted proteins in normal and neoplastic cells in culture.

Shanmugam's group identified and purified novel DNA binding proteins from human placenta and demonstrated recombinase activity by using innovative Rec-Blot method, which was an easy and inexpensive method to demonstrate the

enzymatic activity. He also established a modern cell culture facility to conduct studies and understand cell cycle mechanisms in both normal and cancer cells especially the synthesis of new proteins when the cells undergo transition from G0–G1 and S phases by radiolabelling methods. He analysed the proteins that were expressed transiently both at intracellular–cellular and secreted in the medium. Among the many interesting intracellular and secreted proteins, his research group identified a secreted protein over-expressed during G0–G1 transition, but relatively low expression during S phase. The protein was purified to homogeneity and interestingly, it inhibited DNA synthesis in a variety of cells. Shanmugam continued his focus on the regulation of cell cycle proteins and identified novel extracellular matrix proteins that show differential expression in cancer cells that were transformed by oncogene transfection methods. Besides focusing on doing good science and guiding Ph D students, he took efforts to conduct three DBT workshops to train aspiring students and scientists in the country, to introduce them to advanced cell culture technology and also gene transfer methods.

In the early 90s, Shanmugam's lab started to shift from working with cell culture system to primary tumours. Shanmugam extensively analysed the genetic alterations such as mutational activation of oncogenes (*H-*, *K-*, *N-ras*) and inactivation of tumour suppressor genes (*p53*, *FHIT*, *ING1*, *p16*, *p15* and *p14 ARF*) collaborating with his post-doc colleague Nobuo Tsuchida in Tokyo Medical and Dental University, Japan. He