An Interview of Dr. VK Saraswat, Scientific Advisor to Raksha Mantri, Director General, DRDO & Secretary, Dept. Defence R&D

Dr. VIJAY KUMAR SARASWAT, FIE,FAsSI,FAeSI,FNAE *India Today's "Face of the Millennium Sciences"* is the Director General of DRDO, the premier national organization engaged in defence research. He brought a paradigm shift in approach to the defence R & D requirements of the nation through his creative thinking and dynamic leadership. A Master in Mechanical Engineering from IISc Bangalore had specialized and obtained his doctorate in Combustion Engineering. Dr Saraswat is one of the most enterprising *Indian Defence Scientist* who has built the base for design, development and production of missile technologies. As an innovative researcher, he brought breakthroughs in many critical technological areas to support the strategic and tactical requirements of the nation when India had faced embargoes through MTCR. His initiatives and drive have made India self reliant and placed the nation under the spotlight in the global arena. *A Distinguished Scientist with nearly four decades of dedicated career* is credited with numerous outstanding contributions towards indigenous missile development programs. Dr Vijay Kumar Saraswat, was the *youngest to be appointed as a Project Director. Dr Saraswat* was instrumental in development of *Surface-to-Surface missile, PRITHVI* - A PRIDE OF INDIA and its variants and their induction into *Indian Armed Forces, a rare distinction for the indigenous weapon system to find place in the armories' of all the three armed forces.* Dr Vijay Kumar Saraswat is known as the "*Missile Man II*" in India. Dr Saraswat is the founder and principal *architect* behind the first ever BMD *development program* in India by spearheading major technology breakthroughs in the areas of *missile defence systems, Interceptors, Radars, C4I Systems* and the *integration of battle management resources*. *Dr. Saraswat created history with a successful interception of an incoming missile at exo-atmospheric region in 2006 for the first time.*

In 2009, the Indian Government appointed Dr Vijay Kumar Saraswat as *Secretary to Dept of Defence R&D, Director General of DRDO & Aeronautical Development Agency and Scientific Adviser to Raksha Mantri*. Dr Saraswat with his visionary outlook steers science and technology programs of DRDO and policy with a mission to develop world class defence technologies. At 62 years old, Dr Saraswat retains both his joy in Research and his commitment to self-reliance in defence science. Since he assumed the office, he has guided the *TEJAS* (Light Combat Aircraft) Naval version roll out; *NAG* (Anti Tank Missile) complete User Trials; *ASTRA* (Air-to-Air Missile) complete aerodynamic configuration trials; maiden launch of strategic Missile PRAHAAR; Development of guided Glide Bomb with extended range; development of System on Chip for missile and EW applications; demonstration of RUSTOM-I; Initiated development of Surveillance Systems, Cyber Security, Nano Technologies; Development of LIC & NBC Technologies to support Security & Paramilitary forces *and Induction of DIVYADRISHTI* (EW software) into Services. Dr Saraswat's research initiatives have taken shape into a Research Park at IIT(M) Chennai and Kyrgyz-Indian Mountain Bio-Medical Research Centre at Kyrgyzstan.

The scientific career of Dr VK Saraswat and his defence research won him *international acclaim.* International Academy of Engg, Russia elected him as a Member of Academy and honored him as Academician in 2007, a rare distinction for an Indian scientist. *The Times* Magazine of United States in its Issue dated 17 Sep 2007 described Dr Saraswat as an *Innovator* working on New Technologies. These include development of Propulsion System to accelerate to Mach 8 speed, *SCRAMJET* and *AVATAR* (Aerobic Vehicle for Advanced Trans Atmospheric Research) at low cost. He was conferred with nearly a dozen honorary doctorates (*Honoris Causa*) in Science & Technology from reputed institutes like Sardar Vallabbhai National Inst of Technology (SURAT), Andhra University (VISAKHAPATNAM). He has number of papers at his credit published in various journals at national and international level. *Dr Saraswat is the President of Governing Council of CR Rao AIMSCS, Hyderabad; Chairman of Board of Governors of Motilal Nehru National Inst of Technology, Allahabad and Member of BHEL R&D Advisory Council. Recently, Aeronautical Society of India has declared Dr Vijay Kumar Saraswat as their President (Elect).* During his illustrious career, Dr Vijay Kumar Saraswat won many accolades and awards including *PADMASHREE by Govt of India*; *National Aeronautical Prize* by Aeronautical Society Of India; *Dr Y Nayudamma Memorial Award*; *Prof Jai Krishna Memorial Award from Indian National Academy of Engineering (INAE)*; *FICCI Annual Award* for the year 2005; Lifetime Achievement Award by Ramakrishna-Vivekananda International Foundation, Newdelhi; Vikram Sarabhai Memorial Award from Indian Science Congress.

Dr. Saraswat has, in an exclusive interview, talked to Dr. N Eswara Prasad, Editor, Metal News of IIM on many interesting aspects of DRDO & its latest initiatives, DRDO's materials programmes & their future and finally his vision for DRDO:

Q.1: Sir, materials play a vital role in the development and production of components and systems for Indian Defence. What is the role that you would like to see for the metallurgists and materials scientists of this country in this context?

Dr. VKS: No component or system can retain its competitiveness if its technology is not updated and modernized and this process is impossible without devlopments in advanced materials or introduction of newer materials. Further, Defence systems require state-of-the art materials to maintain superiority in the battle field and none of the systems can afford have obsolescence. I am very clear that advances in materials development will lead to advances in new generation Defence hardware.

Q.2: Sir, you have for several years worked very closely with some of the outstanding Indian metallurgists and materials scientists. Can you please brief on some of your experiences with these scientists?

Dr. VKS: I have had close interaction with many metallurgists and Materials Scientists during my service with DRDO. I always enjoyed their company professionally and hugely benefitted from the association. The systems that I was working it require many materials related inputs and the materials community never let us down. They were always willing to help. As a result we could develop a large number of critical components that led to many success stories.

However, my interaction with Dr. VS Arunachalam and his team of metallurgists in DMRL in late 70's and early 80's for the development of integral turbine rotor using powder metallurgy for the LP engine of PRITHVI missile has been the most rewarding. This led to realization of a highly sophisticated and complex steel rotor with integral blades. This process was later on used by HAL for production.

Similarly, the development of one meter diameter magnesium alloy casting (aerospace grade) under the leadership of Professor P Rama Rao for PRITHVI was another technology development interaction that has led to SUCCESS THROUGH SYNERGY. There are many such interactions which increased my knowledge of materials and metallurgy, and I have learnt a lot, particularly the leadership skills from these great scientists and natural leaders. If I have to name individual interactions, I am afraid the list is really very long and this interview will last forever. Let me restrain from it. However, let me add that I do remember each of those associations and cherish them. Within the missile laboratories and in the materials laboratories in DRDO, especially in Hyderabad, we had a number of distinguished materials people.

Q.3: DRDO has made several distinguished and outstanding contributions to Metals and Materials, such as Steels, Al-alloys, Ti-alloys, Composites, Nano Materials and Functional Materials. Which of these, you think are the most outstanding? What could be the further initiatives to enhance such contributions?

Dr. VKS: All of these are outstanding on its individual merit for different platforms for specific applications.

What I feel personally, India is quite capable and has many matured technologies and systems in place for its air Defence/warfare with its strong fleet of ultramodern advanced aircrafts and navigation systems, either indigenously developed or imported with adequate system understanding. These are also supported by our missile strike capabilities but we lack in naval warfare. Our sub-continent is 60% by area surrounded by sea and this demands for a strong naval support to defend our vast water boundaries. Indian Defence should, therefore, concentrate seriously on naval war fare ships, aircraft carriers and particularly ultra-deep water submarines run by nuclear power so that their underwater stay are enhanced many folds and thus "detection" by enemy and time duration for striking are at its minimum. And mind it, for such naval ships, aircraft carriers and submarines, materials with ultrahigh strength, low weight, excellent fracture toughness and impact properties, good corrosion properties, welding properties are immensely important at the same time, voluminous production capabilities with minimum production cost is a great challenge for the material and metallurgical engineers/scientists of this country.

Q.4: Under your able stewardship, DRDO had initiated several comprehensive programmes for Materials Development, including those for Integrated Guided Missile Development Programme (IGMDP), Main Battle Tank (MBT) and Light Combat Aircraft (LCA) and many more are under progress. All of these programmes are providing excellent support to the development and production of various systems for DRDO and thereby, to the Indian armed forces. Kindly provide your opinion on these programmes in the view of India's present and future warfare capabilities?

Dr. VKS: Future wars will not take place by means of invading the enemy territory which will result in loss of man power, war equipment etc.; instead, wars will be conducted and will be won from our own territory, i.e., by operating from a safer place with the destruction control in your hand. What I mean to say is it is high time Indian Defence should now master the technologies of ICBMs (Inter Continental Ballistic Missiles). Even though Agni IV was a stupendous success very recently covering 3000 kms in 20 minutes, we still have to progress further in the coming one or two years with technologies and systems that cater for 5000 km range. We are at around 3000 kg+ pay load and this should also be enhanced. Of course! There are many more such challenges and we cannot feel complacent with the successes you have cited in your question, we have to move ahead.

Q.5: Sir, DRDO has also embarked on several new initiates, such as Soldier as a System, Newer and Improved Missile Systems, Advanced Armour Tanks and Torpedoes, Sonars, MCA, UAVs, Advanced Composites, Stealth Structures, NBC, LIC and Nano-Materials and Devices. Can we have your views on how these programmes are progressing and also, your initiatives and approach to integrate these programmes with materials scientists in academic institutions and metallurgical engineers in Indian industry for production?

Dr. VKS: All these are the latest advanced technologies by DRDO and these programmes are progressing quite satisfactorily. No technology or system can be successful if they are not produced with quality, consistency and economically. And no technology can be economically or commercially successful if suitable materials are not available in abundance to support the voluminous production. This is where material scientists from academic institutions and metallurgical engineers are to play a key role focusing their expertise in bringing out newer material and processes which can support successfully these ongoing programmes. I take this

opportunity, through this interaction of mine with you Dr. Prasad, that IIM Metal News should design a regular two-page bulletin where it should highlight the new materials and thrust areas directly impacting various ongoing and future programmes of DRDO.

Q.6. Sir, in the context of the above question on DRDO programmes, the Materials for these programmes are being developed and produced directly or in collaboration with DRDO Laboratories by the Indian Industry. Yet, the relation between these two vital bodies is desired to be lot stronger and wider. What do you suggest to strength this bond and make it more effective?

Dr. VKS: Many developed countries in the world had already proved that technological development of a nation cannot be through a few pockets of government and public sector controlled units, be it research institutions, industries or manufacturing firms. DRDO also at its own can not single handedly pursue its comprehensive programmes with the help of these governmental units, which involves various aspects of technology development viz. basic research, laboratory scale and prototype development, freezing of proven technology and mass production of different products and last not the least, creation of vast infrastructure for these as well as for their production in larger numbers. This calls for an extensive interaction of DRDO with academic institutions and Indian private industries. Here, I would like to convey that DRDO had taken up very seriously the path of collaborations as well as joint ventures to be a part of various important ongoing programmes. I can site numerous examples where very energetic, advanced technology oriented industries are playing a major role as programme partners with DRDO. I don't have any hesitation to announce that the contributions from these private entrepreneurs and vendors are one of the key factors for success of many DRDO programmes.

Q.7: Sir, the materials for the system laboratories of DRDO, in general and those for critical defence applications such as Missiles to a large extent and other defence applications to a lesser extent, are often sourced from abroad and other agencies, sometimes without proper qualification. This might be mitigated to a large extent by proper and advance planning by these system laboratories in association with other DRDO laboratories and reputed and reliable Indian industry partners. What is your advice and also, suggestions in this direction?

Dr. VKS: This is a very interesting question and at the same time, a very challenging issue. There are two aspects to this issue. First, various critical DRDO programmes are time bound activities with severe constraints of non-availability of qualified and proven material sources. This results in sourcing of required materials from foreign sources with a question mark on the quality aspects of these procurements. Even though such procurements are made fulfilling certain qualification norms of the origin country or many times becomes an issue for indigenous programme, especially if the quality is not of certain standards, since can affect the performance, efficiency and quality of the indigenized system / product derived out of such import / procurements. Now, the second aspect is what could be the possible solution. The project think tank scientists should in fact start identifying sources, which can provide a complete qualified proven material for a particular application. To that matter, such programme group should develop their own industry partners on a long term joint venture mode who can be a continuous source of qualified proven materials. This can be a win-win story for both the project / programme team and the industry partner, if right steps are taken at right time and also, with

right intention. The aspect of procuring material from sources without airworthiness clearance calls for a brain storming session.

I also wish to state here that CEMILAC, can play a very important role to resolve this issue since its various wings, such as RCMAs have an in-depth knowledge not only on the material requirements / specifications, but also what it takes to qualify materials, vendors, processes, equipments etc.

Q.8: Sir, a large number of technocrats of this country feel that the robust system of developing reliable materials sources within India for Indian Defence can only come with long term association, partnership and may even be with ownership of Indian Metallurgy and Materials Industries. This has been successfully demonstrated by ISRO to a large extent and other government organizations to a smaller extent. Do you feel that DRDO has done enough in this direction? Do you plan major initiatives?

Dr. VKS: Well, in the past DRDO was not in this mode of operation; but, seeing the challenges ahead and expertise available in private sector, I have taken an aggressive approach to have a private industry-partnership mode of operation in our ongoing programmes wherever needed. DRDO definitely plans major initiatives and the results will be seen in years to come. Thanks for bringing up this issue, which I feel is very, very important.

Q.9: Sir, your personal association and involvement with some of the important materials initiatives of DRDO are laudable, for example your directions for DRDO Nano Programme, Materials for HSTDV, National Production Facilities for Turbine Components, Sensors for Intelligent Systems, Indian Steel DMR 1700 for Missile Structures, Production Facilities for Naval Steels and it can go on and on. How is such an involvement possible and how do you plan to cope up with these initiatives despite your large number of national tasks on various defence projects and your own active association with an unthinkable number of missile activities?

Dr. VKS: Dr. Prasad, as rightly indicated by you the important material initiatives taken up by DRDO during my regime are of national importance and technological marvels in their own way. I take these initiatives as challenges to be conquered. All our DRDO programmes are devoted to the nation security and hence delivering these technologies to our defence services will be my prime goal and responsibility as Director General of DRDO. Here I would like to quote from the work of India's first Prime Minister Pandit Jawaharlal Nehru, what he said on as early as 26 June 1946, from which I derive lots of my energy and focus: ***As long as the world is constituted as it is, every country will have to devise and use the latest devices for its protection. I have no doubt India will develop her scientific researches and I hope Indian scientists will use the scientific technologies and the atomic force for constructive purposes. But if India is threatened, she will inevitably try to defend herself by all means at her disposal.***

Q.10. Sir, you have carried forward the same legacy of Dr. Kalam, i.e., the development of materials, devices and systems for civilian applications resulting in many user friendly technologies for the common man of India. Can you kindly dwell briefly on the recent DRDO initiatives for Materials, Technologies and Production Facilities for these civilian applications that have evolved under your leadership?

Dr. VKS: We continue our legacy in this case and will thrive to achieve the best we could in converting many of our success stories, into Civilian spin-offs wherever possible. DMRL itself

have recently given the country the benefits of its two technologies, namely the titanium sponge production facility in Kollam as well as the investment casting technology spin off for the land based turbine applications. I am sure more examples will be there in future.

Q.11. Sir, this question is about adopting more professional human resource management: an approach to evolve guidelines for placing right man in the right position for important responsibilities in DRDO activities on basic research, design, development, manufacturing, testing, evaluation and project management. Your views, Sir.

Dr. VKS: Each individual is different - different scientific approach, different interests, varied inclination towards different fields of activity and so on. Professional resource management's basic role is to understand individual's sense of interest and exploit the same to achieve the best of him which can pay excellent dividend to the organization, not only DRDO, but, any other as well.

DRDO is doing an excellent job towards this through its HR divisions. From the stage of recruitment, each individual is thoroughly analysed in terms of inbuilt skills and interests, then each of them are judged, nourished, mentored and encouraged through various training programmes and effective exposure and management courses, prior to and after their posting. Our young scientistsare highlyencouraged and their skills and virtues are recognized through various organizational and national awards. We are quite happy with the setup we have at present in DRDO, which has evolved with continuous efforts in the last 3 decades.

Q.12. Many feel that DRDO should induct qualified scientists, with higher qualifications such as doctorates at the entry level to strengthen the various advanced research and development initiatives of DRDO? What are your views and directions on such initiatives?

Dr. VKS: I fully agree to this and DRDO doors are always open for such qualified individuals to join DRDO within the frame work and regulation of RAC. We are encouraged a variety of schemes for updating the knowledge and qualifications of our scientists including sponsorship to Post-graduate and doctoral programmes and also conducting targeted training to horn the skills of the scientists. We do encourage the scientists to carry out higher studies and research in academic institutions in India and abroad. In fact our HR policies are getting fine-tuned to have scientists and engineers with minimum of post-graduate qualifications in case of Scientist D and above. Scientists and engineers in DRDO also deriveexcellent work satisfaction from the excellent working atmosphere, ultra-modern facilities and challenging and inspiring work on many a latest technologies and the potential for growth – both professionally and personally.

Q.13. Sir, your advice and message to the young generation of this country, especially the fresh engineering graduates in taking up careers in R&D in general and joining DRDO, in particular.

Dr. VKS: I have said at many forums and occasions on this. Now, I would like to only say: Young engineers and fresh graduates with core subject knowledge, you should avail and exploit fully you core knowledge; Secondly, as an Indian, all of you have the moral duty and responsibility to serve the country to the best of your capabilities. DRDO will provide the best and the state of the art technologies to work on some of the world's most challenging and advanced

programmes with respect to Defence technologies and it is up to these young and budding engineers to become a part of such wonderful experience.

Q.14: Sir, you have contributed immensely to Indian Missile Programme, often to the extent that such services are so distinguished that you have also been termed as Father/Aurhor of Indian Advanced Missile Systems and Technologies. How do you see Indian defence in years to come and what is your personal vision for the development of critical technologies for Independent, Strong and Self-Reliant India, where a common Indian feels confident and assured of the country's defence preparedness?

Our achievements in the missile programme are due to the fact that Dr. Kalam established a strong foundation for managing technologically complex mission mode projects and I could carry forward the pace and momentum set by him with the help of a very dedicated, sincere and competent team of scientists.

I must say that India has bright future in the area of defence equipment and weapons. We have slowly come out of the shackles of technology control regimes by developing critical technologies, viz., avionics, mission computer software and hardware, control system elements, composite structures, high temperature materials and rocket engines for missiles and aircrafts. All these have certainly made us self-reliant in many ways.

Our efforts in future would be to develop fifth generation aircrafts, directed energy weapons, cyber security technologies, hypersonic missiles and next generation of autonomous unmanned systems for ground, air and underwater applications.

Strong teams of scientists in DRDO are working relentlessly to develop these critical technologies in collaboration with academic, industry and national laboratories. The technology gap is narrowing down. Industries in India are well equipped to face any challenge in producing quality goods and absorb technologies from DRDO. With increased indigenous content in defence equipments, particularly in the areas of Missiles, Fighter aircrafts, EW systems, Radars, Naval systems, Submarines and armaments, I am quite confident to state that the defence preparedness of our country has improved considerably and continue to grow in the years to come. I see a very bright future for defence technology growth and wonderful opportunities for the scientists who would be joining DRDO in the coming years.

Sir, on behalf of the Indian Institute of Metals and its vast number of members and associates, I take this opportunity to thank you profoundly for your valuable time and also, for sharing some intimate thoughts with us. May God bless you and we also wish that you continue to serve our Mother India for many more long years with such distinction that would serve as an outstanding example for each and every engineer of this country!! Thank you, Sir.