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Stewards

The launch of the IGMDP was like a bright flash on the Indian scientific firmament. Missile Technology had been considered the domain of a few selected nations in the world. People were curious to see how, with what India had at that point of time, we were going to achieve all that was promised. The magnitude of the IGMDP was really unprecedented in the country and the schedules projected were quite quixotic by the norms and standards prevailing in the Indian R&D establishments. I was fully aware that obtaining sanction for the programme could at best be seen as only ten per cent of the work done. To get it going would be quite a different matter altogether. The more you have, the more there is to maintain. Now that we had been given all the necessary money and freedom to proceed, I had to take my team forward and fulfill the promises I had made.

What would be needed to realise this missile programme, from the design to the deployment stages? Excellent manpower was available; money had been sanctioned; and some infrastructure also existed. What was lacking then? What else does a project need to succeed apart from these three vital inputs? From my SLV-3 experience, I thought I knew the answer. The crux was going to be out mastery over missile technology. I expected nothing from abroad. Technology is a group activity and we

would need leaders who could not only put their heart and soul into the missile programme, but also carry along with them hundreds of other engineers and scientists. We knew we had to be prepared to encounter numerous contradictions and procedural absurdities that were prevalent in the participating laboratories. We would have to counteract the existing attitudes of our public sector units, which believed that their performance would never be tested. The whole system—its people, procedures, infrastructure—would have to learn to extend itself. We decided to achieve something that was way beyond our collective national capability and I, for one, had no illusions about the fact that unless our teams worked on the basis of proportion or probability, nothing would be achieved.

The most remarkable thing about DRDL was its large pool of highly talented people, many of whom were, unfortunately, full of egotism and rebelliousness. Unfortunately, they had not even accumulated enough experience to make them confident about their own judgement. On the whole, they would discuss matters very enthusiastically, but would finally accept what a select few said. They would unquestioningly believe in outside specialists.

A particularly interesting person I met in DRDL was AV Ranga Rao. He was very articulate and had an impressive personality. His usual garb consisted of a red neck-tie with a checked coat and loose trousers. He would wear this in the hot climate of Hyderabad, where even a long-sleeved shirt and shoes are considered an avoidable inconvenience. With his thick white beard and a pipe clamped between his teeth, there was a certain aura around this extremely gifted, but rather egocentric individual.

I consulted Ranga Rao on revamping the existing management system to achieve an optimum utilization of human resources. Ranga Rao had a series of meetings with the scientists sharing our vision of developing indigenous missile technology and explaining the different aspects of the IGMDP. After prolonged discussions, we decided to reorganize the laboratory into a technology-oriented structure. We needed to accommodate a matrix type of structure for the execution of various activities needed for the projects. In less than four months, four hundred scientists began to work on the missile programme.

During this period, the most important task before me was the selection of the Project Directors to lead individual missile projects. We had a very large pool of talent. In fact, it was a market of plenty. The question was whom to pick—a go-getter, a planner, a maverick, a dictator or a team man? I had to get the right type of leader who could clearly visualize the goal, and channelise the energies of his team members who would be working at different work centres in pursuit of their own individual goals.

It was a difficult game, some rules of which I had learnt while working on ISRO's high priority projects for two decades. The wrong choice would jeopardise the entire future of the programme. I had a detailed discussion with a large number of prospective scientists and engineers. I wanted these five Project Directors to train another twenty-five project directors and team leaders of tomorrow.

Many of my senior colleagues—naming them would be unfair, because it could be only my imagination—tried to befriend me during this period. I respected their concern for a lonely man, but avoided any close contacts. Through loyalty to a friend one can be easily led into doing something that is not in the best interests of the organization.

Perhaps the main motive behind my isolation was my desire to escape from the demands of relationships, which I consider very difficult in comparison to making rockets. All I desired was to be true to my way of life, to uphold the science of rocketry in my country and to retire with a clean conscience. I took quite some time and did a lot of hard thinking to decide who should lead the five projects. I examined the working styles of many scientists before making my decision. I think some of my observations may interest you.

A basic aspect of a person's working style is how he plans and organizes tasks. At one extreme is the cautious planner, who carefully spells out each step before making any move. With a sharp eye for what can possibly go wrong, he tries to cover all contingencies. At the other end is the fast mover, who weaves and dodges without a plan. Inspired by an idea, the fast mover is always ready for action.

Another aspect of a person's working style is control—the energy and attention devoted to ensuring that things happen in a certain way. At one extreme is the tight controller, a strict administrator with frequent checkpoints. Rules and policies are to be followed with religious fervour. At the opposite end are those who move with freedom and flexibility. They have little patience for bureaucracy. They delegate easily and give their subordinates wide latitude for movement. I wanted leaders who tread the middle path, those who could control without stifling dissent or being rigid.

I wanted men who had the capability to grow with possibilities, with the patience to explore all possible alternatives, with the wisdom to apply old principles to new situations; people with the skill to negotiate their way forward. I wanted them to be accommodating, to be willing to share their power with others and work in teams, delegating good jobs, assimilating fresh opinions, respecting intelligent people, and listening to wise counsel. They would have to be able to sort out things amicably, and take responsibility for slip-ups. Above all, they should be able to take failure in their stride and share in both success and failure.

My search for someone to lead the Prithvi project ended with Col VJ Sundaram who belonged to the EME Corps of the Indian Army. With a post-graduate degree in Aeronautical Engineering and expertise in mechanical vibrations, Sundaram was head of the Structures Group at DRDL. I found in him a readiness to experiment with new ways of resolving conflicting points of view. He was an experimenter and innovator in team work. He had an extraordinary capability for evaluating alternative ways of operating. He would suggest moving forward into new terrains that could lead to a solution which had not been perceived earlier. Though a particular goal might be clear to a project leader, and he may be capable of giving adequate directions for accomplishing it, there can be resistance from subordinates if the goal makes no sense to them. Therein lies the importance of a leader who provides effective work directions. I thought the Project Director of Prithvi would be the first to make decisions with production agencies and the armed forces, and Sundaram would be the ideal choice to see that sound decisions were taken.

For Trishul, I was looking for a man who not only had a sound knowledge of electronics and missile warfare, but who could also communicate the complexities to his team in order to promote understanding and to earn his team's support. I found in Cmde SR Mohan, who sailed into Defence R&D from the Indian Navy, a talent for detail and an almost magical power of persuasion.

For Agni, my dream project, I needed somebody who would tolerate my occasional meddling in the running of this project. In RN Agarwal I found the right person. He was an alumnus of MIT with a brilliant academic record and had been managing the Aeronautical Test Facilities at DRDL with keen professional acumen.

Due to technological complexities, Akash and Nag were then considered missiles of the future; their activities were expected to peak about half a decade later. Therefore, I selected the relatively young Prahlada and NR Iyer for Akash and Nag. Two other young men, VK Saraswat and AK Kapoor were made deputies to Sundaram and Mohan respectively.

In those days, there was no forum in DRDL where issues of general importance could be openly discussed and decisions debated. Scientists, it must be remembered, are basically emotional people. Once they stumble, it is difficult for them to pull themselves together. Setbacks and disappointments have always been and always will be an inherent part of any career, even one in science. However, I did not want any of my scientists to face disappointments alone. I also wanted to ensure that none of them set their goals when they were at a low ebb. To avoid such eventualities a Science Council was created—a sort of panchayat where the community would sit together and take common decisions. Every three months, all scientists—juniors and seniors, veterans and freshers—would sit together and let off steam.

The very first meeting of the Council was eventful. After a spell of half-hearted enquiries and expressions of doubt, one senior scientist, MN Rao, shot a straight question: "On what basis did you select these five Pandavas (he meant the Project Directors)?" I was, in fact, expecting this question. I wanted to tell him that I found all these five Pandavas married to the Draupadi of positive thinking. Instead, I told Rao to wait

and see. I had chosen them to take charge of a long-term programme where new storms would arise everyday.

Every tomorrow, I told Rao, will give opportunities to these enthusiastic people—the Agarwals, Prahladas, Iyers, and Saras-wats—to gain a fresh perspective on their goals and a strong hold on their commitments.

What makes a productive leader? In my opinion, a productive leader must be very competent in staffing. He should continually introduce new blood into the organization. He must be adept at dealing with problems and new concepts. The problems encountered by an R&D organization typically involve trade-offs among a wide variety of known and unknown parameters. Skill in handling these complex entities is important in achieving high productivity. The leader must be capable of instilling enthusiasm in his team. He should give appropriate credit where it is due; praise publicly, but criticize privately.

One of the most difficult questions came from a young scientist: "How are you going to stop these projects from going the Devil way?" I explained to him the philosophy behind IGMDP—it begins with design and ends in deployment. The participation of the production centres and user agencies right from the design stage had been ensured and there was no question of going back till the missile systems had been successfully deployed in the battlefield.

While the process of forming teams and organizing work was going on, I found that the space available at DRDL was grossly inadequate to meet the enhanced requirements of IGMDP. Some of the facilities would have to be located at a nearby site. The missile integration and checkout facility built during the Devil phase consisted only of a 120 sq. metre shed thickly populated with pigeons. Where was the space and the facility to integrate the five missiles which would arrive here shortly? The Environmental Test Facility and the Avionics Laboratory were equally cramped and ill-equipped. I visited the nearby Imarat Kancha area. It used to be the test range for anti-tank missiles developed by DRDL decades ago. The terrain was barren—there were hardly any trees—and dotted with large boulders typical of the Deccan plateau. I felt as if there was some tremendous energy trapped in these stones. I decided to locate the integration and check-out facilities needed for the missile projects here. For the next three years, this became my mission.

We drew up a proposal to establish a model high technology research centre with very advanced technical facilities like an inertial instrumentation laboratory, full-scale environmental and electronic warfare (EMI/EMC) test facilities, a composites production centre, high enthalpy facility, and a state-of-the-art missile integration and checkout centre. By any standards, this was a gigantic task. An altogether different brand of expertise, grit and determination were required to realise this project. Goals and objectives had already been decided upon. Now they had to be shared with a large number of people from various agencies, through the problem-solving and communication processes that the leader of the team must build and maintain. Who would be the most suitable person to do so? I saw almost all the required leadership qualities in MV Suryakantha Rao. Then, as a large number of agencies would participate in the creation of Research Centre Imarat (RCI), someone had to protect hierarchical sensitivities. I selected Krishna Mohan, who was in his mid-thirties, to complement Suryakantha Rao, who was in his late fifties at that time. Krishna Mohan would encourage involvement rather than relying on obedience and monitoring people at their workplaces.

According to the established procedure, we approached the Military Engineering Services (MES) for the RCI construction work. They said it would take five years to complete the task. The matter was discussed in depth at the highest level in the Ministry of Defence and a landmark decision to entrust the responsibility of building defence structures to an outside construction company was taken. We liaised with the Survey of India and the National Remote Sensing Agency for the inspection of the contour maps and for obtaining aerial photographs of the Imarat Kancha to prepare a layout for the approach roads and the location of the facilities. The Central Ground Water Board identified twenty locations amid the rocks to tap water. Infrastructure to provide 40 MVA power and 5 million litres of water per day was planned.

It was also at this time that Col SK Salwan, a mechanical engineer with boundless energy, joined us. In the final phase of construction, Salwan discovered an ancient place of worship among the boulders. It seemed to me that this place was blessed.

Now that we had started working on the design of the missile systems and development had already commenced for their integration and checkout, the next logical step was to look for a suitable site for the missile flight trials. With SHAR also in Andhra Pradesh, the search for a suitable site spread towards the eastern coastline and finally ended at Balasore in Orissa. A site along the north-eastern coast was identified for a National Test Range. Unfortunately the entire project ran into rough weather because of the political issues raised around the evacuation of people living in that area. We decided therefore to create an interim infrastructure adjacent to the Proof Experimental Establishment (PXE) at Chandipur in Balasore district of Orissa. A funding of Rs 30 crores had been given to construct the range, called the Interim Test Range (ITR). Dr HS Rama Rao and his team did an excellent job of working out innovative and cost-effective specifications for electro-optical tracking instruments, a tracking telescope system and an instrumentation tracking radar. Lt Gen RS Deswal and Maj Gen KN Singh took charge of creating the launch pad and range infrastructure. There was a beautiful bird sanctuary in Chandipur. I asked the engineers to design the test range without disturbing it.

Creating the RCI was perhaps the most satisfying experience of my life. Developing this centre of excellence of missile technology was akin to the joy of a potter shaping artifacts of lasting beauty from the mundane clay.

Defence Minister R Venkataraman visited DRDL in September 1983 to appraise himself of the activities of IGMDP. He advised us to list all the resources we needed to achieve our goals, overlooking nothing, and then include in the list our own positive imagination and faith. "What you imagine, is what will transpire. What you believe is what you will achieve," he said. Both Dr Arunachalam and I saw in the horizon endless possibilities stretching out before IGMDP; and our enthusiasm proved infectious. We were excited and encouraged to see the best professionals in the country gravitating towards IGMDP. Who would not want to associate with a winner? The word had evidently got around that the IGMDP was a born winner.

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