8

Expedients

The SLV-3 project had been formulated in such a way that the major technology work centres, both at VSSC and at SHAR could handle propellant production, rocket motor testing and launch of any large diameter rocket. As participants in the SLV-3 project, we set three milestones for ourselves: development and flight qualification of all subsystems through sounding rockets by 1975; sub-orbital flights by 1976; and the final orbital flight in 1978. The work tempo had picked up now and the atmosphere was charged with excitement. Wherever I went, our teams had something interesting to show me. A large number of things were being done for the first time in the country and the ground-level technicians had had no prior exposure to this kind of work. I saw new performance dimensions growing among my team members.

Performance dimensions are factors that lead to creation. They go beyond competencies such as the skills and knowledge of the individual. Performance dimensions are broader and deeper than what a person must know and be able to do in order to function well in his or her job. They include attitudes, values and character traits. They exist at various levels of the human personality. At the behavioural level—at the outermost ring of the tree—we can observe skills and measure knowledge. Social roles and self-image dimensions are found at the intermediate level. Motives and traits exist at the innermost or core level. If we can identify those performance dimensions which are most highly correlated with

job success, we can put them together to form a blueprint for outstanding performance in both thought and action.

Although SLV-3 was still in the future, its subsystems were being completed. In June 1974, we used the Centaur sounding rocket launch to test some of our critical systems. A scaled down heat shield of SLV, Rate Gyro Unit, and Vehicle Attitude Programmer were integrated into the Centaur rocket. The three systems involved wide-ranging expertise—composite materials, control engineering and software, none of them ever having been tried before in the country. The test was a complete success. Until then the Indian Space Programme had not gone beyond sounding rockets and even knowledgeable people were not ready to see and acknowledge its efforts as anything more serious than fiddling around with meteorological instruments. For the first time, we inspired the confidence of the nation. Prime Minister Indira Gandhi told Parliament on 24 July 1974, "The development and fabrication of relevant technologies, subsystems and hardware (to make India's first Satellite Launch Vehicle) are progressing satisfactorily. A number of industries are engaged in the fabrication of components. The first orbital flight by India is scheduled to take place in 1978."

Like any other act of creation, the creation of the SLV-3 also had its painful moments. One day, when my team and I were totally engrossed in the preparation of the static test of the first stage motor, the news of a death in the family reached me. My brother-in-law and mentor Jenab Ahmed Jallaludin, was no more. For a couple of minutes, I was immobilized, I could not think, could not feel anything. When I could focus on my surroundings once more and attempted to participate in the work, I found myself talking incoherently—and then I realised that, with Jallaluddin, a part of me had passed away too. A vision of my childhood reappeared before me—evening walks around the Rameswaram temple, shining sand and dancing tides in the moonlight, stars looking down from an unlit sky on a new moon night, Jallaluddin showing me the horizon sinking into the sea, arranging money for my books, and seeing me off at Santa Cruz airport. I felt that I had been thrown into a whirlpool of time and space. My father, by now more than a hundred years old, pall-bearer for his son-in-law, who had been half his age; the bereft soul of my sister Zohara, her wounds from the loss of her four-year-old son still

raw—these images came before my eyes in a blur, too terrible for me to comprehend. I leaned on the assembly jig, composed myself and left a few instructions with Dr S Srinivasan, Deputy Project Director, to carry on with the work in my absence.

Travelling overnight in a combination of district buses, I reached Rameswaram only the next day. During this time, I did my best to free myself from the very past which appeared to have come to an end with Jallaluddin. But the moment I reached my house, grief assailed me afresh. I had no words for Zohara or for my niece Mehboob, both of whom were crying uncontrollably. I had no tears to shed. We sorrowfully put Jallaluddin's body to rest.

My father held my hands for a long time. There were no tears in his eyes either. "Do you not see, Abul, how the Lord lengthens the shadows? Had it been His will, He could have made them constant. But He makes the sun their guide, little by little He shortens them. It is He who has made the night a mantle for you, and sleep a rest. Jallaluddin has gone into a long sleep—a dreamless sleep, a complete rest of all his being within simple unconsciousness. Nothing will befall us except what Allah has ordained. He is our Guardian. In Allah, my son, put your trust." He slowly closed his wrinkled eyelids and went into a trance-like state.

Death has never frightened me. After all, everyone has to go one day. But perhaps Jallaluddin went a little too early, a little too soon. I could not bring myself to stay for long at home. I felt the whole of my inner self drowning in a sort of anxious agitation, and inner conflicts between my personal and my professional life. For many days, back in Thumba, I felt a sense of futility I had never known before—about everything I was doing.

I had long talks with Prof. Dhawan. He told me that my progress on the SLV project would bring me solace. The confusion would first lessen and would later pass away altogether. He drew my attention to the wonders of technology and its achievements.

Gradually, the hardware began emerging from the drawing boards. Sasi Kumar built a very effective network of fabrication work centres. Within days of getting a component drawing, he would embark on the

fabrication with what was available. Namboodiri and Pillai were spending their days and nights at the propulsion laboratory developing four rocket motors simultaneously. MSR Dev and Sandlas drew up meticulous plans for mechanical and electrical integration of the vehicle. Madhavan Nair and Murthy examined the systems developed by the VSSC electronics laboratories and engineered them into flight sub- systems wherever it was possible. US Singh brought up the first launch ground system, comprising of telemetry, tele-command, and radar. He also chalked out a detailed work plan with SHAR for the flight trials. Dr Sundararajan closely monitored mission objectives and concurrently updated the systems. Dr Srinivasan, a competent launch vehicle designer, discharged all my complementary and supplementary functions as the SLV deputy project director. He noticed what I had overlooked, heard the points I failed to listen to, and suggested possibilities that I had not so much as visualized.

We learned the hard way that the biggest problem of project management is to achieve a regular and efficient interfacing between the different individuals and work centres. Hard work can be set at nought in the absence of proper coordination.

I had the fortune of having YS Rajan from the ISRO headquarters as my friend in those times. Rajan was (and is) a universal friend. His friendship embraced with equal warmth turners, fitters, electricians and drivers as well as scientists, engineers, contractors and bureaucrats. Today when the press calls me a 'welder of people', I attribute this to Rajan. His close interaction with different work centres created such a harmony in SLV affairs that the fine threads of individual efforts were woven into a mighty fabric of great strength.

In 1976, my father passed away. He had been in poor health for quite some time due to his advanced age. The death of Jallaluddin had also taken a toll on his health and spirit. He had lost his desire to live, as though after seeing Jallaluddin return to his divine source, he too had become eager to return to his.

Whenever I learnt about my father's indifferent health, I would visit Rameswaram with a good city doctor. Every time I did so, he would chide me for my unnecessary concern and lecture me on the expenses

incurred on the doctor. "Your visit is enough for me to get well, why bring a doctor and spend money on his fees?" he would ask. This time he had gone beyond the capabilities of any doctor, care or money. My father Jainulabdeen, who had lived on Rameswaram island for 102 years, had passed away leaving behind fifteen grandchildren and one great-grandson. He had led an exemplary life. Sitting alone, on the night after the burial, I remembered a poem written on the death of Yeats by his friend Auden, and felt as if it was written for my father:

Earth, receive an honoured guest;
William Yeats is laid to rest:
. . . . . .
In the prison of his daysTeach the
free man how to praise.

In worldly terms, it was the death of just another old man. No public mourning was organized, no flags were lowered to half-mast, no newspaper carried an obituary for him. He was not a politician, a scholar, or a businessman. He was a plain and transparent man. My father pursued the supreme value, the Good. His life inspired the growth of all that was benign and angelic, wise and noble.

My father had always reminded me of the legendary Abou Ben Adhem who, waking one night from a deep dream of peace, saw an angel writing in a book of gold the names of those who love the Lord. Abou asked the Angel if his own name was on the list. The Angel replied in the negative. Disappointed but still cheerful, Abou said, "Write my name down as one that loves his fellowmen". The angel wrote, and vanished. The next night, it came again with a great wakening light, and showed the names of those whom the love of God had blessed. And Abou's name was the first on the list.

I sat for a long time with my mother, but could not speak. She blessed me in a choked voice when I took leave of her to return to Thumba. She knew that she was not to leave the house of her husband, of which she was the custodian, and I was not to live with her there. Both of us had to live out our own destinies. Was I too stubborn or was I excessively preoccupied with the SLV? Should I not have forgotten for a while my

own affairs in order to listen to her? I regretfully realised this only when she passed away soon afterwards.

The SLV-3 Apogee rocket, developed as a common upper stage with Diamont, scheduled to be flight tested in France was mired in a series of knotty problems. I had to rush to France to sort them out. Before I could depart, late in the afternoon, I was informed that my mother had passed away. I took the first available bus to Nagarcoil. From there, I travelled to Rameswaram spending a whole night in the train and performed the last rites the next morning. Both the people who had formed me had left for their heavenly abode. The departed had reached the end of their journey. The rest of us had to continue walking the weary road and life had to go on. I prayed in the mosque my father had once taken me to every evening. I told Him that my mother could not have lived longer in the world without the care and love of her husband, and therefore had preferred to join him. I begged His forgiveness. "They carried out the task I designed for them with great care, dedication and honesty and came back to me. Why are you mourning their day of accomplishment? Concentrate on the assignments that lie before you, and proclaim my glory through your deeds!" Nobody had said these words, but I heard them loud and clear. An inspiring aphorism in the Qur'an on the passing away of souls filled my mind: "Your wealth and children are only a temptation whereas: Allah! with Him is an eternal award." I came out of the mosque with my mind at peace and proceeded to the railway station. I always remember that when the call for namaz sounded, our home would transform into a small mosque. My father and my mother leading, and their children and grandchildren following.

The next morning I was back at Thumba, physically exhausted, emotionally shattered, but determined to fulfill our ambition of flying an Indian rocket motor on foreign soil.

On my return from France, after successfully testing the SLV-3 apogee motor, Dr Brahm Prakash informed me one day about the arrival of Wernher von Braun. Everybody working in rocketry knows of von Braun, who made the lethal V-2 missiles that devastated London in the Second World War. In the final stages of the War, von Braun was captured by the Allied Forces. As a tribute to his genius, von Braun was

given a top position in the rocketry programme at NASA. Working for the US Army, von Braun produced the landmark Jupiter missile, which was the first IRBM with a 3000 km range. When I was asked by Dr Brahm Prakash to receive von Braun at Madras and escort him to Thumba, I was naturally excited.

The V-2 missile (an abbreviation of the German word Vergeltungswaffe) was by far the greatest single achievement in the history of rockets and missiles. It was the culmination of the efforts made by von Braun and his team in the VFR (Society for Space Flight) in the 1920s. What had begun as a civilian effort soon became an official army one, and von Braun became the technical director of the German Missile Laboratory at Kummersdorf. The first V-2 missile was first tested unsuccessfully in June 1942. It toppled over on to its side and exploded. But on 16 August 1942, it became the first missile to exceed the speed of sound. Under the supervision of von Braun, more than 10,000 V-2 missiles were produced between April and October 1944 at the gigantic underground production unit near Nordhausen in Germany. That I would be travelling with this man—a scientist, a designer, a production engineer, an administrator, a technology manager all rolled into one—what more could I have asked for?

We flew in an Avro aircraft which took around ninety minutes from Madras to Trivandrum. von Braun asked me about our work and listened as if he was just another student of rocketry. I never expected the father of modern rocketry to be so humble, receptive and encouraging. He made me feel comfortable right through the flight. It was hard to imagine that I was talking to a giant of missile systems, as he was so self-effacing.

He observed that the length to diameter L/D ratio of the SLV-3, which was designed to be 22 was on the higher side and cautioned me about the aero-elastic problems which must be avoided during flight.

Having spent the major part of his working life in Germany, how did he feel in America? I asked this of von Braun who had become a cult figure in the States after creating the Saturn rocket in the Apollo mission which put man on the moon. "America is a country of great possibilities, but they look upon everything un-American with suspicion and contempt.

They suffer from a deep-rooted NIH—Not Invented Here—complex and look down on alien technologies. If you want to do anything in rocketry, do it yourself," von Braun advised me. He commented, "SLV-3 is a genuine Indian design and you may be having your own troubles. But you should always remember that we don't just build on successes, we also build on failures."

On the topic of the inevitable hard work that goes with rocket development and the degree of commitment involved, he smiled and said with a glint of mischief in his eyes, "Hard work is not enough in rocketry. It is not a sport where mere hard work can fetch you honours. Here, not only do you have to have a goal but you have to have strategies to achieve it as fast as possible."

"Total commitment is not just hard work, it is total involvement. Building a rock wall is back-breaking work. There are some people who build rock walls all their lives. And when they die, there are miles of walls, mute testimonials to how hard those people had worked."

He continued, "But there are other men who while placing one rock on top of another have a vision in their minds, a goal. It may be a terrace with roses climbing over the rock walls and chairs set out for lazy summer days. Or the rock wall may enclose an apple orchard or mark a boundary. When they finish, they have more than a wall. It is the goal that makes the difference. Do not make rocketry your profession, your livelihood—make it your religion, your mission." Did I see something of Prof. Vikram Sarabhai in von Braun? It made me happy to think so.

With three deaths in the family in as many successive years, I needed total commitment to my work in order to keep performing. I wanted to throw all my being into the creation of the SLV. I felt as if I had discovered the path I was meant to follow, God's mission for me and my purpose on His earth. During this period, it was as though I had pushed a hold button—no badminton in the evenings, no more weekends or holidays, no family, no relations, not even any friends outside the SLV circle.

To succeed in your mission, you must have single-minded devotion to your goal. Individuals like myself are often called 'workaholics'. I question this term because that implies a pathological condition or an illness. If I

do that which I desire more than anything else in the world and which makes me happy, such work can never be an aberration. Words from the twenty-sixth Psalm come to mind while I work: "Examine me, O Lord, and prove me."

Total commitment is a crucial quality for those who want to reach the very top of their profession. The desire to work at optimum capacity leaves hardly any room for anything else. I have had people with me who would scoff at the 40-hours-a-week job they were being paid for. I have known others who used to work 60, 80 and even 100 hours a week because they found their work exciting and rewarding. Total commitment is the common denominator among all successful men and women. Are you able to manage the stresses you encounter in your life? The difference between an energetic and a confused person is the difference in the way their minds handle their experiences. Man needs his difficulties because they are necessary to enjoy success. All of us carry some sort of a super-intelligence within us. Let it be stimulated to enable us to examine our deepest thoughts, desires, and beliefs.

Once you have done this—charged yourself, as it were, with your commitment to your work—you also need good health and boundless energy. Climbing to the top demands strength, whether to the top of Mount Everest or to the top of your career. People are born with different energy reserves and the one who tires first and burns out easily will do well to reorganize his or her life at the earliest.

In 1979, a six-member team was preparing the flight version of a complex second stage control system for static test and evaluation. The team was in countdown mode at T-15 minutes (15 minutes before the test). One of the twelve valves did not respond during checkout. Anxiety drove the members of the team to the test site to look into the problem. Suddenly the oxidizer tank, filled with red fuming nitric acid (RFNA), burst, causing severe acid burns to the team members. It was a very traumatic experience to see the suffering of the injured. Kurup and I rushed to the Trivandrum Medical College Hospital and begged to have our colleagues admitted, as six beds were not available in the hospital at that point of time.

Sivaramakrishnan Nair was one among the six persons injured. The acid had burned his body at a number of places. By the time we got a bed in the hospital, he was in severe pain. I kept vigil at his bedside. Around 3 o' clock in the morning, Sivarama-krishnan regained consciousness. His first words expressed regret over the mishap and assured me that he would make up the slippage in schedules caused by the accident. His sincerity and optimism, even in the midst of such severe pain, impressed me deeply.

Men like Sivaramakrishnan are a breed apart. They are the strivers, always reaching higher than the last time. And with their social and family life welded to their dream, they find the rewards of their drive overwhelming—the inherent joy of being in flow. This event greatly enhanced my confidence in my team; a team that would stand like a rock in success and failure.

I have used the word 'flow' at many places without really elaborating its meaning. What is this flow? And what are these joys? I could call them moments of magic. I see an analogy between these moments and the high that you experience when you play badminton or go jogging. Flow is a sensation we experience when we act with total involvement. During flow, action follows action according to an internal logic that seems to need no conscious intervention on the part of the worker. There is no hurry; there are no distracting demands on one's attention. The past and the future disappear. So does the distinction between self and the activity. We had all come under the current of the SLV flow. Although we were working very hard we were very relaxed, energetic and fresh. How did it happen? Who had created this flow?

Perhaps it was the meaningful organization of the purposes we sought to achieve. We would identify the broadest possible purpose level and then work towards developing a feasible target solution from a variety of alternatives. It was this working backwards to develop a creative change in the problem solution, that used to put us in 'flow'.

When the SLV-3 hardware started emerging, our ability to concentrate increased markedly. I felt a tremendous surge of confidence; in complete control over myself and over the SLV-3 project. Flow is a by-product of

controlled creativity. The first requirement is to work as hard as you can at something that presents a challenge and is approved by your heart. It may not be an overwhelming challenge, but one that stretches you a little, something that makes you realise that you are performing a task better today than you did yesterday, or the last time you tried to do it. Another prerequisite for being in flow is the availability of a significant span of uninterrupted time. In my experience, it is difficult to switch into the flow state in less than half an hour. And it is almost impossible if you are bedevilled by interruptions.

Is it possible to switch yourself into flow by using some sort of a conditioning device in much the same way that we condition ourselves to learn effectively? The answer is yes, and the secret is to analyse previous occasions when you have been in flow, because each person has his or her unique natural frequency which responds to a particular stimulus. You alone can identify the common denominator in your case. Once you have isolated this common denominator, you can set the stage for flow.

I have experienced this state many times, almost every day of the SLV mission. There have been days in the laboratory when I have looked up to find the laboratory empty and realised that it was way past the quitting time. On other days, my team members and I have been so caught up in our work that the lunch hour slipped by without our even being conscious that we were hungry.

Analysing such occasions in retrospect, I find them similar in the sense that this flow was experienced when the project was nearing completion, or when the project had reached that phase when all the necessary data had been gathered and we were ready to start summing up the problem, outlining the demands made by conflicting criteria and the various positions presented by opposing interests and making our recommendations for action. I also realised that this tended to happen on days that were relatively quiet in the office, with no crises or meetings. Such spells increased steadily in frequency, and the SLV-3 dream was finally realised in the middle of 1979.

We had scheduled the first experimental flight trial of SLV-3 for 10 August 1979. The primary goals of the mission were to realise a fully integrated launch vehicle; to evaluate on-board systems like stage motors, guidance and control systems and electronic subsystems; and to evaluate ground systems, like checkout, tracking, telemetry and real-time data facilities in launch operations built at the Sriharikota launch complex. The 23 metre-long, four-stage SLV rocket weighing 17 tonnes finally took off elegantly at 0758 hours and immediately started following its programmed trajectory.

Stage I performed to perfection. There was a smooth transition from this stage to the second stage. We were spellbound to see our hopes flying in the form of the SLV-3. Suddenly, the spell was broken. The second stage went out of control. The flight was terminated after 317 seconds and the vehicle's remains, including my favourite fourth stage with the payload splashed into the sea, 560 km off Sriharikota.

The incident caused us profound disappointment. I felt a strange mix of anger and frustration. Suddenly, I felt my legs become so stiff that they ached. The problem was not with my body; something was happening in my mind.

The premature death of my hovercraft Nandi, the abandoning of the RATO, the abortion of the SLV-Diamont fourth stage—all came alive in a flash, like a long-buried Phoenix rising from its ashes. Over the years, I had somehow learned to absorb these aborted endeavours, had come to terms with them and pursued fresh dreams. That day, I re-lived each of those setbacks in my deep despondency.

"What do you suppose could be the cause of it?" somebody asked me in the Block House. I tried to find an answer, but I was too tired to try and think it out, and gave up the effort as futile. The launch was conducted in the early morning, preceded by a full night's count-down. Moreover, I had hardly had any sleep in the past week. Completely drained—mentally as well as physically—I went straight to my room and slumped onto the bed.

A gentle touch on my shoulder woke me up. It was late in the afternoon, almost approaching evening. I saw Dr Brahm Prakash sitting

by my bedside. “What about going for lunch?” he asked. I was deeply touched by his affection and concern. I found out later that Dr Brahm Prakash had come to my room twice before that but had gone away on finding me asleep. He had waited all that time for me to get up and have lunch with him. I was sad, but not alone. The company of Dr Brahm Prakash filled me with a new confidence. He made light conversation during the meal, carefully avoiding the SLV-3, but gently providing me solace.

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