The Toymaker

(A chapter from the book The IITians by Sandipan Deb, Penguin 2004)

‘Meet Arvind Gupta,’ Dunu Roy told me as I was taking his leave.
'Who is he!' I asked. 'What does he do!'
'Oh, he's a mad guy,' Roy said. 'He makes toys.'
Toys! An IITian making toys? I thought all toys were made in China! So one late afternoon a few days later, I am ringing the bell at a small government-constructed middle-class apartment in south Delhi. I don't know it yet, but I am about to have the most fascinating three hours of all the hundreds I have spent on this book.

Arvind Gupta makes toys. This tall, bearded, jovial, gentle man makes them out of everything that we throw away as useless: empty tetrapak boxes, film-roll cans, used bicycle tubes, old newspapers, ball-point pen refills that have run out of ink, matchsticks. He does it so that underprivileged children--or privileged ones, for that matter can make their own toys they can have fun with, and simultaneously learn the principles of science - aerodynamics, hydraulics, electromagnetism, acoustics.

'Here, look at this, this is fascinating!' he tells me, and I find myself joining him on the door of his sitting room, on which he has arranged a newspaper littered with all sorts of odds and ends. He is holding in his hand a little contraption, which on closer inspection turns out to be a normal torch battery, which has been attached to two narrow metal strips at both ends. The battery has a small disc shaped magnet tied to it. Above the magnet hangs a copper coil. The two ends of the wire jut diametrically outward and go into two tiny holes drilled in the metal strips. 'What do you think this is!' he asks me. I admit defeat.

'This is the cheapest DC motor on earth!' he says triumphantly, and taps the coil, which immediately starts rotating very fast. The metal strips, in addition to holding the coil, also supply current to the coil. Gupta has scraped off the enamel from three sides of the end leads of the copper wire, so that the enamel remains only at the bottom, touching the metal strip. Enamel being an insulator, no current flows. When he taps the coil, the lead turns, and the metal strip comes into contact with the copper. Instantly, current starts flowing, turning the coil into an electromagnet, which, through the mutual attraction-repulsion with the magnet below it, attached to the battery, starts spinning and continues to do so, till its

south and north poles are aligned to the north and south poles of the other--permanent-- magnet. At which point the enamel part of the leads again comes in contact with the metal, and the coil is de-magnetized.

'The cheapest electrical motor that children in India can buy in a shop costs Rs. 150, and it's a stupid outdated design,' Gupta says. 'But this motor any child can make himself, with the means at hand. Anyone can get hold of a working torch battery, some copper wire and a small magnet. These metal strips are pins from a cooking stove. And once you have made this motor, you can perform an endless number of experiments: What happens when you take a longer wire! What happens when you take thick wire or thin wire? What happens if you add another battery? Try out these things and you end up learning a great deal about electric motors.'

He shows me a hand pump made from an empty plastic film-roll can, a bicycle spoke and a soft drink straw. He shows me an abacus made from the sole of a rubber slipper, three pencils inserted into three holes in the rubber, and up to nine rings on each of the pencils. His enthusiasm is child-like and infectious, and I find myself playing with his toys. Take the rings off the pencils, apply pressure on the rubber sole so it becomes concave, and the three pencils converge as rays of light, explaining how a concave mirror works! Do it the other way round for convex mirror!

'We have this constipated notion of science education, that you can't do it without pipettes and burettes and all those things,' he says, as he hunts for something else to show me. 'Most schools are anti-child. In the laboratories, everything is always locked up, and there's a layer of dust on the tables. I believe that the best thing that a child can do with a toy is break it and try to see how it works. Encourage the child to break his or her toys!'

He brings out his matchstick models. Connecting matchsticks using cycle valve tubes-extremely cheap, sold by weight in cycle shops--he has constructed two and three-dimensional geometrical shapes. The basic shape is the triangle. As Gupta points out, the triangle is the only rigid polygon (you press a square structure hard enough, it's become a rhombus; you press a pentagon hard enough, it will attain a boat-like shape), which is why trusses, bridges and electricity towers are made up of triangles, to make them inflexible and strong. Once you have made an equilateral triangle of matchsticks, you can add three more to make a tetrahedron. You can join two triangles together with three more matchsticks to make a prism. Place the prism on a cube of matchsticks, and you have a house-shaped structure. And while you are having fun and letting your imagination run riot, you are also learning three-dimensional geometry.

Gupta's book on matchstick models has sold half a million copies in more than a dozen languages at last count. He hasn't taken any royalties for the book. ‘My needs are very simple,’ he shrugs, ‘so I have managed to get by.’

'Hardly anyone remembers it any more,' he tells me, 'but each scrap of paper was once a living branch or a tree trunk. We don't remember that each ball-pen refill, broken pen, all other plastic comes from crude oil. That we have a duty to the earth to understand this, and reuse and recycle everything. Take a newspaper. Surely it deserves a better fate than being cast away after three minutes? You can fold newspapers to make a dozen varieties of caps for children, you can turn them into nice boxes to store things in, you can make them into gift packs. Use a pair of scissors and you can turn small pieces of newspaper into happing birds, talking crows, flying fishes, helicopters, stunt planes, the possibilities are truly endless!'

It all started with a lecture by educationist Anil Sadgopal that Gupta went to, in 1972, as an electrical engineering student in I.I.T, Kanpur. Sadgopal was a molecular biologist who had studied at CalTech and come back to India to work in the field of education. 'Those were pretty revolutionary times. There was the Naxalite movement, the Jayaprakash Narayan movement was gathering force, educated people were trying to find a more humane role for themselves in society.' Gupta was deeply influenced by what he heard, perhaps much more than he realized at the time.

By the time Gupta graduated in 1975, the Hoshangabad Science Teaching Programme, in the eponymous district in Madhya Pradesh, had already begun. Two voluntary agencies convinced the state education department to allow them to run a programme of teaching science, based on experimentation and activity, from Classes VI to VIII. Since most government schools had no library or laboratory, no equipment and no facilities, science was being taught—often by teachers untrained in science--without performing any experiments. Students learnt the textbooks--whatever was available--by rote, and passed, or failed, examinations. All independent inquiry was suppressed in the name of maintaining discipline in the class.

Sadgopal and his team wanted to change this. In time, the Hoshangabad programme, committed to teaching science the right way, through experiments, which children perform in the classroom, spread to over 1,000 schools with more than 100,000 students in fifteen districts of the state. The objective was to make a difference in science teaching,' says Gupta. 'The usual way that science is taught in school - even schools where they have equipment to perform experiments--is very mutilating. It's usually taught using western concepts, western equipment. This is an alienating way to teach science. Plus it is expensive, and on top of that, if there are other problems, like if something goes wrong with the equipment, there's no replacement available. Yet there are lots of possibilities of learning science material easily available at hand.'

From IIT, Gupta went to work for Telco in Pune making Tata trucks. In 1978, he took a year's study leave. He spent that year in Hoshangabad, devising science toys and experiments for the children. He then travelled to Kerala to work with

Laurie Baker, the pioneering architect who worked with local material and traditional living-space concepts to provide cheap housing for the poor. He returned to Telco for two more years, but by then he had found his life's calling. He resigned his job and arrived at Shahdol (see Chapter 26) to work with Dunu Roy for two years.

Returning to Delhi in 1984, at a loose end, he wrote to Professor Yashpal, who was in charge of the satellite television-driven school education project, SITE. Yashpal gave him the break he needed. He published his first book. He started making films on science (he has made more than seventy so far); he got a few fellowships to support his work. Since then, he has written nearly a hundred books, in English and Hindi. 'Hindi is my mother tongue, and there is an awful paucity of good books in Hindi for children. So I translate a lot. In fact, every day, I spend five hours translating.' He shows me his translation of Shel Silverstein's *The Giving Tree,* perhaps the best green book ever written. 'There are so many books available in the public domain! All one has to do is publish them in India!' He shows me Michael Faraday's *The Chemical History of a Candle,* C.V. Boys' fascinating book on soap bubbles, and *My Friend Mister Leakey* - the only children's book J.B.S. Haldane ever wrote.

He has also conducted workshops for students and teachers in more than 1,000 schools all over the country, and across the world.

As he recounts his wanderings, he keeps showing me his toys. ‘This is amazing!' he exclaims often. 'Look at this! Try it! Isn't it wonderful!' Before I know it, I am also whirling the astonishingly-simple-to-make paper bird round my head, twirling the little broomstick-and-eraser thingie that could give the child an understanding of centripetal and centrifugal force.

'Any fool can make a thing complicated, right!' he says. 'It's simplicity which is difficult to achieve.'

For example, there's this toy with two straws and a string. He cuts a soda-straw into three pans. One part he discards, one par*t* he makes a hole in, and the end of the third part he cuts at a sharp angle so it looks like a pen nib. He puts the pen nib into the hole in the other straw part so the two straw pans are at an acute angle to each other, and uses cello-tape to join them together. He then weaves a string of wool through the non-pen-nibbed straw piece, ties the ends of the string together to make a loop, and carefully trims the ends. He then hands the contraption to me to blow into the open end of the pen-nibbed straw piece. I blow and the whole loop of wool rotates in a circle. Any child would be delighted with this simple toy, which takes less than five minutes and no money at all to make. 'There's high incidence of asthma among children in Delhi because of the particulate matter in the air,' Gupta explains. 'So what do doctors tell children to do!

They tell them to blow. The child can use this toy and have fun and at the same time get therapeutic benefits!'

Twenty-nine years after it began, the Hoshangabad Science Teaching Programme was shut down by the Madhya Pradesh government in 2002. Though technically the government's orders stated that the government-notified curriculum and textbooks had to be implemented across the board, and the Hoshangabad books and experiments could be used as supplementary material, in effect, it was death knell for the experiment. Among the reasons cited was that students from Hoshangabad were not doing as well as those from many other districts in the school board examinations.

The voluntary agencies protested that the Hoshangabad pedagogical techniques were limited to Classes VI to VIII so performance in the board examinations might not be valid criterion to judge the methods. Besides, the board examinations tested memory recall rather than any genuine understanding of science. And anyway, there were many districts in Madhya Pradesh which did not use Hoshangabad methods and whose students were doing far worse in the board exams. But it was to no avail.

Like most new ideas, the Hoshangabad Programme had always attracted hostility from diverse groups of people. Many parents worried about their children being made guinea pigs in some strange experiment. Publishers and sellers of the standard-sub-standard-textbooks had been fighting against it since inception. Many schoolteachers were hostile because the children didn't take tuition in science any more; others were unhappy since they had to work harder in the science classes without any extra monetary benefits.

In 1992, the Bharatiya Janata Parry government was about to close the whole programme down when the government fell. In 2002, the Congress government managed to do what the party it bitterly opposes failed to. Both had come to see the programme as some sort of leftist plot. Many of the people involved may indeed have been leftists, but the programme's content dealt only with the best way to teach science to underprivileged children. It also reflects on our education system that this enlightened experiment actually made no difference to the marks and grades a student obtained when he or she sat for the board examinations that would determine the student's career.

'School education in India is such barren terrain that even a good seed would die due to lack of soil,' Gupta tells me. 'My humble task is to find a bit of soil so the seed can be nourished.'

I ask him about the end of the Hoshangabad dream. He is smilingly laconic. 'I suppose the government wanted control over the education system,' he shrugs.

He shows me the flute he has made from a soda straw. As he blows into it, he keeps snipping off the flute from the end with a pair of scissors, and the sound changes. 'So the child gets a qualitative understanding of the phenomenon of vibration,' he explains. 'I work with children. Whatever I see that children can do, whatever I see that brings a gleam into the child's eye, that's the work I do.'

As I leave, my head is filled with all the fun my seven-year-old daughter and I am going to have from now on, all that I am going to teach her and be taught.