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## Science from Junk: The World of Arvind Gupta

Bipin Indurkha, Professor, International Institute of Information Technology

The other day Mr. Arvind Gupta came to our institute to talk about doing science with junk material. The first I had heard of Mr. Arvind Gupta was in February of 2005, when I was visiting Indian Institute of Technology (IIT), Kanpur (a top-class technological institute in India) with some of my students to learn about the Robotics in Education activities going on there. The students at the IIT showed us an air-pump they had made with two discarded film-roll cans, a piece of rubber tubing cut from an old bicycle tube, a piece of straw and cello tape. The pump could be used to blow up balloons. They also showed us an electric motor in which the most expensive component was a D-size dry cell - the other components being, a piece of enameled wire such as used in motor and transformer windings, a small magnet like a refrigerator magnet, two safety pins and a rubber band. All these projects, they said, were based on the ideas of Mr. Arvind Gupta, which are available in his books or can be freely downloaded from his website(<http://www.arvindguptatoys.com/>). Needless to say, we were all very impressed. So a few months later when Mr. Arvind Gupta was invited to our institute, we were eagerly looking forward to seeing him in person and to see his demonstrations of science projects - all made from junk material.

When I first saw Mr. Arvind Gupta, he was having a session with our robotics club students. They were all sitting in a circle, and a humble-looking man was talking to them in a soft voice, seemingly telling stories. Strewn around him were a bunch of items like geometric figures made from matchsticks, newspaper pages folded into various shapes (origami), and a number of assorted models - I could recognize the air pump made from film-roll cans; in another model I could recognize part of an empty toothpaste tube. The students were all sitting around mesmerized. It was like they did not want this session to end.

In the late afternoon of the same day, Mr. Arvind Gupta had a general session in which all the students and faculty of our institute were invited. This time I could watch the whole thing from the beginning. Mr. Arvind Gupta is a master storyteller, and his talk was peppered with humorous anecdotes. Like a magician's bag of tricks, Mr. Gupta had his junk bag from which he would take out an amazing variety of props and models, all made from cheap and discarded material like used toothpaste tubes, rubber soles of old slippers, discarded juice boxes, soda bottle caps, old newspaper, old bicycle tubes, old spokes from a bicycle wheel, plastic ballpoint pens, pencils, old CDs, straws, string, nails, and on and on. In the hand of Mr. Gupta, these commonplace objects seem to acquire a mind of their own, and assemble themselves effortlessly into a myriad of functioning models, as if that was the sole reason for their

existence. A water bottle cap would fit snugly into a film-roll can, as if it was meant just for that, to make a piston-cylinder assembly for a hand-pump. Ten heavy-duty nails would balance on the head of another nail like a well-practiced troupe of circus acrobats. An ordinary pencil would need only a little scraping to fit through ring-shaped magnets in a levitation demonstration - the pencil defies gravity to hover horizontally in the air, with only its sharpened point in contact with a piece of old CD.


In the projects of Mr. Arvind Gupta, the principles of physics and mathematics are brought to life. Geometric facts become evident from origami models. Different kinds of pumps clearly show how fluids respond to pressure changes and how one-way valves work. Magnet-based projects, including the levitation demonstration that was a hit with our students, reveal the mysteries of magnetic fields. The nail-balancing act shows how the center of gravity is determined. By making what I would call a *minimalist* electric motor, like a Mondrian painting, students get to see directly how electric and magnetic fields interact to create motion. And so on. The simplicity of each project allows - I should rather say *invites* and *encourages* - the students to experiment and stimulates their curiosity. For example, when you turn the motor upside down, it reverses its direction of rotation. Why is that? If you increase the number of turns in the coil, does the motor turn faster or slower? What happens if you change the diameter of the coil? All these questions naturally arise, and the children can simply try them out and see the effect for themselves.

Mr. Gupta is an alumnus of IIT, Kanpur - demonstrating his minimalist motor, he quipped during his talk, "I spent five years at this top-class institute studying electrical engineering, and no one ever showed us how you can make a motor yourself!" He worked for a few years at a large engineering company that designed locomotives, but then gave up that career to pursue his interest in science education for children. For about thirty years, Mr. Gupta has been actively engaged in developing creative and imaginative science teaching aids, or 'toys' as he likes to call them, using low-cost and junk material. He has given seminars on how to teach science using such toys in Hong Kong, Germany, Sweden, UK and USA. He has published several books and articles on this topic, and has also translated many children's books into Hindi. Mr. Arvind Gupta's Herculean contribution to science and mathematics education has been recognized in numerous prestigious awards and honors conferred upon him. Yet, in spite of all these achievements, he is an unusually humble person with a very down-to-earth attitude.

The day after his visit to our institute (which is an institute of Information Technology), Mr. Arvind Gupta visited my daughters'school, and had a session with the children there. That evening my daughter, who is in the 5th grade, told me, "This was the best day of my school! From now on I am going to collect all kinds of junk, so don't throw anything away!!"

Note: The directions for building most of the science 'toys' designed by Mr. Arvind Gupta and his publications are available at his home page at: <http://www.arvindguptatoys.com/>

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