

# Rocket science isn't rocket science any more

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**Every time Pakistan test-launches a Shaheen or India an Agni, subcontinental testosterone levels shoot sky high. The fiery plumes carry aloft a nuclear-capable missile that can lay a city to waste. Iranians, though not nuclear, have their Ashouras, Emads and Shahabs. As for the North Koreans, they celebrate with fireworks and street parties when their Little Rocket Man sends up an ICBM to annoy the Deranged Dotard who, in turn, threatens them with total annihilation.**

Mirza Ghalib, while fondling his goblet of wine and reciting his bazeecha-i-afzal, might have taken an elevated view of these antics. But, strictly from a scientific and engineering point of view, are missiles worthy symbols of national prowess? What does it take to make one of these things? And, over the decades, how has missile technology progressed?

The era when rocket science was rocket science is over. At least for offensive missiles, the technology does not need the genius of Werhner von Braun, Hitler's legendary rocket scientist who nearly brought Britain to its knees with his V-1 and V-2 missiles. These were such a breakthrough that the US took von Braun and other Nazi rocket scientists to the US after the war and put them to work building rockets — military and civilian. The Soviets did similarly.

Missiles like Shaheen or Agni are minor technical feats but testing them helps create war psychosis.

While space vehicles, satellite launchers, and missile defence systems remain at the cutting edge of technology, the design and production of missiles that can traverse even thousands of miles is now fairly mundane engineering stuff that can be studied from commonly available textbooks with titles such as Supersonic Missile Ballistics, Missile Engineering Handbook, etc. Consider, for example, how navigation systems have changed.

Back in the early 1970s, guiding a city-busting missile to its target 10,000 kilometres away depended critically upon rapidly spinning, super-sophisticated gyroscopes levitated by magnetic bearings. These were also crucial to the development of multiple independent re-entry vehicles (MIRV) technology. A single MIRVed missile with thermonuclear warheads can destroy several cities.

In an idle moment, I looked around to see what's up with gyroscopes these days. Like many other physicists, I've always had a soft corner for them because of the tantalising motion of spinning tops; this has been the topic of some famous physics PhD theses. Plus, I've had a special interest ever since I was briefly arrested in 1972 — and then released — for being among the students demonstrating against the development of ICBM gyroscopes by MIT's Draper Labs.

Some internet browsing told me that, with the invention of the laser gyroscope, today's best gyroscopes don't gyre at all! The intricate electromechanical stuff has been replaced with cheaper and more robust circulating laser beams all neatly packed into a matchbox-sized unit. This feeds into the missile's onboard computer. Multiple suppliers compete to give you the best and cheapest product. Export controls can presumably be overcome because laser gyroscopes are dual-use technologies that are equally good for commercial satellites or aircraft navigation.

From navigation and propulsion to stabilisation and terminal guidance, every aspect of missile systems is now at one's fingertips. So, for example, using a commercially available computer programme called MATHCAD-15, an engineer can — all without leaving his desk — see how a rocket's performance changes upon making small adjustments to the body design, shape of fins, size of the exhaust nozzle, etc. Similarly, and again virtually, one can substitute one chemical rocket propellant for another to see which would be the most suitable for a given weapon.

To their dismay, the countries that had pioneered ICBMs — the United States being the foremost — are now finding themselves vulnerable targets. It is much harder to defend a country against missiles; at best, such defence can only be partial. On the other hand, many little rocket men in many countries now make many kinds of rockets of many shapes, sizes, performance levels, and designed to carry many kinds of payloads. Giants are unneeded where pygmies can do the lifting just as well.

But what is presently easy will soon become dramatically easier. Experts are seeing third and fourth revolutions up ahead where one can literally 'dial a missile' — ie design and build missiles tailored to very specific battle requirements. This owes to rapid advances in an area of manufacturing technology called 3-D printing.

3-D printing has already crossed infancy and is revolutionising the production of things as diverse as jewellery, car parts, and computers. Two years ago, students at the University of California in San Diego built and successfully launched a 3-D printed model rocket. The US and British navies now use 3-D printers on aircraft carriers at sea to produce customised drones. More sophisticated printers will allow the manufacture of high-end rocket engines and key missile parts.

None of this comes for free. The poorest must foot the bill. Take North Korea whose missile programme is more advanced than Pakistan's. It has also tested a hydrogen bomb which, for Pakistan, is still far away. But the United Nations reports chronic malnutrition in under-five children there — 33 per cent overall and 45pc in the northern part of the country. South Korea, which shares a common language and a common border, has a per capita GNP that is 15 times larger.

Contrary to what the armed forces of any country or their missile men would have us believe, to kill at will and to kill en masse no longer requires valour or extraordinary technical prowess. Looking around, one sees another fact: the poorer a nuclear country, the richer and more powerful its generals and political leaders.

Let the truth be told — the real purpose behind launching missiles and then dancing to their success is to create war psychosis. Only the naive and uninformed are impressed by missile-making and missile-testing. From the point of view of science, these are low-level achievements, a mere consequence of technology in the service of destruction. Countless peacefully directed technologies are more challenging in technical terms — and much more needed. Why our supposedly rational species still seems to prefer war, pain, and death instead of peace, happiness, and life remains a mystery.

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**P.S.**

The writer teaches physics in Lahore and Islamabad.

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