To attempt a description of Feynman in a few thousand words is a folly. Yet it would also be a folly not to remember the genius called Feynman in his centenary year.

**RICHARD Feynman** was exceptional. He was awkward. He had very little regard for conventions. He was an atheist who would not concede even the tiny space to God that Einstein was happy to allow.

He invented and discovered so much that record keepers have failed to keep track of his contributions. And so he is generally remembered for a very small portion of the huge corpus of his work that shaped the twentieth century physics.

**An Exceptional Childhood**

Feynman’s childhood does not disappoint us – it was full of outstanding achievements. He learned calculus at the very young age of fifteen. Students even from the higher classes came to him for solutions to difficult puzzles. In fact he would retain his fancy for puzzles all through his life. But these are trivialities. One of his deeper interests lay in toying with machine parts – from radio circuits to in-house communication channels. There is this well known piece from his highly readable composition *Surely You’re Joking Mr Feynman* where he shocked his parents with a burglar alarm fitted innovatively on the door of his bedroom. As his parents, back from a night out, opened the door to check whether young Feynman was asleep the alarm went into a high volume blare. Ignoring his parents’ shock Feynman yelled with enthusiasm that the combination had worked!

He also had an expertise with radio sets. The young boy was often called...
to repair radio circuits. In the era of economic depression the young boy’s service came in handy. Feynman was born in 1918 and he was just twelve when his obsession with radio sets started.

In the Far Rockaway High School that he attended he scored 125 in an IQ test. It was respectable but definitely not outstanding. His sister Joan scored higher and claimed that she was smarter than her brother. But as experts commented later, the school test must have put more stress on verbal ability as opposed to mathematical ability.

Interestingly he maintained this weakness in non-mathematical subjects throughout his career. His abilities in physics and mathematics made this contrast more pronounced. The website of the Mathematical Association of America lists the team and individual winners of the Putnam competition since 1938. In 1939, we have Feynman at the top of the list of individual winners and his institution at the second position as a team. What the list doesn’t mention is that the scorers were astounded “by the gap between his result and the next four”.

**MIT Years**
Columbia University reminded Feynman once again that he was a Jew. Jews could get in if they satisfied a peculiarly designed quota system. Feynman failed at Columbia but was accepted by the Massachusetts Institute of Technology (MIT). Students here, in the great American tradition, first tried their hands on lathes and motors in the labs and if they could survive the strain and had energy left then indulged in theoretical talk.

Feynman was not very adept at machining but he learnt the dynamics and rhythm of the system much better than the others did. He also did quite a bit of shuttling with his subjects. He originally majored in mathematics but later switched to electrical engineering. Not satisfied he again opted for physics which he thought retained the charm of both the subjects that he had valued so much earlier.

In his undergraduate years he was able to publish two papers in the *Physical Review*. The first one concerned cosmic rays about which very little was known at that time. The rays stream through space at high energies and leave trails of electric charges. The source of these rays was not known to physicists. In a bid to close the knowledge gap, scientists were sending ray detecting equipments on ships, aircrafts and balloons anywhere they could.

One of Feynman’s professors Manuel Vallarta asked a very pertinent question: how are these rays scattered? Does the scattering have a net effect in terms of giving the rays a resultant direction? Feynman’s research work proved that no such effect was there.

The second problem led to a deeper course of exploration by Feynman. The problem was suggested by his professor John Slater. It was regarding the relatively little expansion of quartz when heated. Its coefficient of expansion is much smaller compared to that of metals. Feynman proceeded in the classical way to understand the force exerted by a pair of oxygen atoms on a single silicon atom in quartz to minimize expansion due to heating.

But he had to switch to the quantum path very soon. Schrodinger’s wave equation had to be calculated to understand the position of the electron cloud surrounding the atomic nucleus. Further, it led to the understanding of minimum energy that every system in this universe aims to arrive at. The way he calculated the mathematics to find a solution to the original problem posed by Slater was unique. It was so simple that many scientists refused to believe that it was true. The publication of his thesis in *Physical Review* was possibly a trivial event as his proof actually became famous later as the Feynman-Hellmann theorem.

He graduated in 1939 and was eager to continue at MIT but his well wishers Professor Slater and Professor Philip Morse thought otherwise. They were eager to send him to Princeton and communicated with their colleagues there. But Feynman’s Jewish identity intervened again.

Henry Smyth, head of the Physics department at Princeton said that they harbored reservations about Jewish students. Smyth clarified that they wanted to keep the proportion of such students ‘reasonably small’ in their department. Morse went the extra mile to placate his fears. Along with declaring that Feynman was exceptional in talent he had to vouch that Feynman’s being Jewish would not pose any problem to Smyth. Princeton finally accepted him.

**The Road to Los Alamos via Princeton**
The Second World War had begun but not in America. Feynman started his research under the already famous John Wheeler. For his PhD thesis Feynman devised the path integral approach to quantum theories. Along with his supervisor Wheeler, Feynman was interested in the electromagnetic interactions of the electron from a completely different point of view rooted in a theory involving action-at-a-distance. The resultant method of their actions is what we know today as path integrals for quantum mechanics.

Feynman received his PhD in 1942. At the same time Feynman decided to marry. He tied the nuptial knot with his high school sweetheart Arline Greenbaum. She had contracted tuberculosis before her marriage and that was to remain with her till her death in 1945. Feynman cared for ailing Arline till her last breath.

Meanwhile, the project for the atom bomb had received the approval of the American President Roosevelt in October 1941. It was soon to be called the Manhattan Project to which Feynman was also recruited. His first assignment was to visit Chicago where Enrico Fermi had constructed a pile with graphite bricks and uranium balls on a university squash court. Fermi found that chain fission reaction was happening inside the pile. It was December 1942.
While the scientists had gathered at Los Alamos by April of 1943 it took several more months for the equipments to arrive. The first consignment of Plutonium arrived only in October. Overseeing all this was Robert Oppenheimer who put Hans Bethe in charge of the theoretical division. Feynman paired comfortably with this senior scientist and when the two were together loud laughter could be heard from a distance.

Making the Bomb
The research at Los Alamos involved some difficult layers of calculations, which were done on Marchant calculators. However, the heavy use of these calculators led to massive wear and tear of the machines. Broken machines had to be shipped to California for repairing. Feynman teamed up with Nicholas Metropolis, a Greek mathematician, and soon became adept at identifying the points of malfunction and event hung a board saying “Computers Repaired”.

But calculation at Los Alamos was not limited to simple arithmetical processes. IBM machines, precursors of modern computers, had to be ordered. Feynman had to appear again in the avatar of an engineering wizard to assemble the different parts of those multipliers and tabulators. The composite machines helped scientists to calculate how much temperature and pressure would be there just before the bomb detonated in a desired, stable way.

One particular exercise in which Feynman found boyish charm was tinkering with locks. He would surprise everyone by opening a newly arrived safe, which was believed to be the most difficult to tinker with, in a matter of minutes. Feynman required small hints to open a lock. The mechanical arrangements in a lock always had some in-built weaknesses. He loved to exploit those. His sharpened kills became an irritant for the administrative department and he was often denied a chance to even have a look at a locked cabinet. Feynman felt amused.

Detonation and After
The Manhattan project heightened appeals for more funds to be invested in nuclear research in particular and physics research in general. Physicists acquired a never-before aura in the eyes of the public. Universities and institutions were trying to attract Los Alamos scientists to their camp. Where would Feynman go?

After some initial bouts of indecision he chose Cornell University and joined as an Associate Professor. But he was carrying the emotional baggage resulting from the killing of hundreds of people by the bomb that he also had helped to design.

Feynman’s mother Lucille wrote to him about the death and destruction caused by the bomb and her peculiar fear about her son’s part in this. Feynman could not help becoming somewhat depressed after reading it.

On the research front, in dealing with Quantum Electrodynamics Feynman was searching for a clear picture that was constantly evading him. Feynman was deeply disturbed. But from this broth of disturbance arose some diagrams that would change for ever the way particle interactions were understood.

Freeman Dyson also shared time and space with Feynman at Cornell. Dyson showed in 1948 that Feynman’s diagrams and rules for calculation were the same as the Field Theory approaches of Julian Schwinger and the Japanese Sin-Itiro Tomonaga.

Caltech and Brazil
In 1950, Feynman was offered a position at the California Institute of Technology or Caltech. Before going there he took a half year off to relax in Rio in Brazil, where he taught Physics and learned to play the bongo drums.

While his music blossomed he was appalled to see the sad state of science education in developing countries like Brazil. Feynman taught basic electromagnetism to students at the University of Brazil in Rio. He urged the students to ask questions as he lectured but they would not respond at all. The curriculum was rote and Feynman felt that European influence on the curriculum was too much. The students were very good at memorizing names and abstract formulations but never thought of approaching a formula from an unusual viewpoint. Feynman despised this system.

In 1965, Feynman received the Nobel Prize with Julian Schwinger and Sin-Itiro Tomonaga. The award committee stated that the prize was given “for their fundamental work in quantum electrodynamics, with deep-ploughing consequences for the physics of elementary particles”.

Science historians say that Feynman could have won this prize for his other contributions as well such as superfluidity of Helium and his research on the sub-structure of nucleons.

In 1959, Feynman delivered a talk titled “There’s Plenty of Room at the Bottom”. It laid the foundations for nanotechnology. His untiring efforts of demystifying nature came to an end on 15 February 1988 when he died of a rare form of cancer that led to complete kidney failure.

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