DETAILS OF INTERVIEW AS FEATURED ENGINEER BY
https://www.eeweb.com/featured-engineers/interview-with-abhijit-pathak

Abhijit D. Pathak

- **Can you describe what variety of fields you have worked during your lifetime?**

  By chance, I got opportunities to work in diverse fields during my lifetime. Just after my M.S. (EE) I worked in design and development in the field of Power Electronics. It was both challenging and fun to build 8 KW, 8 KHz sine wave power inverters, using fast turn off SCRs and polycarbonate metal can capacitors with screw terminals and special low loss inductors, using bifilar winding and Litz wires to minimize skin effect. It also involved designing and building high frequency high voltage power transformer that can generate corona discharge, when connected to an electrode. Today with availability of fast IGBTs and MOSFETs, it is so easy to build sine wave power inverters. But when fast turn-off SCRs were the only high voltage, high current switches available, turning them off at high switching frequency, using well designed commutation circuits was tough. GE product planners of SCRs visited me when they heard that I finally built and tested a 15 KW sine wave inverter at 8 KHz. They wanted to know how I did it.

Fig. (1) A High Voltage Corona discharge Treater in operation

  The output power was fed to a step-up high frequency transformer to generate controlled corona discharge, as can be seen in the photo above in Fig.(1), to enhance surface tension of running plastic film so that it can be printed with ink.

  Then I worked for one of world's biggest machine tool manufacturers and got a chance to develop metrology instrumentation and developed analog portions of Digital Readout Systems capable of 1 micron resolution and ±3 micron accuracy for 3-axis coordinate measuring machines. I also developed strain gauge instrumentation and LVDT electronics with 1 micron high resolution for electronic gauges. I learnt a lot, while doing this. Later on, I transferred residency to India and worked in space science and technology for many years during formative years of Indian Space Research Organization (ISRO). Now I am working on application of power electronics in Aerospace and other High reliability fields in the U.S.A.

- **Which experience in your life left an unforgettable milestone in your work career?**

Just after receiving M.S. (EE), when I started my first job, I was asked by company's Director of Engineering to improve speed regulation of an existing D.C. Drive using SCRs. When I tested I found that the D.C. Drive could give only 2% speed regulation. I opened the books and read about this. Then I designed and built Lead/Lag network and slowly tuned the drive electronics with motor connected, while increasing loop gain. Finally I could improve the speed regulation to 0.2% with perfect stability. As this was done in my first two weeks of job, the boss remarked that I can get paid for whole year without doing anything else!

- **What are your thoughts for future of sustainable world and how and what can EEs contribute?**
- I think engineers carry extra responsibility for making this world sustainable. We ought to keep in mind the following at all times:

1. Can we optimize a design for higher efficiency?
2. Can we build it using lesser number of parts?
3. Is it possible to use ecology friendly parts & manufacturing techniques in doing everything?
4. Can we add intelligence to every powered equipment, tool or subsystem to consume lowest minimum power when not in use by turning itself off?
5. Is it possible to use less paper, gas, water & electricity in doing everything?

- **What name would you like us to use for the interview? Abhijit D. Pathak**
- **How did you get into electronics/ engineering and when did you start?**

I opted for EE, when I had a choice for choosing specialization at college/ University level. So in first year of Engineering I studied all subjects such as Physics, Chemistry, Mathematics and basics of all engineering disciplines. Later on, emphasis was on Electrical Engineering curricula. So I got Bachelor's degree in Electrical Engineering, but with less emphasis on electronics. Then I came to U.S.A. and studied towards my M.S. (EE) at the University of Rhode Island. At URI, I studied Electronics, Telecommunication, Control Systems, Electromagnetic waves and computer hardware & software.

- **What are your favorite hardware tools that you use?**

Digital Storage Oscilloscope, Spectrum Analyzer, Electronic loads, D.C. Regulated Power Supplies, True RMS DMMs, Portable Digital scope, Signal Generator, Environment test chambers, Temperature sensors and monitoring systems, Current probes etc.

- **What are your favorite software tools that you use?** PSpice, and other simulation tools
- **What is the hardest/trickiest bug you have ever fixed?** I remember trying to troubleshoot a 3-axis coordinate measuring machine interfaced to a microcomputer board. The three dimensional measurement data were captured by microcomputer and used for computing various dimensions, O.D., I.D., concentricity, eccentricity etc. to determine whether the engine part being measured met all design goals of accuracy. When a malfunction occurred, I went through all hardware and software for troubleshooting, but could not find any systematic errors. The random errors were finally traced to a mouse's excreta on some tracks of microcomputer board. After cleaning this with isopropyl alcohol I got the problem resolved.
- For the benefit of the readers I am giving below some basic information of a 3-axis coordinate measuring machine, popularly called CMM. CMM is composed of three axes- X, Y and Z, which are orthogonal to each other. Each axis has a scale system that indicates the location of that axis. The machine will read the input from the touch probe, as directed by the operator or programmer. The machine then uses the X, Y, Z coordinates of each of these points to determine size and position with micrometer precision.
- I was part of the team of design engineers who designed and built first such machine in the U.S.A.

Fig. (2) A 3-Axis coordinate measuring machine

- **What is on your bookshelf?** I have several books on variety of subjects like Power electronics, Mathematics, Feedback control systems, Digital Designs, Analog Design, Power semiconductors and many magazines on electronics**. .** I love to read about alternate energy sources and how to save energy. But I also love to read on Gandhi and Peace, good governance, sustainable and just world-free of violence, hunger and injustice. I also read about advancements in the field of medicine.
- **Do you have any tricks up your sleeve?** (Special way to analyze circuits, special process you use to make something, etc.) My philosophy is: Look for current, i.e. shape of current pulse drawn by circuit tells more about circuit than applied voltage. The nature of circuit and component is characterized by what current it draws, when excited by voltage. Components eventually fail also due to current. So any circuit has its own "signature" defined by shape and size of current it draws. Another trick is to isolate circuits logically from beginning to end while trouble shooting, looking at waveforms. To troubleshoot TTL logic, I used to isolate bad ICs by sensing heat on IC, or sometimes instantly cooling hot ICs by spray, and opening IC pins from sockets to zero in on bad ICs, while looking at waveforms. To analyze other problems, I first look for any systematic pattern. If none found then I look for possibility of random errors.
- **What has been your favorite project?** When I was working for Indian Space Research Organisation in India, I was appointed as Project Leader of "Upsonde Project" to measure in-situ temperature, humidity, wind speed and direction of upper air from ground level up to stratosphere, using a small inexpensive payload that could be tied to an inflatable 3 feet diameter latex balloon. This project was part of Global Atmospheric Research Project (GARP) and India was a participant country. ISRO was called upon to develop entire system. Right from concept to finalization and execution, this project generated great challenges and helped me innovate and harness new techniques and technologies for the first time in India. For example, my team not only designed and built our own hardware, but also wrote system and application software. My team built 16-bit microcomputer; using TI's TMS1600 (the only 16 bit microprocessor available at that time) wrote device handlers, system software in assembly language and application software in BASIC. I designed and developed a memory aided digital phase lock loop for acquiring phase information of OMEGA NAVAID signals to determine wind speed and direction. Before GPS became available, Eight Omega transmitting stations, strategically located all over the globe on both sides of equator, were used for navigation on sea and in air, using hyperbolic radio navigation techniques. These Omega stations continuously transmitted stable VLF frequencies between 10 KHz to 14 KHz in allotted time slots. By using triangulation method and by determining time of arrival of omega signals from three or more stations, the omega receiver's location can be determined and by successive determination of locations one could compute speed and direction. We used cheap cassette recorder as mass storage for recording flight data on one track and stable clock on second track for synchronous data storage and retrieval using NRZ method. We took our base station aboard research ship and conducted actual flight experiments in Arabian Ocean before monsoon season arrived. The sea was rough with 36 feet waves and this was my first such ocean going experience. This new method of pressure, temperature & humidity and wind determination helped alleviate problems and costs associated with earlier method, using radar,

which required stabilized platforms for ship mounting. You can see below our team launching the balloon with payload from the ship's deck.

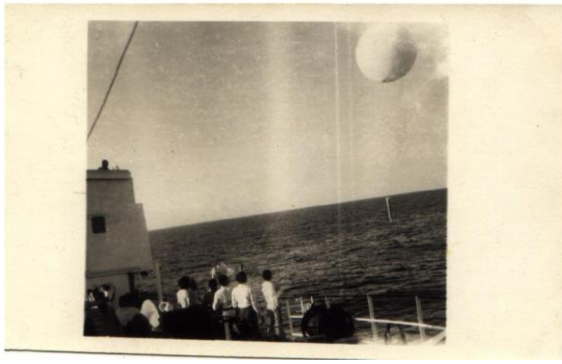


Fig. (3) A weather sounding balloon being launched from a research vessel (Ship)

- **Do you have any note-worthy engineering experiences?**
  Another equally challenging, but at the same time, exciting project involved development of tethered balloon for the first time in India. This large Zeppelin shaped balloon is made up of strong synthetic fabric such as Kevlar and is tied to ground by an equally strong tether. We used to inflate the balloon with hydrogen at night in large open space for safety. Helium was too expensive and not easily available. The balloon, its payload, that is tied on the bottom side of the balloon, and its support system were developed by our team at Indian Space Research Organisation for the first time. We termed it "KYTOON". I was project engineer in charge of its payload. The payload consisted of data acquisition system, power supplies, batteries, telecommand & telemetry and automatic control system to maintain balloon shape and orientation and overall health of all systems onboard. After building first such tethered balloon, we had successful test flight up to a designed altitude of 1 mile. Everything worked without any problem. Being the first tethered balloon flight, it was considered a big achievement for ISRO and India. I have shown below photo the First such balloon of India: "KYTOON" that our group built and flight tested. Fig. (4) Shows this Kytoon being readied for test flight.

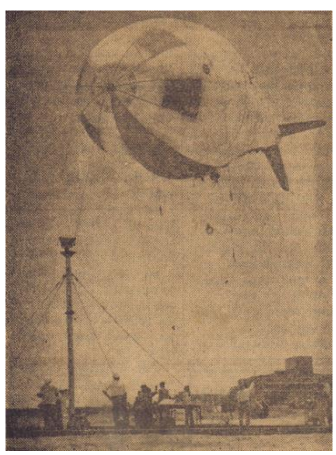


Fig. (4) The first Tethered Balloon ever built in India being launched

- **What are you currently working on?** I am working on application of HiRel products such as radiation hardened MOSFETs, radiation hardened Solid State Relays, radiation hardened DC to DC Converters, high temperature electronics and radiation hardened point of load converters.
- **What direction do you see your business heading in the next few years?** I think the trend is to achieve still higher efficiency, smaller volume, higher reliability, highest MTBF and lowest MTTR and lower cost.

- **What challenges do you foresee in our industry?** I think our challenge is how to make everything ecology friendly. The economy has its impact on everything and so we are likely to adjust our development and growth to fit in the overall market growth. The field of electronics can also help us eventually reduce our dependence on fossil fuels and help us achieve sustainable earth.

- **Can you tell us more about the high temperature electronics?**

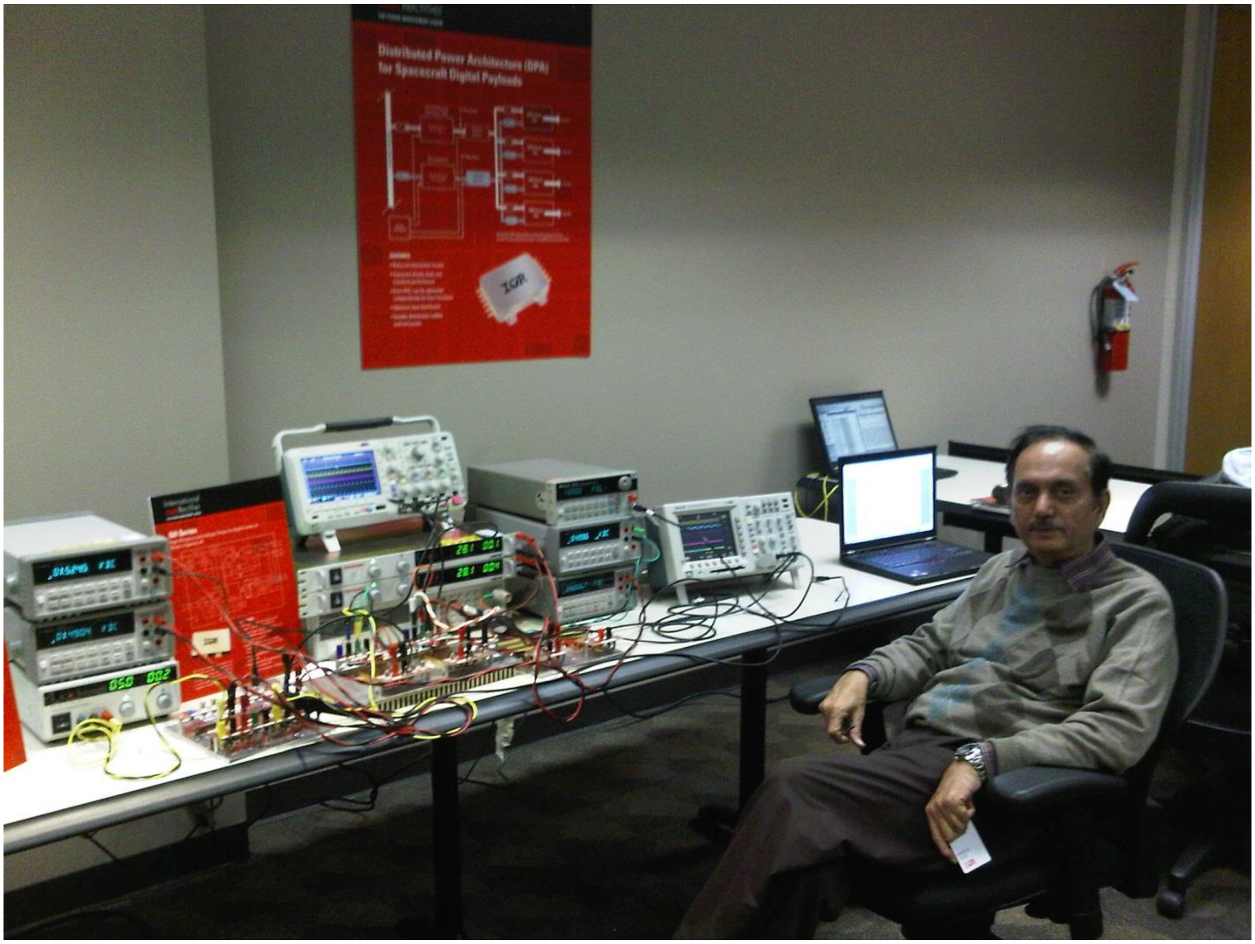
High Temperature Electronics field requires that the specially designed electronics work in high ambient temperature, say, from 150 ^{0}C to 200 ^{0}C and sometimes even beyond. We are all familiar with the commercial environment of -40 ^{0}C to +85 ^{0}C and Military environment of – 55 ^{0}C to +125 ^{0}C. So to make electronics work above +125 ^{0}C does require special care, design margins and guard bands.
We are also aware of upper limit of junction temperature of most silicon die to be 150 ^{0}C.

- **What uses do they have?**

With this background, when we think of the special high temperature environments present, say, in Jet engine, underground and in deep space probes, it is necessary to find ways to design electronics that not only survive, but function reliably at high temperatures, say, from 150 ^{0}C to 185 ^{0}C and, in rare cases, even beyond. This requires special care in choosing components and manufacturing processes

- **For the development of the radiation hardened point of load converters, what has been the biggest challenge?**

A fully functional radiation hardened Point of Load converter with input and output filters and all passive and active components in place has weight and volume, which are at premium in space applications. So the challenge is to get the performance, i.e. high efficiency, high reliability, wide operating temperatures, tight regulation and ripple free output with the minimum weight and volume.



- **What tools are generally used while developing this?**

The most important tools are modeling and simulations, which enables one to predict, with reasonable accuracy, the performance, EMI profile, MTBF etc. before embarking on the actual experimental work.

- **Where are the Radiation Hardened POLs used?**

Radiation Hardened Point of Load Converters are used in powering Radiation hardened FPGAs and other Radiation Hardened digital loads mostly for space applications.

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