Introduction to Research Scholars' Fair

Timothy A. Gonsalves
Director, IIT Mandi

Good morning, everyone. On this Research Scholars' Fair, Anusandhan 2019, I'd like to narrate two stories.

One Story

Until 2004, it was known that jellyfish existed in the oceans ~600 mya (million years ago); ~400 mya vertebrates (fish) were common in the oceans but not found on land; 4-legged amphibians and vertebrates appeared on land ~300 - 200 mya. From where did they evolve?

In 2004, Neil Shubin and colleagues discovered fossils of Tiktaalik, a fish with legs in place of fins, with lungs and eyes adapted for life on land. This established the evolutionary path from jellyfish to *Homo sapiens*. They had planned meticulously and made 4 expeditions over 6 years to remote Ellesmere Island in the Canadian Arctic before this momentous discovery.

There is no written record, no pictorial evidence, no monuments to tell us what happened 375 mya. While we can have a high degree of confidence in our explanations of what happened 100s of millions of years ago, we can never be certain. Paleontologists rely on an intricate set of tools, techniques and bodies of knowledge to make inferences. These include geology, chemistry, physics, climatology, biology, and other disciplines.

Another Story

In the 1880s-1890s, electricity distribution systems started to appear in New York and other cities. Thomas Edison's company, Edison Electric, was building DC systems. George Westinghouse's company, Westinghouse Electric opted for AC. After a bitter fight, which descended to decidedly unscientific levels, AC won out and over the past 100 years, AC has been universally used for electricity distribution.

This has led to an anomalous situation when we install solar PV panels. These generate DC which is converted to AC and then used to power lights, fans, etc. Increasingly, lights, fans and other appliances are electronic and run on DC. Thus we have DC solar power converted to AC for transmission and then converted back to DC for use. This results in extra expense and in loss of power. Often, batteries are used to overcome the intermittency of solar power. This involves further expense and loss of efficiency as AC is converted to DC for the batteries and back to AC. Overall, the conventional design can result in ~50% loss of efficiency.

In 2010, at IIT Madras, Ashok Jhunjhunwala, Bhaskar Ramamurthi and colleagues developed an ingenious system that is fully DC. It is significantly less expensive to install and results in much higher efficiency. The system has been commercialised and installed in 100s of houses in villages in several States. It has brought 24x7 electricity to rural houses that were practically without electricity earlier, thus transforming the lives of many villagers. It is in use in some buildings here on our campus.

This development took many years of hard work. It drew on expertise and personnel from a variety of disciplines including electrical engineering, mechanical engineering, computer science, economics, sociology, and history.

Which Story is Research?

Which of these two sagas are research? Everyone would agree that Shubin's discovery of Tiktaalik is clearly research of a high order. Many would say that it is of no practical significance, some may question why such research is being funded with public money.

Many academicians may doubt whether the IIT-M development of DC solar power system is research. It may be viewed as interesting engineering work that is best done in industries.

Basic scientific research explains the world as it exists, filling in gaps in our knowledge of the world. Engineering research changes the world, extends the world for the benefit of society. In both these examples, established theories and practices were overturned by novel out-of-the-box thinking. In both cases, passion and diligence over many years resulted in many journal papers, and several MS/PhD scholars got degrees.

I hope that the young researchers of IIT Mandi will be inspired to follow in the footsteps of these researchers. Through your passion to understand or change the world, your curiosity and thinking across disciplines, and your hard work, I'm sure that in the years to come new understanding of the world and new useful technologies will emerge, for the benefit of Indian society and to carry the reputation of IIT Mandi ever upwards!

Reference: Neil Shubin, *Your Inner Fish: The amazing discovery of our 375-million-year-old ancestor*, 2008