Vernacular[1] Science

The Science of Delivery.

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In this talk, Milind looks at key questions of development and the connection with the way we do science. He points out that the question of delivery is an important motivation as well as a source of exciting problems for science as is the joy of discovery. He then proposes a more socially connected "vernacular science" as a possible approach to a more sustainable and equitable world.

A. Introduction and Objectives.

Its a pleasure to be here. I am going to talk about questions of development, i.e., the concrete stuff of *sadak, bijli, paani*, and jobs. And I am going to point out its connection with the way we do Science. In fact, I am going to propose a new and a more functional method of doing Science called Vernacular Science.

[1] *vernacular*: spoken as one's mother tongue, not learned or imposed; domestic and functional rather than public or monumental.

Manisha and her family

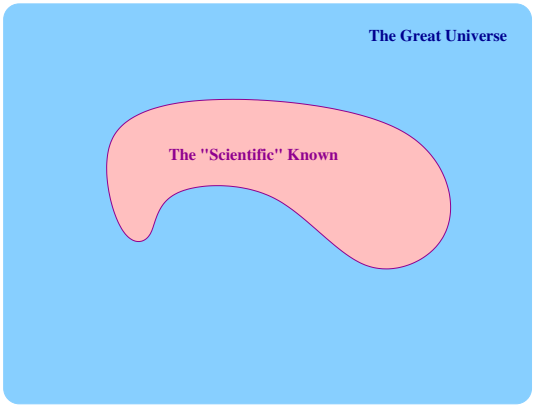
Hirabai at her cookstove

Here are 3 recent pictures from within 100 kilometers of IIT Bombay. The obvious questions are: Why is it that even after such advances in Science does Manisha still have to fetch water this way? Why does Hirabai cook on smoky chulhas and Anil use such primitive tools?

More than 25% of Maharashtra's rural population fetches water like this and more than 40% cook on chulhas. So this is a very important problem. Let us see how this connects with the way we teach and do Science.

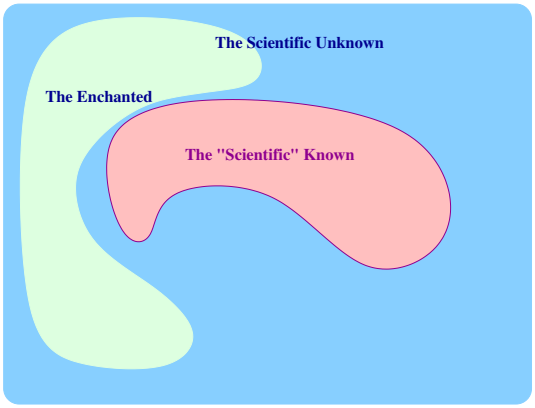
B. The frontier model, method of science, theory and laws.

The frontier model is perhaps the simplest conceptual model of Science. And this is what we teach in our schools.

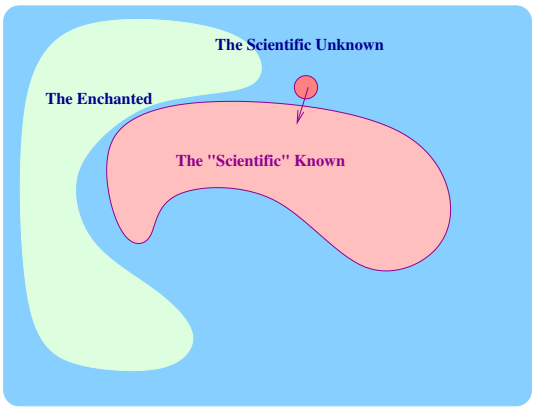


In this, there is the great universe of questions or phenomena in the physical, natural and social world, which we observe. Then there is a blob called **The Known**, i.e., which can explained by scientific laws. And these are typically very simple laws, e.g., $S = ut + \frac{1}{2}at^2$ or $F = \frac{q_1 q_2}{r^2}$. Stuff outside the known is the **Great Unknown**.

There is course **The Enchanted World** of myths and stories, of Music, of Love and Grief, of Nature and the Seasons.



What we learn later in college, is that there is a **Method of Science** which begins with a **desire** of converting an unknown into a known.



This consists of a cycle.

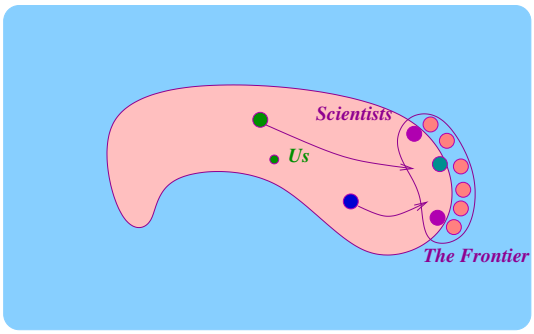
It starts with a particular question, e.g., the formation of bubbles, and a systematic observation of the quantities concerning it, e.g., the radius, the room temperature and pressure, the viscosity of the solution etc. After maybe hundreds of observation, we come up with a hypothesis and a theory, a relationship expressing the radius, say as a function of the temperature and viscosity. We then announce this theory and the data and wait. There will be comments and corrections. After these are resolved, the theory becomes a law and joins the corpus of Science and an unknown has become a known!

Two important points about the cycle of Science are the notions of falsifiability and repeatability. It is this right to contest a theory given to every human being. This improves and corrects theories which makes Science a great idea and a force for the good.

C. The application of Science and Global Science

Repeatability is that a law formulated in Toronto also holds reasonably well in Pune or Bangalore. The great spin-off of the repeatability has been the applications of Science, i.e., technology. This includes e.g., transistors, lasers, vaccinations, new breeds of corn, new ways of manufacturing, the internet, and of course, new bombs. Many applications of Science have become global. This has made Science a global project.

Recently, scientists have proposed a new paradigm of doing Science called Big Science. Here is a nice picture about what it is.



1. It is a selection of problems from the frontier of Science, e.g., right now these are mathematical models of climate change, nano-materials, of genetic engineering, stem cells, and the lastest poster boy, machine intelligence.

2. Research in these areas is supervised and led by an international coalition of elite universities, eminent scientists, and very prestigious journals and their peer groups.

3. There is a popular argument that these areas are of great relevance for the **future**, and a call to all scientists world-wide to join this effort.

This has had several impacts on how society sees science. Firstly, it has bred a science of excellence, of a high-tech approach to our problems. Second, it has now divided society as a few talented producers of science and most of us as consumers of science, as its beneficiaries. Even more so, this is driving school and college curricula and research funding across the world. Nobody wants to be left behind.

D. Will Big Science Deliver: Manisha and Hirabai

There are several philosophical questions about this approach, e.g., is it too big to fail? But there is one key material question especially for us. And that is How will it improve development outcomes? Will it get us safer drinking water, better public transport, or more jobs?

Manisha and her family

Hirabai at her cookstove

How will Big science impact Hirabai or Manisha?

Let us take Manisha's case.

In fact, Big Science would say that it has already delivered. Dotted across Maharashtra are RO plans and young lads delivering 100% pure water at Rs 20 for a 20-liter jar. Perhaps, better technology would make it cheaper at Rs. 10 for a jar. So the problem is solved!

But lets ask Manisha. Is this what she wanted? What she wants ample and cheap water, just as in the city. And that can only be provided by a community water supply scheme with a common standpost close to her home. And the fact is that rural water supply systems are failing all over Maharashtra!

Now it is a department of the state which designs and builds these water supply schemes. Based on our study of hundreds of water supply schemes, two primary reasons for failures in this part of Maharashtra are:

- Failure of the groundwater source of the water supply scheme, i.e., a well which goes dry. Lack of a good and practical method of selecting a well and testing its capacity.
- The second reason is that the source of water for the scheme is very far. The energy costs are too high for the community to pay.

Thus what we have is a set of problems, or unknowns: How to test a well? How to find a well or improve an existing well. How much should or can a community pay? If these two unknowns became known to the water supply department, thousands of villages will get ample and safe water.

What about Hirabai's chulha or cookstove. This problem is trickier. Do you know that the chulha is a cultural object in India. Counting the number of households is done by counting the number of kitchens and chulhas!

There are many questions.

1. What are the different types of stoves? What is the typical cooking schedule?
2. What is desirable? Faster cooking? Less wood? Less smoke?
3. Who selects the stove? Who pays for it? The husband, the son or the woman herself?

Whatis the Big Science answer? To design, manufacture and disseminate an ideal, effeicient smoke-less cook-stove. But that is not what we did. We wanted to show the stove is not only a cultural device but also a scientific gadget. That it could be adapted to improve its performance. This

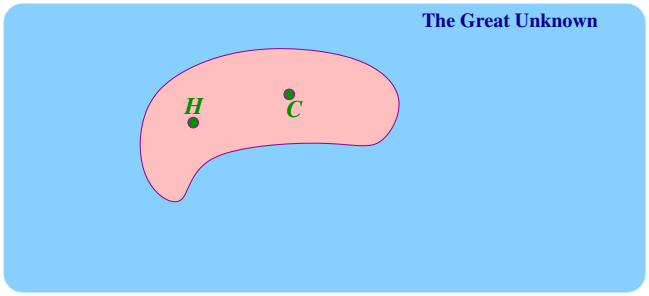
was done first by an attachment, a jali, or mandolya, as the women called it, and then a small variations in the design such as a grate.

As you can see, there were many modifications of chulhas and a lot of happy women. It also led to different enterprises. Many groups wanted to share their discoveries.

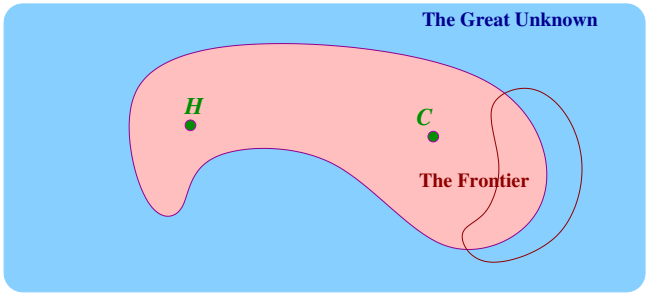
E. Science: Where to work and what to do.

Let us understand this from the world of Science.

This was how Science looked like 50 years ago and here are Hirabai, Cathy from Toronto or Charu from Pune.

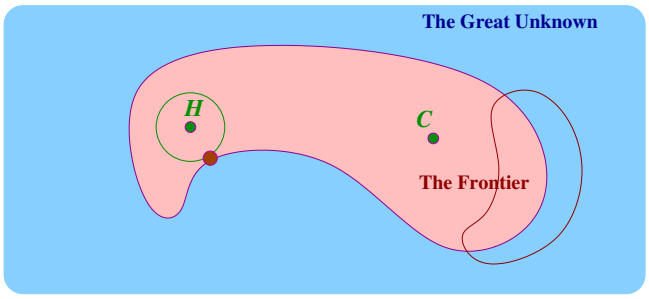


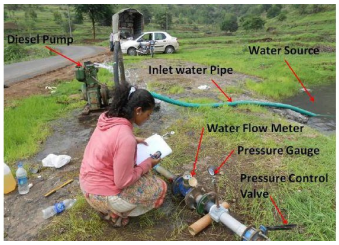
And here they are, 50 years hence. We see that while Cathy, Charu have moved with the frontier of Science, Hirabai and her world has not moved at all. If she did not receive anything from the science of 50 years ago, why should the new Science be more likely to help her? In fact, the frontier is more likely to help Cathy and Charu.



If we must reach Hirabai, then we must change where science looks for its problems and the way it explores them. And that is exactly what we did.

We need to investigate the neighborhood of Hirabai, the way basic goods and services are delivered to her, the agencies and their policies and technical content, the problems that they face. These are the key unknowns! In fact, such an approach may lead us to a new frontier of knowledge, somewhat closer to Hirabai. And this is vernacular science.





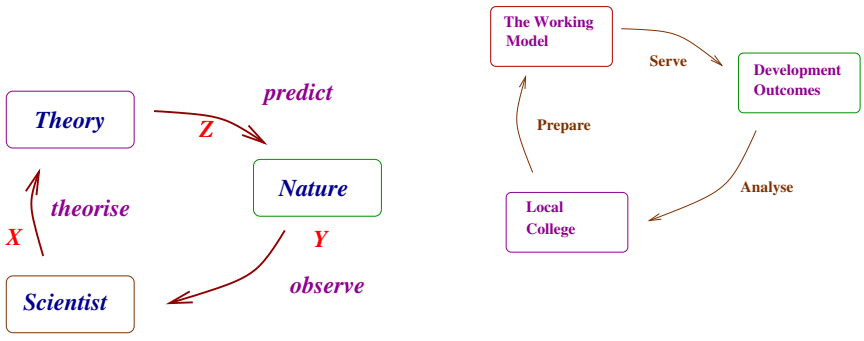
1. The first tenet of vernacular sciences is to begin with the vicinity. Of people under-served, of problems faced by the community, households, of farmer irrigation systems, of small enterprises and factories.

2. Next, is to understand that these are problems actually solvable by ordinary people, by regional colleges, their faculty members and students, by systematic field work, experimentation and analysis, i.e., by **using the method of Science**.

3. Finally, to appreciate that it needs a synthesis of many fields, of understanding economics, groundwater, engineering, energy bills and how they come together to deliver drinking water.

F. Science, Vernacular Science and the University

Sadly, such an an approach is not followed in todays Science or Social Science. In fact, many scientists are likely to say, "all this is very good, but is it science? Is it hard? Is it interesting?" In fact, I would say YES to all three questions. Firstly, the mission of Science is to describe reality and not to further itself or its heroes. And if reality for most of us is a combination of social and technical factors, that is what we must study. Secondly, groundwater modelling or informal economics is as hard and cutting edge as it gets. Finally, it is this immersive and creative pedagogy of science which is closer to the spirit of science. So vernacular science is as good as it gets. And it is accessible to everyone. Most importantly, vernacular scientists are more likely to come up with appropriate and sustainable solutions.



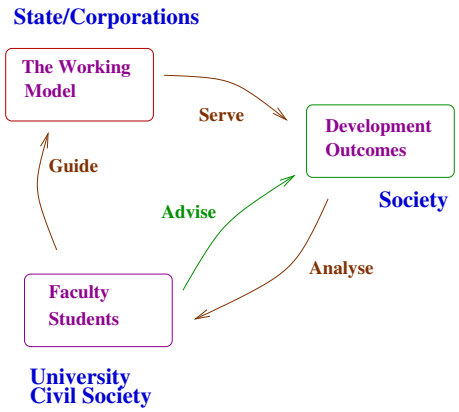
Actually, if you look carefully, the Vernacular Science loop is quite similar to the loop of Science. It too begins with the real world, in this

case, of concrete problems of ordinary people. Just as scientists, it too has local students and faculty members, working to a methodology based on empirics. Moreover, its objective is to develop a working model, as a network of agents, their *job descriptions* and their scientific content. For example, in public transport, it would mean the taluka bus depot, its time table and crew schedule, routes and coverage, profit and loss.

Thus for it, the "theory" is the working model, which is open to improvement. For it, the job of a district collector, local bus time-tables or the design of a pumping test are also valid unknowns which need to analysed, optimized and eventually become known.

Thus vernacular science is a science and it aims to deliver!

The obvious location for Vernacular Science is the regional University.



But it would be a very different university. Its agenda is not to produce employees or expand a prescribed frontier of science but to serve society and analyse its problems. To guide the market and to strengthen the state. It should enable a better and more publc understanding of the issues involved.

It is also the vehicle of society's concerns and values, e.g., of trust

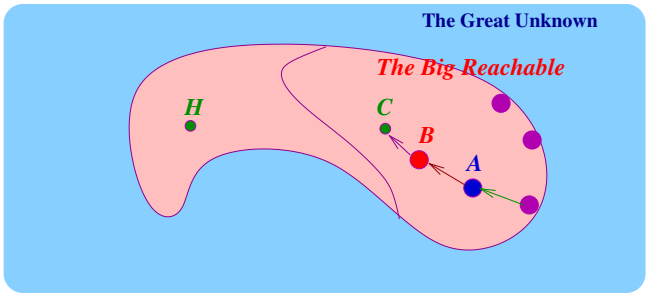
and role models, of sustainability and equity. In fact, it is through this that the regional university localizes knowledge production and creates new enterprises and new job definitions.

It also recognizes that, in India, jobs will begin first with the the development sectors.

This is how the regional university becomes a cultural asset for the community.

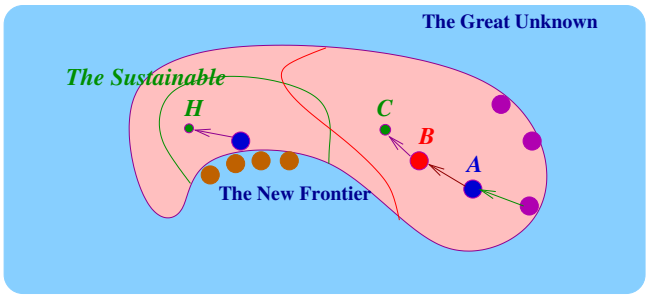
G. Contrast with Big science: Sustainability

Let us now contrast this with Big science. So why has big science not delivered to Hirabai. We must first understand that it comes with a delivery model. For example, e-commerce delivers through air-freight and tracks through GPS. That is how Cathy gets her coffee beans or Charu her smartphone. The delivery model of big science is Big Business, or the Global Economy, or Industry 4.0, of driverless cars, big data and a digital economy. This model has its own problems of selective coverage, rising inequality, few jobs and poor sustainability!



Given this, it is not clear how will big science engage with Hirabai or Manisha.

Sustainability throws up another angle. Now, it is likely that a sustainable earth is closer to Hirabai's world than Cathy's. So, if we must look for a sustainable world, then we must open a new frontier closer to Hirabai. A frontier which aims to make sustainable lifestyles more comfortable, more secure, instead of comfortable lifestyles more sustainable or more certain.



H. Final Pitch

All this, as we said, needs a new paradigm for science - of new methods and mechanisms of social engagement. We must borrow the abstract cleverness of global science and combine it with the groundedness of the vernacular in a new curriculum of doing science.

It is a science in which the laws of Science are as important as the social comprehension of how and when they deliver or fail to deliver. The chemistry lab or a simulation is no better than a visit to the bus depot and fixing the timetable. Or weighing babies at the *anganwadi* and counting trees in the forest.

Where disciplinary knowledge is coupled with the understanding of social, political and cultural systems. And students learn the art of conversation and empathy and of field-work within a community. Thus Science becomes a culture of the people, by the people and for the people, and not merely a science of scientists and their beneficaries.

Perhaps, such a science of social comprehension is the only road to a way of life closer to nature, and one which will enhance the beauty and bounty of the seasons. Perhaps, it is the only way to sustain the variety and diversity of life and cultures that we have on this earth.