You and Your Research: Lecture by Dr RW Hamming 7 Mar 1986

Retold: HS Jamadagni

Lecture context

- **The Question:**

Why do some scientists make significant contributions and so many are forgotten in long run?

Why is it important?

Why shouldn't you do significant things in this one life, however you define significant? I'm not going to define it you know what I mean. I will talk mainly about science ……. outstanding work is characterized very much the same way in most fields ……

Luck factor

People think great science is done by luck. Well, consider Einstein. Note how many different things he did that were good. Was it all luck? Wasn't it a little too repetitive? Consider Shannon. He didn't do just information theory. Several years before, he did some other good things ……..

Luck factor

- *Pasteur said, "Luck favors the prepared mind."*
- *There is indeed an element of luck, and no, there isn't.*
- *The prepared mind sooner or later finds something important and does it.*

Brain factor

- *Great work is something else than mere brains. Brains are measured in various ways. In mathematics, theoretical physics, astrophysics, typically brains correlates to a great extent with the ability to manipulate symbols.*

Brain factor

- Bill Pfann, the fellow who did zone melting, came into my office one day. He had this idea dimly in his mind about what he wanted and he had some equations. It was pretty clear to me that this man didn't know much mathematics and wasn't really articulate. I showed him how to run computers so he could compute his own answers. He went ahead, with negligible recognition from his own department, but ultimately he has collected all the prizes in the field.

Courage factor

- One of the characteristics of successful scientists is having courage. Once you get your courage up and believe that you can do important problems, then you can. If you think you can't, almost surely you are not going to.

Age factor

- They always are saying that you have got to do it when you are young or you will never do it. On the other hand, in music, politics and literature, often what we consider their best work was done late. I don’t know how what-ever field you are in fits this scale ……

Age factor

- Why age seems to have the effect it does.
- In the first place if you do some good work you will find yourself on all kinds of committees and unable to do any more work.

Age factor

- When you are famous it is hard to work on small problems.
- They (famous ones) fail to continue to plant the little acorns from which the mighty oak trees grow. They try to get the big thing right off. And that isn't the way things go.

Age factor

- The Institute for Advanced Study in Princeton, has ruined more good scientists than any institution has created, judged by what they did before they came and judged by what they did after. Not that they weren't good afterwards, but they were superb before they got there and were only good afterwards.

Working condition factor

- What most people think are the best working conditions, are not.
- Because people are often most productive when working conditions are bad.

Drive factor

- Most great scientists have tremendous drive.

Hard work factor

- "Knowledge and productivity are like compound interest." Given two people of approximately the same ability and one person who works ten percent more than the other, the latter will more than twice out produce the former. The more you know, the more you learn; the more you learn, the more you can do; the more you can do, the more the opportunity it is very much like compound interest.

Hard work factor

- I spent a good deal more of my time for some years trying to work a bit harder and I found, in fact, I could get more work done. I don't like to say it in front of my wife, but I did sort of neglect her sometimes; I needed to study. You have to neglect things if you intend to get what you want done. There's no question about this.

Ambiguity factor

- Most people like to believe something is or is not true. Great scientists ***tolerate ambiguity*** very well. They believe the theory enough to go ahead; they doubt it enough to notice the errors and faults so they can step forward and create the new replacement theory. ***If you believe too much you'll never notice the flaws; if you doubt too much you won't get started***. It requires a lovely balance.

Commitment factor

- Most great scientists are completely committed to their problem. Those who don’t become committed seldom produce outstanding, first-class work.
- When you have a real important problem you don’t let anything else get the center of your attention you keep your thoughts on the problem.

A matter of importance

- If what you are doing is not important, and if you don't think it is going to lead to something important, why are you working on it?
- If you do not work on an important problem, it's unlikely you'll do important work.

A matter of importance

- *You can't always know exactly where to be, but you can keep active in places where something might happen. And even if you believe that great science is a matter of luck, you can stand on a mountain top where lightning strikes; you don't have to hide in the valley where you're safe.*

A matter of importance

- ***Most great scientists know many important problems. They have something between 10 and 20 important problems for which they are looking for an attack. And when they see a new idea come up, one hears them say "Well that bears on this problem." They drop all the other things and get after it.***

A matter of importance

- You should do your job in such a fashion that others can build on top of it, so they will indeed say, “Yes, I’ve stood on so and so‘ s shoulders and I saw further.” ***The essence of science is cumulative.***

Open door factor

- I notice that if you have the door to your office closed, you get more work done today and tomorrow, and you are more productive than most. But 10 years later somehow you don’t quite know what problems are worth working on; all the hard work you do is sort of tangential in importance.

Stress factor

- But if you want to be a great scientist you're going to have to put up with stress. You can lead a nice life; you can be a nice guy or you can be a great scientist. If you want to lead a nice happy life with a lot of recreation and everything else, you'll lead a nice life.

Dialogues

- You want to get rid of those sound absorbers who are nice people but merely say, “Oh yes,” and to find those who will stimulate you right back.

A matter of reading

- You need to keep up more to find out what the problems are than to read to find the solutions. The reading is necessary to know what is going on and what is possible. You read; but it is not the amount, it is the way you read that counts.

A matter of selling

- You have to learn to write clearly and well so that people will read it
- You must learn to give reasonably formal talk
- You also must learn to give informal talk

A matter of updating

- Somewhere around every seven years make a significant, if not complete, shift in your field. …. because you tend to use up your ideas. When you go to a new field, you have to start over as a baby. You are no longer the big mukity muk

Where to be?

- *If you want to be a great researcher, you won't make it being president of the company. If you want to be president of the company, that's another thing.*
- *When your vision of what you want to do is what you can do single-handedly, then you should pursue it. The day your vision, is bigger than what you can do single-handedly, then you have to move toward management.*

Talk, an art

- You should paint a general picture to say why it’s important, and then slowly give a sketch of what was done.

The system error

- ***Scientists will fight the system rather than learn to work with the system and take advantage of all the system has to offer. It has a lot, if you learn how to use it. It takes patience, but you can learn how to use the system pretty well, and you can learn how to get around it.***

The personality defect!

- ***Wanting total control and not willing to recognize that you need the support of the system***

The personality defect!

- ***Ego assertion: If you chose to assert your ego in any number of ways, "I am going to do it my way," you pay a small steady price throughout the whole of your professional career. And this, over a whole lifetime, adds up to an enormous amount of needless trouble.***

The personality defect!

- ***Able people don't get themselves committed to that kind of warfare. They play it a little bit and drop it and get on with their work.***
- ***Very few have the ability to both reform the system and become a first-class scientist.***

The personality defect!

- ***Often a scientist becomes angry, and this is no way to handle things. Amusement, yes, anger, no. Anger is misdirected. You should follow and cooperate rather than struggle against the system all the time.***