# Promoting science vs promoting scientists

The editorial 'Promoting Young Scientists' by P. Balaram (*Curr. Sci.*, 1999, **76**, 1059–1060) is quite thought-provoking. Let me begin by sharing my own experiences, having once been a 'bright young scientist', before I scatter a few thoughts around.

I received my Ph D from Wisconsin in 1969 at the age of 21, and spent the next twenty years teaching in USA and Canada. The Canadian version of our S. S. Bhatnagar (SSB) prize is the E. W. R. Steacie Fellowship, and is administered by the National Research Council (NRC). Unlike our SSB prizes which are given in each of nine branches of science, the Steacie prize was given to a maximum of four young scientists per year, in all branches of science and engineering. Thus, unlike in the case of our SSB prizes, biologists were compared with engineers who were compared with chemists, etc. How did they make the comparison? Probably they did the time-honoured thing and counted publications. The fact that when I received the Steacie prize in 1980, I was only the second engineer to get it in the (then) sixteen-year history of the prize showed that the system was not perfect. Anyway, back to the main point. For the purpose of the Steacie prize, the definition of a young scientist was someone who was under 35 years of age. Accordingly, the University of Waterloo (where I was working at the time) nominated me for the prize in 1980. The logic was that even if I did not win that year, I would still have a few more cracks at it. But, suddenly and without any warning, the definition of a young scientist was changed to 'someone who had completed his Ph D within the previous ten years', which put me out of bounds. Apparently, the NRC thought that it was raising the upper age limit; obviously the NRC had never contemplated the possibility that someone might finish his Ph D before the age of 25. But no one at the University of Waterloo noticed this change, and in due course of time not only was I notified that I was a winner, but I even picked up my prize from the Governor General of Canada in a very formal-looking ceremony. Now, one of the hazards of getting a prize like this is that from that year onwards you keep getting letters asking you to nominate people. The letter said, 'For your information we enclose the eligibility criteria'. This was the first time I realized that the criteria had been changed, and that strictly speaking, *I was not eligible at the time I won.* I fully expected to get a telephone call saying, 'Sorry old man, but it was all a mistake you see! So would you kindly send back the medal and certificate?' Upon enquiry I found out that the prize committee at that time was fully aware of my 'ineligibility' but decided to overlook it. I wonder whether an Indian committee would act likewise in similar circumstances. My guess is that they would be so scared of the possibilities of court cases, writ petitions, etc. that they would make a very literal interpretation of the rules.

Coming now to the entire business of recognizing young scientists, I entirely agree with Balaram that, 'It remains to be seen if money alone ... is a sensible solution to enhancing the quality of science in India'. I have served on many of the award selection committees, probably because by the time I returned to India I was no longer a young scientist and thus could safely be put on all these committees. I have also served on many worldwide award committees for IEEE (Institute of Electrical and Electronics Engineers) and IFAC (International Federation of Automatic Control). Let me say right away that *the level of intellectual honesty I have seen in Indian award committees is in no way inferior to, and is in many cases much superior to, what I have seen in the rest of the world.* So please let us stop proliferating all sorts of conspiracy theories everytime the winners of some awards are announced. We Indians seem to be particularly gifted not only in creating but also propagating conspiracy theories, but it is high time we put a stop to this pernicious practice.

But this does not mean that I don't entertain misgivings about both the nature and the number of the scientific awards in our country. In my view, there are far too many awards, and *the amount of money is far too large*. In science, as in cricket, teamwork is of paramount importance, and anything that destroys the collegial spirit among scientists should be avoided. In my view, singling out a few individuals for lavish financial rewards is *potentially* one of the most harmful things we can do to science and its practice. The level of resentment felt by those not chosen is directly proportional to the quantum of the money given with the award. Moreover, I think it is not only the 'losers' but also the members of the award selection committees that have reason to entertain self-doubts. Whenever I come out of one of these selection meetings, I ask myself how sure I was that we collectively did the right thing, and speaking frankly I must say that most of the time the answer is 'not very'. At least it is the answer *for me*! If the decision was, say, the Fellowship of INSA, which carries no monetary value and for which there is no upper age limit, then I can console myself that the consequences of a wrong decision are not catastrophic. But in the case of the Swarna Jayanthi Fellowship whose cash value is Rs 15 lakhs (Rs 25,000 *extra per month* over five years, on top of one's regular salary), I really don't like having to make these decisions on the basis of what I honestly admit are imperfectly articulated criteria that are in any case highly subjective. Let me repeat that *I have no doubts at all about the intellectual honesty of the committee members who make these decisions.* However, I am prepared to admit candidly that another, equally honest, committee could examine the same slate of candidates and select quite a different set of winners. So my question is: *Why must we as a community take it upon ourselves to make such decisions?* Are we really promoting the cause of excellence in science by instituting and perpetuating these awards? Does any youngster really embark upon a career in science enticed by the prospect that he/she could be a Bhatnagar laureate or a Swarna Jayanthi Fellow one day?

I think the answer is obviously a resounding NO!!! For my Steacie Fellowship in Canada, I did not receive one cent extra. Instead, the Fellowship paid my *normal salary* for two years so that I could be relieved from teaching and concentrate full-time on research. I told the University of Waterloo that I enjoyed teaching and that I saw no reason to stop teaching because of this Fellowship. Instead I asked for, and got, a two-year holiday from serving on committees!

It is time we stopped confusing the promotion of science with the promotion of scientists. If we are at all serious about promoting science, we must get science out of the ivory towers into the streets and gullies, so to speak. We must communicate to young people the excitement of doing science, and the passion we feel that drives us to work absurd hours in pursuit of scientific excellence. This is most definitely not done by instituting more and more awards! As a first step, the so-called elite institutions (including Balaram's own) must start by teaching undergraduate students. It is preposterous that the professors in these elite institutions think that teaching undergraduate students is something beneath them, and is to be left to lesser mortals. Giving a few lectures now and then to college or high school students might serve to assuage their guilt feelings but does nothing to promote science. The catastrophic decision to separate undergraduate teaching from graduate education must be reversed, by force if necessary. Can we think of any institution abroad which has an outstanding graduate programme (MIT, Berkeley, Stanford, Oxford, Cambridge, etc.) which does not also have an outstanding undergraduate programme? It is only in India that we are foolish enough to divorce graduate education and research from undergraduate education. Let us strive to emulate the Russian model whereby an all-time great mathematician such as Kolmogorov taught not only undergraduates, but occasionally even high school students. (The same could be said of the French school as well, e.g. Cartan, Dieudonné, etc.) In addition to this, well-endowed government R&D organizations (such as my own) should take in large number of eager undergraduate students to do projects (which CAIR already does, I am glad to report). Complete sets of laboratory experiments in various disciplines could be prepared, with the aim of communicating the excitement of discovery, and not the skills of passing examinations!

And as a noble first step, let us reduce all cash awards to 20% of their current value!

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# Some new inputs on the *Ghauri*

This concerns the article authored by me entitled, 'The origins and antecedents of the *Ghauri* missile – An assessment', that appeared in *Current Science* (1999, **76**, 280–285).

David Wright of the Union of Concerned Scientists, in an e-mail to me, has pointed out that the effect of the earth's rotation on the velocity and range of the missile (especially for short- and medium-range missiles) is very small and can be neglected. Wright's comments are in order.

While the earth's rotational velocity does affect the velocity requirements for a satellite launch, it does not contribute significantly to the range of short- and medium-range missiles. This is because the contribution of the earth's rotational velocity to the range of the missile is nullified to a large extent because both the launch and the impact points of the missile rotate with the earth during the duration of the missile's flight.

In our paper, we had estimated the range of the *Ghauri* with a 1 tonne payload as 950 km when launched in a north–south direction where there would be no contribution from the earth's rotation. This range will hold true irrespective of the launch direction. With this range, the *Ghauri* may just fall short of hitting Hyderabad. This range can be increased to 1120 km not by launching in an eastward direction but only by reducing the payload to 700 kg.

As mentioned in the paper, Pakistani newspaper reports, which gave the launch and impact points, suggest that the *Ghauri* was tested over a distance of 705 km. This would mean that the trajectory of the *Ghauri* was not chosen for maximizing range, but was, instead, a lofted trajectory. Such a trajectory may have been chosen for being able to monitor the flight of the missile and from the need to confine the test within Pakistan. One of the anomalies mentioned in the paper was the mismatch between the reported flight time and estimated flight times using a trajectory that maximized the range. A lofted trajectory would be more consistent with the reports in Pakistani newspapers of flight times and the altitude reached by the missile.

This does not change, in any way the conclusions drawn in the paper about the liquid propulsion technology used in the *Ghauri* missile (viz. clustering of *Scud*-type engines), the most likely specific impulse and its North Korean origins. The range of the *Ghauri*, as stated in the conclusions in the paper, will continue to remain between 950 km and 1120 km with a payload of between 1 tonne and 700 kg.

Recent newspaper photographs of the supposed *Ghauri*-II launch further strengthen our belief that clustered engines were used. Judging by the length to diameter ratio, it seems probable that the so-called *Ghauri*-II is actually the *Ghauri*-I, perhaps with a much reduced payload to increase range.

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