Output or impact: What should we be evaluating in research programs?

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It is with trepidation that I pose this question: what should we be evaluating in research programs? Moreover, should the criteria differ when the program is of a single investigator, a research team, or a department or college? Among the output metrics that can be used are the following:

- Number of refereed papers and the quality of the journal in which they are published;
- Proposals submitted, awards/contracts/grants received, or externally funded research expenditures;
- Number of PhD and MS students graduated;
- Patents issued on the work.

But is science really just a numbers game? Are there ways to establish the impact that a paper or body of work has on the field of science or on industry? I would argue that yes, there are ways, but none are without drawbacks. If we consider the output indicators, we can develop impacts from each. Of course, when the output is zero, the impact is likely to be zero, too.

- A concept of the impact of refereed papers is the individual and aggregate impact factor. However, there has been recent criticism of impact factor because of issues of self-citation or multiple citation of a problem paper or one with fallacious claims (Gorman, 2008).
- Proposals submitted are an essential prerequisite for awards, contracts, and grants received and ultimately externally funded research expenditures on high-quality postdoctoral fellows and graduate students.
- The impact of the number of PhD and MS students graduated is what those individuals achieve in their careers.
- The impact of patents can be determined by whether they are licensed and the royalty income that results from the licensed product or method.

The overall impact of a body of research can be delineated by the reputation of the research team:

- National and international recognition of a researcher can be assessed by the number of symposia invitations, awards by professional societies, fellowships in professional societies, and membership of the national academies. This presupposes that the researcher knows the system. For instance, the “I’ll scratch your back, if you scratch mine” approach of nominating a colleague for one award and asking to be nominated for another or the mentor helping a junior colleague.
- The impact of fundamental research is evaluated by how transformative it is on the field.
- The impact of applied research is evaluated by how useful it is, perhaps transformative, to the industry.

There needs to be an infrastructure of fundamental and applied research undergirding the industry. There are different metrics for outcomes and for impacts. We need to come together as a community to decide how to have a consistent set of metrics for outputs, outcomes, and impacts.