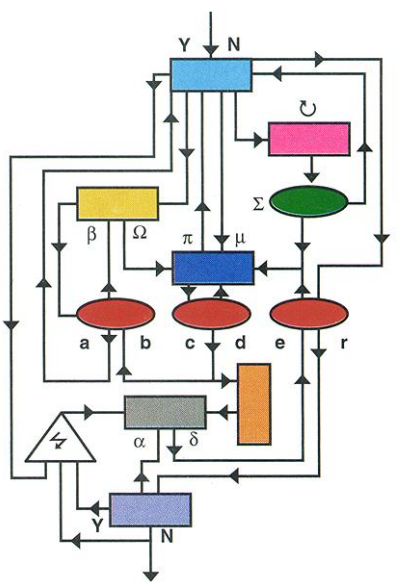
An Algorithm for Discovery

As academic physicians, we are experiencing the rush to restructure medical services and have participated in the development of algorithms for the evaluation and treatment of patients. It has been argued that such algorithms are a critical tool for evidence-based medicine, for improving patient management, and for raising the community standard of clinical care.

One day, during a particularly lengthy commute in our carpool, we began to wonder whether the process of creating new knowledge—asking the right question, pursuing the unknown, making discoveries—might also benefit from such an algorithmic approach. Surely a formula for boosting the rate and magnitude of discoveries would be most welcome. Of course, there are many great treatises on discovery in science, but we were thinking of something more compact for everyday use, a kind of flow chart that could be carried on a laminated card. Many carpools later, we came up with the solution shown on the right.

After rigorous computer simulations of this algorithm's performance over a broad range of parameters, we unexpectedly discovered that its properties could be reduced to five simple principles.

1. Slow down to explore. Discovery is facilitated by an unhurried attitude. We favor a relaxed yet attentive and prepared state of mind that is free of the checklists, deadlines, and other exigencies of the workday schedule. Resist the temptation to settle for quick closure and instead actively search for deviations, inconsistencies, and peculiarities that don't quite fit. Often hidden among these anomalies are the clues that might challenge prevailing thinking and conventional explanations.



2. Read, but not too much. It is important to master what others have already written. Published works are the forum for scientific discourse and embody the accumulated experience of the research community. But the influence of experts can be powerful and might quash a nascent idea before it can take root. Fledgling ideas need nurturing until their viability can be tested without bias. So think again before abandoning an investigation merely because someone else says it can't be done or is unimportant.

3. Pursue quality for its own sake. Time spent refining methods and design is almost always rewarded. Rigorous attention to such details helps to avert the premature rejection or acceptance of hypotheses. Sometimes, in the process of perfecting one's approach, unexpected discoveries can be made. An example of this is the background radiation attributed to the Big Bang, which was identified by Penzias and Wilson while they were pursuing the source of a noisy signal from a radio telescope. Meticulous testing is a key to generating the kind of reliable information that can lead to new breakthroughs.

4. Look at the raw data. There is no substitute for viewing the data at first hand. Take a seat at the bedside and interview the patient yourself; watch the oscilloscope trace; inspect the gel while still wet. Of course, there is no question that further processing of data is essential for their management, analysis, and presentation. The problem is that most of us don't really understand how automated packaging tools work. Looking at the raw data provides a check against the automated averaging of unusual, subtle, or contradictory phenomena.

5. Cultivate smart friends. Sharing with a buddy can sharpen critical thinking and spark new insights. Finding the right colleague is in itself a process of discovery and requires some luck. Sheer intelligence is not enough; seek a pal whose attributes are also complementary to your own, and you may be rewarded with a new perspective on your work. Being this kind of friend to another is the secret to winning this kind of friendship in return.

Although most of us already know these five precepts in one form or another, we have noticed some difficulty in putting them into practice. Many obligations appear to erode time for discovery. We hope that this essay can serve as an inspiration for reclaiming the process of discovery and making it a part of the daily routine. In 1936, in *Physics and Reality*, Einstein wrote, "The whole of science is nothing more than a refinement of everyday thinking." Practicing this art does not require elaborate instrumentation, generous funding, or prolonged sabbaticals. What it does require is a commitment to exercising one's creative spirit—for curiosity's sake.

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