

Pending the submission of physical evidence, *Abduction* will likely remain, more through default than excellence, one of the definitive works on the abduction phenomenon.

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Prometheus Bound: Science in a Dynamic Steady State by John Ziman.
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Desperate competition for grants; scarcity of academic positions for Ph.D.s (especially in physics); funding of research via the pork-barrel rather than peer review; rising overhead charges and disputes about them; fascination with technology transfer and university-industry cooperation; professional misconduct by scientists. All these have been widely noted in recent times; but they have been regarded as unconnected and temporary, singular occurrences or perhaps cyclic ones. John Ziman shows us, to the contrary, that these and more are but divers symptoms of "a radical, irreversible, world-wide transformation in the way that science is organized and performed" (7). "Knowledge-creation, the acme of individual enterprise, is being collectivized" (vii).

That some such change had to come was adumbrated decades ago by Derek Price. Science — numbers of scientists, numbers of research papers, numbers of journals — had been doubling every 15 years in an amazingly steady way since the 17th century, Price noted; and this could not continue indefinitely. No one disagreed, but neither did anyone seem to worry much about this vague, surely quite distant prospect; yet symptoms of ebbing growth were beginning to appear even as Price wrote.

Now the circumstance of exponential growth is deeply ingrained in our view of how basic science is *and should* be done. Each discovery opens more than one new direction, *and we think it right and proper that all of them be pursued*. Professors are able to accomplish so much in research because they train so many graduate students, and expect that opportunities to do basic research will become available for most of the good ones. Successful professors have left several dozen intellectual heirs to carry on their approach and style, and those who seek success as professors want to do the same; yet in a "steady state," there will be opportunities for only a bare handful of successors from each major professorial stable.

Reflect on how just this change alone will influence professorial life: expectations for the amount of research that one can accomplish; criteria for tenure and promotion; attitudes toward recruiting graduate students (even fiercer competition among colleagues than now — if one can imagine that! — for who gets to train them). Academic life is changing *profoundly*, in other words: its very nature and therefore also the attitudes of the people engaged in it (168).

Ziman reminds us that "the systematic pursuit of scientific research in institutions of higher education... is essentially a *traditional* activity, without a compelling rationale... [that] originated less than two centuries ago in Germany, and although it has been widely copied elsewhere it is still not fully established in a number of advanced countries" (133). In the steady state at which we've arrived, it seems inevitable that research will cease to be primary in "most institutions in the basal strata of higher education" (163).

The ethos of those involved in research will change from one appropriate to individual scholars — *individual intellectual entrepreneurs* — to that of a professional cog in a larger wheel; as Ziman describes it, from CUDOS to PLACE: from the Mertonian norms of Communalism, Universalism, Disinterestedness, Originality, Skepticism to rewards from doing Proprietary, Local, Authoritarian, Commissioned, Expert work (7.4). "Academic" researchers will increasingly strive to satisfy, not their own unfettered curiosity but the wishes of those who fund their work. In that sense academic research will become more like industrial or military R&D; but institutional loyalty *in universities* will further decline, for it is *external* funders that each little research entity must please.

These changes are upon us not only because resources are finite and science cannot take more than a few percent of a nation's income. It is also the case that, as knowledge grows, much of the distinction between pure and applied dissolves. As applications seem more feasible, the pressure grows to set the research agenda externally (by social needs and desires) rather than internally (by the researchers' curiosity and judgment of what can best be pursued). A Senator Proxmire with his "Golden Fleece" awards for basic research, then, is not an unlucky happenstance but a step in the overall change brought on by the very success and growth of science. Like the increase in pork-barrel funding, it is just part of the change from *allocating* to *managing* resources for research on the part of those who pay the pipers (120); "from the patronage of research... to its *purchase*" (125). So "Publish-or-Perish" gives way to "Apply-or-Die" as the formula for survival (97).

The disputes over overhead charges, too, reflect not only the tightness of resources but also the growth and success of science itself. "Scientific and technological progress... continually raises the level of resources required for further research" (53). The costs of research used to be little more than salaries, and consequently fairly stable over periods of years; no longer so (142). And corollary costs must not be skimmed: the necessity of an up-to-date infrastructure is known to "any scientist who has had to work for a while in a developing country" (52); and so "overhead" or "indirect" costs must continue to rise (54). It is *not*, in other words, as Congress and the media and grant-getting academics are wont to have it, only institutional greed that has led to the rise of universities' overhead charges.

Ziman's discussion of all this is characteristically comprehensive, multifaceted, realistic. In this book he cross-references sections somewhat less

than in most of his other works, and consequently there is a shade more repetition; but the writing remains dense with meaning and the prose is often masterly. (I regret only his frequent use of "she" as though it were a generic, non-gender-specific pronoun.) How more succinctly or better could one portray how science has changed than thus: the "civilian science that was enlisted for the duration of each of the World Wars of our century was demobbed as a veteran, hardened and rather coarsened by the experience. Indeed, in the Second World War science had demonstrated its strength so convincingly that it was effectively retained with the colors" (77). As to international aspects of science, we are reminded (or instructed) that governments sometimes agree to joint ventures in basic science "essentially for sacramental reasons": "The announcement of such an agreement in the wake of a fruitless Cold War summit meeting was startlingly reminiscent of the customary exchanges of armor, horses and slaves between mediaeval potentates on similar occasions of scarcely veiled hostility" (222).

Our only experience of successful science, Ziman points out, was during its exponential growth. Can we discern what principles are absolutely necessary for healthy science even in a steady state? Can we arrange that they will apply?

Ziman's minimal list of what is inescapably necessary for research to proceed fruitfully is:

- social *space* for personal initiative and creativity;
- *time* for ideas to grow to maturity;
- *openness* to debate and criticism;
- hospitality towards *novelty*; and
- respect for specialized *expertise*.

It is rather depressing to observe how few administrators, research managers, bureaucrats, or politicians understand any of that. From his experience, Ziman offers many cautionary illustrations. As to the benefits of market-type competition, for instance, he points out that there is often only one significant "buyer" for a given project (NIH, say); such *monopsony* is as destructive of competition as is monopoly, yet governments are moving to privatize and de-centralize in the expressed belief that research entities will become more efficient through needing to survive in the resulting competition: but "[i]t would be absurd to suppose... that a market dealing in such intangible commodities as 'research' or 'education' could ever approximate to 'perfection' in the classical economists' sense" (137).

Again, "strategic" and "applied" also mean commercial and therefore relatively secret; yet we must never forget that "public assessments of research claims... are the ultimate arbiter of scientific validity" (41). As to the globalization or internationalization that many pundits applaud without further ado, Ziman is careful to distinguish among international *facilities*, *institutions*, *programmes*, and *projects* (232) and the different consequences of those; and between the traditionally cosmopolitan nature of science and its increasingly

supra-national character as it becomes increasingly *funded* and *managed* and planned by international organizations. And "the concept of a comprehensive international research system dealing with all the ills of humanity leads to all the follies, farces and horrors of research planning in a command economy" (238).

No matter how and where we decide to spend our money, no matter how "relevant," "strategic," "mission-oriented" we make research, still its success depends on "researchers carrying on their work as if motivated solely by curiosity" (36-7). Moreover, the "various disciplines and sub-disciplines... advance hand in hand, if not quite in step with one another" (37); cutting off research done without strategic objective will sooner or later slow down or bring to a halt the strategically oriented R&D as well. Ziman has words of genuine wisdom about interdisciplinary ventures, centers of excellence, and much else. Incisively he exposes the stupidities committed under such fashionable rubrics as "accountability," "evaluation," "exploitation" of basic science, "priorities," and the like. Ziman, customarily the most self-effacing and dispassionate of writers, reveals his own anxiety in sharp commentary on managers and politicians: "apparently responsible people can now be persuaded that targeted R&D can blast its way to any technological goal, however implausible this may seem to the great majority of the relevant experts" (30). "As politicians say when they have no idea what to do, this is a time of challenge and opportunity" (250).

The move from *CUDOS* to *PLACE* also marks a fundamental change as to appropriately ethical behavior. It is no coincidence that it is in the "hottest," most "relevant" fields of contemporary science that scandals have been the most frequent, in molecular biology and genetic engineering. Conflicts of interest become more painful and more unavoidable. The framework of scientific activity becomes legalistic instead of customary (99). It is no longer a question of proper behavior for autonomous scholars but rather, how scientists should behave as professional employees in research and teaching institutions — which are themselves more and more commercially greedy. Thus opportunities for whistle-blowing arise in universities as well as in commercial environments.

Ziman focuses on science and technology. But the profound and pervasive changes he describes will impinge on all academic circumstances. Nowadays we think in terms of grant-funded research "projects" not only in the sciences but also in the humanities and the social sciences. Just as those disciplines sought affluence and prestige by trying to ape the natural sciences and ride their coat-tails, so now the down-sizing will affect them at least as much, bringing changed expectations and changed views of how a professor properly allocates time between teaching and scholarship. Unfortunately, the changes take place while money is scarce; and so short-term fixes are applied rather than the best long-term solutions. Under demands for quick action, "collegial procedures have been... transformed into more formal managerial structures,

where consensus is no longer the condition for change" (148). Competition for money tempts us into short-cuts and dubious practices, and these in turn generate even more demands for external accountability and auditing (146). "Real strategic thinking manifests itself less through formal plans than through innumerable tactical decisions, each directed towards a clearly perceived objective" (251); yet we are awash in "strategic plans" and "mission statements" even while administrators fail to make the coherent, decisive, steadfast choices that might eventually add up to something like a *real* plan and reveal actual movement toward fulfilling a mission.

Indeed, the issues Ziman raises are of society-wide concern. It is not only in science and in academe that we have to ask (section 5.5), can relatively democratic governance learn to rely on informed, qualitative, expert judgment rather than on the misleading numerology favored and imposed by managerial bureaucracies?

Then too, as science is fettered, perhaps its widely presumed availability as a substitute for religion will seem less viable. Scientism assumes science to be an autonomous pursuit making dramatic progress, unfettered and without foreseeable end; a bound Prometheus is the gods' warning, to the contrary, that some things remain properly beyond human ken.

So this is a timely and important book. Societies do not easily notice the early signs of fundamental change; and scientists are notoriously naive about or uninterested in larger questions about science and society. Ziman wakes us from blissfully ignorant dreams. In doing so, he helps us to understand even personal experience. I knew vaguely, for example, that grant-grubbing had become too great a chore, and that managing a research group was not what I really enjoyed; but I had not fully realized how typical my own experience in science has been in these respects; nor how natural, in a way, it was to become interested in anomalies, which still offer something like the scope that mainstream science *used to*, for autonomous individual thought and research. As more and more fields of knowledge become developed and collectivized, the old spirit of personal vocation, learning for its own sake or to the greater glory of God, may survive only in interstices, neglected nooks and crannies — pre-eminently, perhaps, in anomalistics.

Everyone in science and technology, all academics, all who care about scholarship and education, should read this book and ponder its implications.

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