readily extended in new directions, as desired by the researcher.

6. The principal sources of data on these groups are: N. C. Mullins (*7*); D. Krantz, *J. Hist. Behav. Sci.* **8**, 86 (January 1972); *J. Appl. Behav. Anal.* **4**, 61 (1971); numerous personal communications between Krantz and B.C.G. (in his work on operant conditioning, Krantz is continuing the most thorough study ever made of a single specialty); J. Cairns, G. S. Stent, J. D. Watson (*8*); G. Gamow, *Thirty Years That Shook Physics* (Doubleday, Garden City, N.Y., 1966); R. Moore, *Niels Bohr* (Knopf, New York, 1966) (note that Copenhagen may be only the putative home for this specialty; several other centers, particularly Manchester, are of great importance in the development of quantum physics); C. Reid (*9*); *Reports of the Project on Scientific Information Exchange in Psychology* (American Psychological Association, Washington, D.C., 1969); N. C. Mullins, *Theory and Theory Groups in Contemporary American Sociology* (Harper & Row, New York, in press).
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8. J. Cairns, G. S. Stent, J. D. Watson, Eds. *Phage and the Origins of Molecular Biology* (Cold Spring Harbor Laboratory of Quantitative Biology, Cold Spring Harbor, N.Y., 1966).
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20. D. J. De Solla Price, *Little Science, Big Science* (Columbia Univ. Press, New York, 1963); *Science* **149**, 510 (1965).
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23. Compare Kuhn (*19*) to H. Butterfield (*21*, pp. 13–28) to gain some impression of the relation of Kuhn's concepts to earlier work.
24. J. Ziman, *Public Knowledge* (Cambridge Univ. Press, Cambridge, England, 1968).
25. D. J. De Solla Price, *J. Amer. Soc. Inf. Sci.* **22**, 74 (1971).
26. Skinner and his followers doggedly rejected behavioral theory; their rationale was that it offered no explanatory advantage over operational formulations of psychological laws—a rationale that, in itself, is a major theoretical stand. In general, we speculate that these groups are either, as Butterfield would contend (*21*), picking up the other end of the stick (that is, viewing findings from an entirely new perspective), or creating a methodology through which a variety of new problems can be stated and examined. Quantum mechanics and molecular biology seemed to embody both aspects clearly. The audition researchers, alone among these groups, appear to have been mainly introducing a more sophisticated methodology, and it is curious to note that, around 1940, Delbrück was teaching biologists about mathematical tools similar to those the audition researchers had recently adopted.
27. A similar process occurred earlier in biochemistry. See R. Kohler, "The early history of biochemistry," a talk given to the history and sociology of science department of the University of Pennsylvania, Philadelphia (1971).
28. We thank Marilyn Jahn, A. James Miller, Carolyn Mullins, and Beth Krevitt for contributing in many ways to the preparation and writing of this article. Also, we thank M. Carl Drott, William Garvey, Dorwin Cartwright, and Georgess McHargue for reviewing this article. B.C.G.'s work was supported by Public Health Service research grant 1 RO1 LM 00911-01.

Paradoxes of Science Administration

Thomas A. Cowan

In the course of an analysis of the nature of the mind, the philosopher Hegel calls attention to a deep paradox which attends all human effort. I might risk putting it somewhat as follows: By dint of superior effort, by a stroke of good fortune, or perhaps by the exercise of chicanery, one man becomes boss over another. From the point of view of the boss this looks like a happy or at any rate a superior position; the "worker" is an inferior. But then a peculiar thing happens. Time and again, the boss begins to deteriorate as a human being, and the worker gains in moral stature. Apparently, what dignifies human effort is the work itself. The loafer, the shirker, the time-server, be he boss or subordinate, pays for his dereliction in moral degeneration.

I should not like anyone to think I am here referring to the so-called Puritan ethic, the doctrine that morality is encompassed in cheerless and dogged attention to duty. What our philosopher was examining was not any specific creed dedicated to success or gain, whether spiritual or material. He was investigating the nature of the human being himself and reporting on a universal phenomenon. Some men are superior to others. This is a concrete, objective state of affairs based on discernible productivity—physical, mental, moral, and esthetic. Superiority may begin in natural endowment, but it takes sustained effort to maintain. The boss may quickly become the slave of his own workers, of his own community, even of his own image of himself. These humble truths are so well worn that it may be puzzling to imagine what new grist can be extracted from them. For one thing, a question.

Is the dialectical process, this paradoxical turn and turn about, applicable to the community of scientific workers? Or, on the contrary, is there something about the nature of scientific activity that exempts it from this human perplexity? Is science such a self-purifying activity that one need not worry about dominance-servience effects? We should hesitate to say that this is so. But are there nevertheless certain processes at work in science, such as the freedom with which scientists select or elect themselves to membership in the scientific community, that guarantee exemption from the common fate? This alternative is very tempting. For it is true that the scientist does elect himself. We do not have press-gangs shanghaiing scientists for work in the scientific salt mines.

Scientists do join up freely. How then can it be said that they are constrained by the laws that govern the exaction of slave labor? The chapter in Hegel's *Phenomenology of the Mind* to which reference has been made is entitled "Lordship and Bondage." In science, however, we are not dealing with peonage.

True. But I think the old philosopher might have something further to say. He was asking himself how men might feel constrained to work and yet feel free or, as he put it, come to know

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themselves, come to a knowledge of self, the liberating effects of constraining oneself to work. Surely, this situation is one well known to scientists. If the scientist happens to be one who works by himself, on his own, then on occasion he knows the joyful agony of freedom through self-imposed constraints. He willingly enters into a situation where freedom and slavery go so intimately together.

Suppose, however, that the scientist we are thinking of has elected to work in an organization, a community. Then, since he has agreed to accept constraints from others, the pattern of freedom and bondage changes, without however giving up any of its paradoxical character. Our scientist enters into a relationship with another or with other scientists—people like himself who will exercise toward him the familiar behavioral patterns of lordship and bondage. Now our individual scientist coerces not alone himself but others: now he is coerced not only by himself but by his "superiors" (if I may venture the word) and also by "inferiors." There is a man "over" him in some real sense. There are men "under" him. These are scientists like himself. How could this ever have come about? How can there be a question of a scientist giving himself in bondage to another? Of allowing another to direct his work, to administer his work, as it is said? Is not the very conception of "scientific administration" a contradiction in terms?

Of course it is. And if scientific administration were not such a palpable obvious fact it would be necessary to deny its existence. Since it does exist, however, the real question is, how can it justify its existence?

In examining the remarkable human phenomenon of servitude, of the submission of one person to another, of the idea of dominance and of the ideal of service, Hegel sees in all aspects of the phenomenon a single aim: the struggle of the individual to realize himself, to attain to the level of the truly human. In the words of the philosopher, to develop and maintain consciousness of the self as a fact of experience.

When I confront another in the act of service, whether voluntarily undertaken or imposed by force, the immediate fact of experience seems to be the quality of subordination or superordination in the relationship. But since service is a universal human phenomenon, the mere fact that it is a dominant-servient relationship says nothing concerning the actual state of my service. It gives no indication of who benefits more by the relationship, of who is likely to suffer moral injury, of who sacrifices more in the way of human dignity and personal worth, or, indeed, whether everyone may not gain in these respects.

I am not now speaking of the clash of wills, of the power struggles that inevitably ensue whenever one human being engages another. Though this question is closely related to the question of service, I should like to put it aside. For, beneath the universal clash of individual wills lies the much more fundamental fact of conflict of service. What I insist upon doing for you, you cannot do for yourself. What I insist that you do for me, I, in turn, cannot do for myself. To work is a deeper need for human beings than to will. Without work we sicken and die. He who performs a service becomes dignified in the work. To prevent him from working, as by doing it oneself, is to deny him a necessary condition for full humanity. Who is master, and who is servant when we reach this level of human life? Who is the better man —Marcus Aurelius, the emperor, or Epictetus, the slave?

The master confronts the servant with a task. The servant performs it, let us say, and thus is dignified in the work (*1*). What now of the master? Subtly, his position has changed. He is in danger of moral degeneration. If now, the master can somehow become a servant, it may be the servant of the servant, and perform his task in turn, he is then rehabilitated. If he cannot, he must destroy the relationship or it will destroy him.

I am describing, I think, the age-old process by which revolt succeeds. Not the strength of the underprivileged, the slave, the minority, but the weakness of the masters, the leaders, the superiors accounts for successful revolt.

So much, then, for this brief excursus into the fundamental dilemma of human superordination and subordination. Coming back to our own particular concern, the problem of science administration, we may now apply the lesson learned from the philosopher's reflections on the nature of the human mind.

1) The science administrator cannot be or, if he is, cannot remain a master. All questions of power struggle aside, the mere fact that he assigns work, rather than does it himself, assures him that the relation of dominance and servience will be interchanged. Hence, the administrator must find his salvation in his own work, not in the work assigned to others. Here arise the dilemmas that beset all administration. It is vain for the administrator to refuse to recognize any difference between himself and his subordinates. The attempt at this pretense in the field of science is, for some people, well-nigh irresistible. The temptation must be resisted or the administrator must stand down. Regardless of what his own predilections tell him, the relation he has to his "subordinates" will ultimately be determined by the work, not by his or others' feelings.

2) It is vain for the administrator to attempt to merge administration and purely scientific work. These spheres are and must be kept separate. To be sure, one can be or become a part-time administrator, but a failure to keep the two roles separate results inevitably in confusion. Besides, the work of administration is itself inevitable. Someone must do it. For it consists in nothing less than the unavoidable conditions necessary to the doing of any scientific work whatever. It is the humble *conditiones sine qua non*, the indispensable care necessary to the success of the work that is in question here. Hence, if one man steps down another must take his place.

We have admitted that "scientific administration" is a contradiction in terms. And a contradiction is indeed a very formidable entity. The only thing that can successfully confront a contradiction is its equally implacable foe, namely, a necessity. Let us in imagination abolish all scientific administration for the moment. There results a random assemblage of unrelated single scientists. What happens is that each becomes his own administrator. Each creates a monster which allows the scientist no freedom whatever. It is precisely this horrendous system of constraints that forces the scientist to associate with his fellows and to try to rationalize the division of labor by means of administration. But the chief concern is and always remains scientific freedom. When and if administration costs too much in terms of freedom, it becomes not administration but bondage. When administration is too loose it forces the individual scientist to become his own administrator and the unwilling administrator of others.

We are addressing ourselves to the problem of scientific freedom, not, fortunately, freedom from the impositions and interferences of government, but freedom from the untoward constraints of one's own activities. We ask how scientists may be able most freely to work at being scientists without undue cramping from the very machinery which was set up to enable them to work in freedom, in peace, in health, and in happiness.

To the extent that work involves scientific administration as a part-time or full-time specialty we have the same question to ask: How can the scientific administrator as an individual human being dedicated to the pursuits of science maintain his own freedom to further the ends of science in his own way? One of the warnings to be gained from the wisdom of pondering the dialectic of power is this: The administrator is in constant danger of losing his own scientific soul. For we may be sure that if he has not been able to maintain his own freedom and faith in the scientific enterprise he is not likely to be of much use in helping others to attain their goals.

Having succeeded all too well in showing us how the ruler becomes the slave, our philosopher Hegel passes on to other concerns. But we would stop him with a question. "Do you mean that I, well-intentioned person that I am, must endure slavery as I try to minister to others?" "Yes," will be his cheerful reply. Our response might well be "Damn!"

Evidently our philosopher like all his tribe is content to raise questions, the more baffling the better. It is no business of his to answer them. Still, the very way in which the paradox of administration is raised is helpful. It seems that what bothers us most is not the specialized problems of administration, but the perfectly general one of ministration.

So far I have been talking about the paradox of service—how impossible it is to tell who is servant and who is served. What I have said pertains to a whole spectrum of human relations. When we examine the specific relation of a scientific worker to the organization in which he works and to his fellow workers, we must go further. Granted that science administration raises all the problems that administration in general does, and that the work of science is not exempt from the universal paradox, in what way does the paradox get its special coloration so far as science is concerned? Is there anything special about the nature of science that makes this kind of work different from other types of human activity?

Of course there is. The scientist's product is *truth*, of a quite particular kind. It has the following earmarks. (i) *It is a general kind of truth.* The scientist is a generalizer. So, however, is the philosopher, the theologian, the historian. We must go on. (ii) Therefore we say the scientist's truth is truth about the nature of the world, the universe of animate and inanimate beings, investigated for the purpose of discovering the universal laws that govern it. This eliminates the theologian and the historian whose concerns are seldom with inanimate nature, though it leaves intact the philosopher. (iii) Finally, the scientist investigates the laws of nature under a system of controls that are peculiarly his own. These are what is known collectively as scientific method. Scientists produce statements that are either analytically true or that conform to a more or less rigidly controlled model by which observations on the state of nature are processed. This rules out the philosopher and leaves the scientist as sole practitioner of what has in modern times become a highly complex activity of a self-validating kind. Only a scientist can tell whether he is conforming to the canons of scientific procedure, whether he is or is not being scientific at any given moment.

This highly specialized art is jealous of the scientist's energy. It entrenches on his personal life. It tempts him to neglect all aspects of his work save those that conform to the scientific ideal. These are conditions of extreme dedication.

But this way of life exacts its toll. Collectively, it bears most heavily on the *feeling life of the scientist.* I believe that it is here that the scientist must make his greatest sacrifice.

For example, he is often told that the power which science creates is impersonal, nonpolitical, amoral. We will not stop to debate this issue. That it can even be raised is the significant point. For another example, the scientist's expertise in the art of generalization subjects him to risk of generalizing ordinary human relations, thus killing off the human sentiment that calls for individuation, the making unique of the relatedness that all human beings seek. It is a lawyer who is supposed to have answered the question, "How is your wife?" with the chilling reply "Compared with whom?" Would an equally hypothetical scientist have said, "Under what conditions of temperature and pressure?"

It is not recorded in the annals of science that the scientist necessarily wants himself to be treated as a generalized object of scientific scrutiny. Indeed, the practice of science requires that the scientist himself be highly individuated, be treated at certain critical moments, as the unique focus of attention in the interests of scientific advancement. He needs his own special equipment. He needs assistants and associates. He needs to be both housed and fed. In a word, he needs ministration.

I think much of what an administrator must do for a scientist is to treat him as a unique human being in sore need of a multitude of services to enable him to practice his art. I put this need, which I call a need for the proper feeling life, even prior to any function which the administrator may exercise as an adjudicator. Obviously, when human beings come into conflict, whether they are scientists or just citizens, they need law and a judge to settle disputes and apportion scarce goods. But an administrator is not primarily a judge. He is primarily a ministrator, and what he ministers to is the feeling life of the scientists he has undertaken to care for.

Not all men have the psychic equipment necessary for ministering to the feeling needs of others. Those who lack this human endowment should not attempt science administration. Human ambition and the desire to lead others is laudable. And there is plenty of scope in other fields for the exercise of the administrative talents that need an outlet in leadership. But such talent, such ambition, and such desire for personal glory is, I am afraid, out of place in the administration of science. Not triumph over the persons of others, but triumph with others in the conquest of nature is the scientific ideal. If I had to state the science administrator's role in brief, I think I should say: *His role is to create an environment that nourishes scientific creativity.* And let it go at that.

Reference

1. "Thus precisely in labour where there seemed to be merely some outsider's mind and ideas involved, the bondsman becomes aware, through this rediscovery of himself by himself, of having and being a 'mind of his own'."—G. W. F. Hegel, *The Phenomenology of Mind*, J. B. Baillie, translator (Harper & Row, New York, 1931), p. 239.