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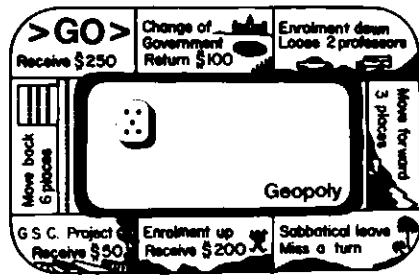
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Earth Science Departments in the Eighties: Prepare for the Worst-You May be Surprised

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Introduction

We all know the recipe for an excellent Department of Geology or Geophysics. A dotting President; twice the number of faculty and supporting staff indicated by any staff/student ratio; twice the space that any formula suggests; an energetic, knowledgeable, wise, inspiring chairman; faculty members who are lively, dedicated, hard working, inspiring teachers and perceptive research workers. Such a Department will face the challenges of the eighties with verve, with vision, and will succeed. An energy crisis - you need us to find oil; a minerals shortage - we have just the recipe; the environment - set us to work; you need good students - try ours. I know one or two excellent Departments in Canada with many of the ingredients of the recipe, which are marching into the eighties in this sort of way. But I only know of one or two, and the realities of the eighties for most departments will be quite different. There are many reasons for this, not enough babies were born in the early sixties - there were 18,314 children in Grade 1 in Nova Scotia in 1955 but only 14,086 in 1975; many universities have tried to be excellent in everything, with

no discrimination; indexing of social benefits and de-indexing of income tax produces deficits, not surpluses in governments' budgets. Most Departments of Geology and Geophysics will as a consequence be under increasingly severe and by-now-familiar pressures. Do not replace staff. Lower standards. Do not replace equipment. Presidents will become Managers, and Departments will have to learn to live with new realities.

The question is then: what to do? There is no single answer, of course, but it may be worth inciting people to discuss the variety of answers there are to the question, and out of the discussion some truths, some recipes for action may emerge. So if you think what follows is nonsense by a bureaucrat, write and say so, but be sure to give your version of the answer to the question: What to do?

Management

Books on Management tell us that Management involves: setting objectives, planning the work to meet them, budgeting and acquiring the resources, organizing and controlling the work, and evaluating the work when done. Is it not worthwhile to look at Departments in this way? I appreciate naturally that the faculty of a university Department is a collection of individuals each of whom is talented in his or her own way, and that the normal Department Chairman cannot reasonably play more than a minor role in, say, establishing the objectives for the work of the Department's superb mineralogist insofar as mineralogy is concerned. The Department can, however, be sure of its global objectives, toward which all staff members are, in their own way, striving. I do not mean to be cynical when I ask if a Department's objectives are: to teach well and to do first-class research? or, to obtain large grants from the various granting agencies? or, to have many students by hook or by crook? or, merely to survive? Certainly the pressures on faculty at the present time suggest that the prime objectives proposed by a university's administrators are not to teach well and to do good research, but are some of the others which I mention. We see that this is so in the system of rewards. For example, a university may promote its faculty primarily on the basis of grants

received and publication records, if only because it is superficially easier to "measure" the quantity and quality of activity by using proxies such as numbers of papers and sizes of grants than it is to evaluate the quality of teaching. Again, commendations flow if a Department doubles the number of students who enroll in its classes, but this may not be appropriate if the objectives are to teach well and to do good research. Commendations are appropriate, of course, if the Department's objective is simply survival. A Department should, therefore, I argue, set its objectives clearly and see that everybody knows what they are.

A critic to whom I said this wondered if this emphasis on objectives is appropriate for universities; there are, he said, surely some differences between General Motors, the United Church of Canada and the universities, and, for the sake of sanity and the well-being of society these differences should be preserved. Of course these differences are very real, and must be preserved, but this will be apparent in the objectives set - a university should have a mission just as does any company or government agency, which will be made clear in a statement of objectives. I do not see that it is degrading to be clear what one's mission is; after all, Bell Laboratories have received seven Nobel Prizes.

If a Department knows what its objectives are the resources can then be apportioned so that the objectives can be met. If, using an example I have just referred to, a University implies by its system of rewards that published research (not necessarily good research) is more important than teaching, but then demands a high ratio of students to staff so that teaching takes up all the time available to faculty, then faculty members are being short-changed. Many staff will, of course, derive a large number of their rewards in important intangible ways, such as the pleasure in viewing the development of lively, well-educated undergraduates for example, or from the pleasures of completing a good piece of research which has shaken the world. Although this is true, the strong movement towards unionization of faculty suggests that the informal system of rewards has, for whatever

reason, broken down.

Organizing and controlling work means of course organizing and controlling resources as well. It is worth accounting properly. It is worth knowing what teaching and research costs, so that the resources involved can be assigned properly. I would put the emphasis here in the order of the costs of different items which might be: salaries, space, capital equipment, operating costs of major equipment, travel and field trips, undergraduate laboratory supplies, and so on. It's worth knowing the *true* costs of items so that budgeting can be done properly. Granting agencies such as the Natural Science and Engineering Research Council usually allow costs of thin sections, analyses, computing, drafting, and so on in grant applications. If these services are provided apparently "free" by the Department, there are often two consequences. First, resources may be mis-used and money intended for undergraduate teaching may be used for something else, and, second, services provided "free" are often abused. More thin sections will be demanded than can be examined. It may well be silly to initiate a complicated costly system of charging for all services to a large number of small accounts, but it is usually easy to establish an *appropriate* system for accounting and control.

Some staff members of universities laugh derisively at these sorts of suggestions - bureaucracy, they cry, worse than the government. Well, bureaucratic control in the Public Service is at the horrendous level which it is largely because the Public doesn't trust the Service, and the restrictive controls reflect this lack of trust, rightly or wrongly. That is not the point here, which is that when resources are scarce they must be used well, and to do this does demand control. Furthermore, teaching and research *is* expensive - \$50,000 to \$100,000 per staff member per year, and it is public money which is being spent.

The greatest asset a Department has is, surely, its people - if only because they cost more than anything else! The investment in a faculty member - the cost of his or her education, the salary paid until now, and the potential cost in terms of salaries in the future - is huge.

Time spent so that a faculty member is just a little bit better will, surely, be more important than anything else. What will universities do with the fraction of their faculty which is now of little value? (Dalhousie shipped me off to the Government, but the Government can't be conned every time; this is not a universal solution.) I don't think that universities are very imaginative in dealing with these people. There are people - like me - 15 to 20 years to go to retirement, salary at an indecently high level, productivity at an indecently low level, bored and boring, hopeless as teachers, and worthless in research. Will the university spend 20 times \$30,000 or \$40,000, more than half a million dollars, just *carrying* this unfortunate flotsam? I maintain that it is worth spending a substantial fraction of that - otherwise worthless - investment in attempting to see that there will be a return on it. There are many approaches. Offer \$100,000 plus accrued pension rights, if he or she will leave, now. Spend university money on re-training. Send the faculty member away for a brand-new M.Sc. or Ph.D. or for a B.Ed. Don't allow a sabbatical, that's not the answer, we don't want a restful year somewhere else.

Teaching: One Half of the Work

A major complaint of smaller Departments - the majority of Geology and Geophysics Departments - is that the burden of undergraduate teaching is too great. I have used the arguments myself: here we are, just 12 of us, trying to give our poor underprivileged Nova Scotia children the same quality of education that they can get in the bloated rich Departments in Provinces such as British Columbia, Alberta, Ontario, and Newfoundland. We *have* to make 50 classes (or whatever) available to our honours' students, our budding professionals; classes in the Geology of Actinium, Aluminium, Americium, . . . , Zinc and Zirconium; our students deserve it, it is their right. Well, such arguments may be fit for a Dean's office, but cannot surely have much of a place among intelligent people. A student has only so much time - perhaps half of his or her university time can be spent on Earthy Matters, perhaps 10 full-year classes, some with laboratories, some without, in the whole of a four-year program. Furthermore, a

student graduating at age 22 has a potential 43 years work ahead. Except possibly in the first year or two with Gulf, or Amoco, or Inco or Noranda or wherever, those details of Actinium, Aluminium, . . . , Zinc and Zirconium will not be pertinent. Why instruct in matters with such a limited sphere of application and with such short half-lives? What is needed is an integrated teaching program which gives students the essence of what they require within the bounds of what is possible within a Department's resources.

A manual for developing this program might contain the following material.

1) Establish the individual teaching load over the next few years, taking into account sabbaticals, etc., and the amount which can be undertaken by teaching assistants and other ancillary, useful people. Take into account the lesser load which should be carried by the potentially productive in research if good research is expected of them; take into account the lesser load to be carried by the inexperienced if they are to teach well; and, take into account the small load which should be taken up by the inadequate. Take into account the greater load which may be carried by the more experienced. And so establish the Department's capability.

2) Write down everything that is taught now; course by course, lecture by lecture, lab by lab, three lines per lecture and lab. This exercise improves teaching straight away and gives all students a program outline, which in many cases, probably did not exist before.

3) Rationalize, using this document. Cut out the duplication (unless required); integrate, so that all courses relate; spot opportunities for innovation. For example, earthquake focal mechanisms and parts of plate tectonics, Tuzoitis, etc., can be taught in crystallography as an extension of the inevitable lecture on stereographic projection because first motions are conveniently plotted on this projection. My point is - you do not need a *course* called plate tectonics, or well-logging, or bums-of-brachiopods-which-I-have-known, if the essence is covered by proper planning.

4) Examine the content of courses taught by other Departments. See what courses your students could attend,

lock, stock and barrel. Even if the material is a little peripheral, it will be good for them to find out that mathematics students are very smart, if impractical. Extract from these other courses material to which you will refer in your courses. This stops mathematic classes from becoming "irrelevant", because you refer to them all the time, and the problems of inorganic chemistry become those of geochemistry. Give to the instructors of the courses in other Departments, geological and geophysical material you would like them to use. For example: in Math 100 - spherical trigonometry and its applications in navigation, surveying, rock magnetism and plate rotations; in Math 300 - Bessel functions, and where you see them in seismology and fluid flow. If you don't tell them, no one else will. Departments of Mathematics, Physics and Chemistry exist to teach service courses - let them serve you!

5) Write down the work in your courses which has survived, lecture by lecture, lab by lab, and divide into new courses.

6) Compare with the course load possible. Cut - rationally - if there are more courses than can be handled (and you know how many can be), or add programs if there is spare time, or, better still, tell no one, and spend the time skiing.

7) Establish a course evaluation system, from which comes feedback on the quality of teaching and the content of classes.

Research

A Department may find it beneficial to be as coldly analytical about its research efforts as it should be about its teaching. For example, how much time is available? Will your efforts be those of a conglomerate - unrelated projects by individuals - or of an integrated team? Whichever route a Department takes, it is self-evident that the most creative must have the greatest influence on the ideas to be pursued. A Head or Chairman or other respected figure has an enormous responsibility with respect to the style of research in a Department. He or she can ensure linkage between apparently unrelated projects and topics, and spot areas of collaboration ripe for

temporary partnerships, which individual research workers may miss. It may not be obvious, for example, to a theoretical geophysicist concerned with rheology that vitrinite reflection data gives temperature - time history of potential value. A research manager might spot it, and it is his or her duty to ensure that the knowledge is spread around.

Management of Departments in General

I mentioned before that some would say that the management appropriate for industrial or government laboratories is not necessarily appropriate for the universities. There are certainly many differences; a Department is usually quite conspicuously a democratic collectivity, and it will not always be clear whether the views of the noisily mediocre or the quietly excellent will prevail. Further, Departments are on the whole, semi-autonomous fiefdoms, and the relationship between Departments is perhaps one of sovereignty-association. The argument has been made to me that everything "above" a Department in a university exists only to permit the individual departments to be excellent. However, although there are many differences between the universities and other sorts of institutions, I still think that the Department Chairman or Head has many responsibilities comparable to those he or she would have in other institutions. Let me give an example of the sorts of areas in which the Chairman's responsibility and authority are, to me, quite clear.

Many of us know of poorly managed facilities in university laboratories, as of course in other sorts of institutions, - microprobe laboratories on which \$250,000 has been spent with very little production and enormous downtime. We are all aware of unnecessary duplication of facilities. A Department Chairman's business is to see that facilities are managed well, and that they do fill a real need. A critic has said to me that none of this is the Chairman's business - that peer review takes care of it, as in the various disciplinary selection committees of the Natural Science and Engineering Research Council. The general

examples I point to suggest to me that peer review can only be one part - a most important part - of the process by which talented individuals are funded to do creative work at large public expense. The other part of the process is the orderly management of facilities; a creative individual who has instigated the acquisition of a large facility, and whose reputation has carried the proposal, may not be the best person to manage it, and it is the Chairman's business to see that it is well managed. The Chairman's business is to see that programs large and small, be they directed towards teaching or research, are under control.

The last step in management of programs is evaluation. The Auditor-General has the responsibility and authority to see that Departments in the Public Service give value for money. Universities owe society the courtesy of asking the same question of their Departments. No single method will do, because any one will be incomplete, and only satisfactory for certain elements of Departments' programs. Course evaluations, valuable as they are, suffer from students' lack of perspective. Peer review is vital, but leads to the tendency to judge by size of grant, surely deplorable. Visiting Committees can and should probe uncomfortably, but may pass through too quickly to be well-informed. So *all* these and other tricks must be used, sparingly; I say *must* be used, which I certainly mean. But I add "sparingly" - examination of a beautiful navel is wearing on the navel if carried to excess.

Finally

The elements of bureaucracy which I must appear to be advocating here are repugnant to most of us, and are not welcome parts of our dream-worlds. Ideally, if one faculty member teaches poorly, we should hire another. If the Brand X facility fails, we should buy Brand Y. If the heating in the building fails, we should acquire another building. But dream-worlds are just that; babies were not born in sufficient numbers in the early 60s, and some Departments of Geology and Geophysics will suffer, brought down by the general financial problems. My colleagues tell me, quite properly, that

this is the Age of the Earth Sciences; the universities' students will be in great demand, and professional talent will be needed as never before so that we properly manage the Earth. I do not doubt this, but I do not believe that this will be enough to overcome the general restraint which is now upon the universities. And when resources are in short supply they must be well-managed, whether the resources are supplies of gasoline for Californians or drafting services in a laboratory.

So why not privately and secretly ask yourself some questions. What are the objectives of my Department? What is the work? How is it planned? How do we budget? How do we organize and control the work? And how do we evaluate the work when done?

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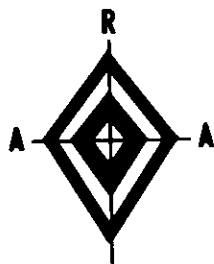
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