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ON THE IDENTIFICATION OF "USER GROUPS" FOR SOCIO-ECONOMIC CONTROL MODELS

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During the past year, I have been associated with an extensive interdisciplinary program at Michigan State University, entitled, "Ecosystem Design and Management". The program was initiated jointly by a zoologist, William F. cooper, and an engineer, Herman E. Koenig The principal long-term goal of the program, as articulated in one of the proposals generated by it, is "to develop a scientific basis for landscape management and planning. This includes tools for the assessment and prediction of the ecological impacts of present and future technological and economic developments… (and) methodologies for identifying and evaluating the relative effectiveness of alternative regulatory policies and economic pricing mechanisms in preventing or minimizing the detrimental effects of technological developments and economic growth on the environment".

To accomplish this long-term goal, a variety of "prototype studies" were initiated under the program. Each of these prototypes was regarded as epitomizing, in a microcosm, a few of the important features which would become ingredients of the overall long-term program activities. Furthermore, an attempt was made to choose these prototypes in such a way that their investigation would lead to immediate short-term pay offs for the program itself. In other words, the prototypes were chosen in such a way that their investigation would (a) lead to solutions of limited but important practical problems, and (b) at the same time, provide insights into the methods and concepts required for attaining the long-term goals.

Five prototype programs were chosen, in accordance with the above criteria. These may be briefly described, as they will become important later.

1. *Power Plant Siting*

One of the obvious ingredients of the long-term program goals has to do with the interaction of industrialized man with the environment. As a prototype of all such problems, we can consider the problem of how to decide where to put power generators. This problem is, of course, a matter of topical concern, and one for which data exists. To quote again from the proposal:

> "computer-based models will be developed from which the trade-offs between the technological and economic efficiencies of power generating facilities can be evaluated against the ecological impact created by the externalities of the energy conversion processes. The model will provide an effective tool for designing the technological features of the power plant to enable it to operate in harmony with

the local environment as a closed system, cooling towers, stack gas scrubbers and plant capacity, for example, will be considered as design parameters. The model will also be structured to provide systematic procedures for evaluating the relative merits of alternate regulatory and pricing mechanisms in motivating private industry to develop a plant site design that is ecologically sound."

"The proposed model will serve as a prototype of other plant site design models and will demonstrate the basic principles of plant site design and economic regulation."

2. *Agricultural Production*

The prototype system chosen for this aspect of the over all long-range problem was the beef feedlot. As the proposal states:

"A computer-based analysis…will be developed to evaluate the trade-offs between the technological and economic efficiencies of alternate agricultural production practices against the ecological impact created by the practices. The effort will focus initially on the problems of beef production and the impact of high-density feedlots on the environment. It will be used to provide a basis for evaluating the relative merits of various forms of physical and economic regulations that might be used to motivate agricultural technologies that are consistent with regional soil, hydrological and other environmental conditions. it will be used to identify and demonstrate basic principles of regulation and control."

"A second major objective is to identify the basic tradeoffs between the economic cost of beef production associated with restricted scales of mechanization and specialization, as against large-scale mechanization and specialization. The answer to these questions is expected to contribute significantly to estimating the environmental and sociological impact of large-scale mechanization in agriculture as reflected in the spatial distribution of the population."

3. *Pest Management*

As a prototype to the problem of ecosystem design, and the control of interacting biological populations, a problem was chosen from the area of pest control. The particular pest chosen for study was the cereal leaf beetle, a nasty Eurasian pest of grains recently (ca. 1950) introduced into the United States presently moving inexorably westward towards the country's grain belt, and with the capability of decimating some of our most important crops. We will consider this problem in more detail below.

4. *Terrestrial Ecosystems*

The particular prototype chosen here was directed primarily at the development of models which would allow us to evaluate the effects of massive spray-irrigation of municipal and animal wastes. The models involved are rather detailed and specialized, involving plant communities, their couplings with the soil, and an attempt to characterize those combinations of soil and plant populations which have the best and the worst ability to process such wastes. Moreover, it seems necessary to develop models relating to the movement of materials within soils of various types, as a function of such things as soil composition, temperature, rate of water

application and organic carbon content, as well as uptake models for such substances in soil microbes and large plants.

5. *Aquatic Ecosystems*

The prototype chosen here reflects the capacity of woodland lakes and streams to absorb and process a variety of thermal and material inputs. The effort here takes the rather conventional form of modelling the food-chain and population dynamics of lakes and streams, with a particular eye to the response of such systems when perturbed by thermal changes, factory effluents, organic molecules in solution, and particulate waste-disposal effluents. I might mention as a preliminary result that such bodies of water seem to do better (i.e. tolerate larger inputs) when a waste effluent is particulate than when it is completely solubilized. Thus there can be such a thing as too much waste processing.

The project as a whole has been rather lavishly funded by the National Science Foundation under the RANN program (Research and National Needs) . The project has been in operation for three years, with one more year to go on the present grant, and the total funding has amounted to something like $2 million. It is now necessary to say a few words about the RANN program itself.

The National Science Foundation has always been the most conspicuous, and hence the most vulnerable, agency involved in the governmental support of scientific research, When research funds first began to be cut back sharply around 1968, there was a general scramble to re-allocate the contracting budget for research into areas in which there would be an immediate practical pay-off RANN was apparently created as a by-product of this scramble, and primarily has specialized in sponsoring scientific research dedicated to the solution of relatively immediate environmental problems.

The RANN program was responsible for one major innovation in the relationship between science, government and society. Heretofore, it has always been accepted that the endproduct of a piece of scientific work was a paper or papers, appearing in one or another technical journal in the open literature. In principle, this work is then available to all those who need it or who can use it. But in practice, this view places a massive and sometimes paralyzing burden on the potential users of research. It is they who must scan the journals for applicable results, and it is they who must transform these results into a form suitable for the particular applications which they have in mind. Particularly in realms in which the ultimate users of research are themselves not scientists, such as in a variety of planning activities, it is practically impossible for them to identify relevant research outputs, let alone convert these outputs from the form in which they were published (technical journals, with the associated requirements of terseness and acceptability to referees interested primarily in narrow disciplinary matters) to a form in which they can be used.

The RANN program changed all this by shifting the burden to the researcher himself. Research sponsored under the program must be undertaken with specific applications in mind from the outset. It is up to the researcher to find the potential users and appliers of his research, to involve these users in the research activity itself at an early stage, and to present the results of his work to the users in a form directly translatable into policy. Such a shift in responsibility cannot but have a salutary effect; in this age of specialization and information-glut, too many important papers have effectively disappeared into specialized literatures, impenetrably shielded from all those who could make use of them.

Under the RANN program, then, it was necessary for the MSU project to identify from the outset the potential user groups for the research outputs. This was thought to be a relatively simple problem, at least for the prototype studies which were undertaken. For the power-plant siting project, for example, contact was established with Consumer's Power Company in Michigan. For both the pest-management program and the agricultural production program, it was expected that such agencies as the US Department of Agriculture and the Agricultural Experiment Station, and the associated agricultural extension service, would be the natural user groups, and contacts were set up accordingly. For the aquatic and terrestrial ecosystems projects, contacts were established as well with the Wayne County Planning Commission. Thus, everything seemed neat and tidy; RANN was satisfied, we were satisfied, and the user groups we had identified were prepared to be satisfied.

As the prototype projects were further developed, it became more and more clear (to me, at least) that there was an implicit assumption involved in the RANN strictures; namely, that the potential user groups *already exist*, and need only be identified. By "user group", I mean here a group in a position to implement the results of a particular research program a group with both the authority and the responsibility to solve a particular problem. In at least a few of our prototype projects, however, it was turning out that those we had identified as users did not possess the requisite qualifications of responsibility and authority, and in fact *could not* implement whatever solutions came out of the research. Worse than this; there *was* no group of potential "users" with these qualifications, and, apparently, no capacity to generate such a group under existing conditions.

In order to understand how this conclusion was arrived at, let us look at one of our prototype projects, that of pest management, in more detail. I have already indicated that we were concentrating on a particular pest of grain, the cereal leaf beetle. Let me first indicate what the problem is, how it was approached, and how (in our opinion) it must be solved, We will then compare the properties of the proposed solution with the properties of those groups available to implement the control. If these two sets of properties do not match, then the proposed control cannot be implemented; no "user group" exists. Moreover, the authorities required by the "user group", which are implicit in the control strategies proposed, seem inextricable from pre-existing patterns of authority distribution; hence no appropriate "user group" can be created easily.

The cereal leaf beetle is now well established throughout the states of Michigan, Illinois, Indiana, Ohio, Pennsylvania, New York, West Virginia and Kentucky, as well as throughout eastern Ontario. It is inexorably moving westward despite massive chemical and quarantine efforts by federal and state governments. In dry years, this pest can totally destroy crops of spring grains unless massive doses of pesticides are employed. This kind of spraying is ecologically unsound, as well as imposing a massive economic drain upon crop raisers. Some other modes of control need to be developed.

There are a variety of biological factors which can presumably be employed in a management program for this pest. For one thing, the feeding habits of the beetle and its larvae make certain kinds of grain less susceptible; oats are less susceptible than wheat. The reason for this lies in the relative timing of plant growth in the spring to the appearance of larvae. Thus, appropriate strategies of planting and crop rotation can, in effect, act as lenses to help keep these populations localized, and their densities below economically acceptable thresholds.

As a further mode of biological control, a search was made in Europe for natural enemies or parasites of the beetle; apparently it is these parasites which keep the beetle populations under control in its original habitat. It turned out that there are some 20 different cereal leaf beetle

parasites in Europe; of these, three were selected at random and introduced into the United States. In my view, the parasite program was badly bungled, mainly because no models of hose-parasite interaction were employed. It turns out that the parasites chosen for introduction interfere with each other, so that the combination introduced has less effect on the beetle population than any one of them alone; and now they are all present. As one of our senior researchers in this area, Dean Haynes, wryly put it, "Perhaps we are not too far from the time when we will be looking for chemical control of parasite populations".

Nevertheless, it appears that an effective combination of biological, chemical and agricultural methods can be developed as an effective control of pest population levels. Local crop rotations, the geometric layout of the crops, localized spraying when necessary (e.g. in strips) and appropriate parasite manipulation can be combined to give a synergistic effect far greater than any one of these strategies in isolation. But the crucial aspect of the control in order for this synergy to be manifested lies in the timing of control measures as a function of the beetle's life cycle. This in turn is overwhelmingly dependent on two variables: what happened last year (i.e. the distribution of over-wintering adults) and the present temperature. These variables are local variables in a large distributed system. Therefore the local control strategies, which are also distributed, must be tailored to local conditions, although the overall strategy of control, and the criteria by which effectiveness is judged, is a global one, involving the whole system. And the form which the local strategies must take must involve the on-line acquisition of local data (especially temperature) fed into a central control center, from which individual local strategies can be computed in terms of the overall situation.

Now it turns out (a) that no agency of federal or state governments is authorized to bear the expense of establishing and maintaining the local monitoring facilities which must be the backbone of such a control strategy; (b) no federal or state agency has the authority to implement the kinds of local control strategies, which differ from region to region and from year to year, which our analysis mandates.

In fact, then, what is the "user group" at which our strategy is to be aimed? Neither federal, nor state, nor local authorities can, individually or collectively, take the responsibility for the establishment and maintenance of any of the facilities required to solve the primary problem, that of controlling the cereal leaf beetle. In the absence of such an integrated program, each farmer is left to fend for himself, and will, when his crops are threatened, fall back on massive spraying, with all of its expensive and harmful correlates in the aggregate. The authority required is at present spread in an uncoordinated way over a host of local and regional jurisdictions, and it is difficult to find a way, in the present scheme of things, whereby it can be extricated and vested in an appropriate agency. Thus, our work allows us to specify the properties required by the presumptive "user group"; but the group itself does not exist, and it will be a major effort to create it.

Thus we see that, in order to solve one relatively circumscribed problem of pest management, we require an effort which is at bottom political; the establishment of an entirely new structure which cuts across traditional lines of authority in a novel way. And it should be remembered that the cereal leaf beetle problem was intended as a *prototype*; if it is a prototype, then many other similar problems will likewise lead to control strategies for which no "user group" exists. Thus we see that the problem of the "user group" is a serious one indeed.

Our present distribution of administrative authority, with its partition into local, regional, state and federal jurisdictions, was created to solve a particular class of problems arising in the preceding two centuries. There is no reason to expect this separation of jurisdictions to be

applicable to the kinds of problems which are now before us and indeed, it is our conclusion that such a partition of jurisdictions is in fact inadequate to solve these problems. On the other hand, our existing structure has created an inertia which resists, or inhibits, the development of new structures explicitly geared to deal with these problems. It will be one of our most serious problems, implicit in all the existing ones, to find mechanisms whereby the appropriate "user groups", with the responsibility to implement global control policies and the authority to do so, can be created and superimposed upon existing political structures.

Let us sharpen the question somewhat by asking what is the appropriate "user group" for the research result which we are announcing in this note; namely, that re-allocations of political and fiscal authority are necessary to solve many, if not all, of the outstanding questions with which we are confronted. Who has the authority to determine whether, and when, this is in fact the case? And who has the authority to implement such re-allocations, which often seem to violate traditional principles of local and regional autonomy? Obviously, the user group in this case is the Congress of the United States. How is it possible to follow the RANN precepts, and involve this user group into the research endeavor so that the results of the research may be most fruitfully applied? It is on the solution of problems like these that the solutions to other problems will depend.

It is implicit in the foregoing that, in the absence of an appropriate "user group", empowered to implement and maintain the patterns of control continually revealed by research to be necessary to solve our pressing problems on the landscape, we will have to rely only on modes of control compatible with existing distributions of authority. These controls will in general be sub-optimal, and in many cases may serve to intensify and exacerbate problems rather than solve them. In many cases, as for example in the cereal leaf beetle problem referred to above, the nature of the controls to be implemented will determine what properties, (i.e. what authorities) the appropriate "user group" should have. And in such a case, it can be determined that, in the absence of such a group, we could not begin to approximate such a control. Thus it is possible to quantitatively determine how much harm is done by the non-existence of the user group. When this number is multiplied many-fold (for each of our problems for which an appropriate user group does not exist) we have some indication of the cost incurred by the political and fiscal inflexibilities intrinsic in our present structure.