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THE EFFECT OF A "SOCIAL PROBLEM" ORIENTATION ON THE ORGANIZATION OF SCIENTIFIC RESEARCH*

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ABSTRACT

This paper examines the proposition that the non-scientific frame of reference in which a researcher perceives his problem affects his scientific work on that problem. A survey of scientists and engineers involved in research on problems related to environmental quality shows that researchers who define their research topics as having social relevance are more likely to engage in interdisciplinary research on those topics than are researchers who do not define their topics as socially relevant; this is especially true among those not initially favorable to interdisciplinary research. Possible explanations for this finding are considered.

The hypothesis to be tested in the present study was suggested by the argument that perception of scientific problems is affected by the existing scientific frames of reference ("paradigms"), and that major changes in those frames of reference lead to changes in the way scientific problems are viewed [1]. I think that a process which parallels that of a "scientific revolution" occurs with respect to what might be loosely called "social paradigms"—philosophies, ideologies and world-views which develop in, or are introduced into,

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societies [1, p. 92]. The consequence of a change in a scientific paradigm is to drive out adherents of the older view. The social system of modern science includes normative criteria for deciding among competing paradigms [2]. New "social" paradigms are less likely to drive out older ones; since there is no consensus regarding criteria of choice among competing value-systems, incompatible social paradigms continue to exist side-by-side.

The development of new social paradigms results in the creation of new social problems, defined as issues about which people are concerned [3]. Individual scientists are likely to differ in the degree to which they see their own work as relevant to these social problems. Eventually, a stable group of scientists may develop which is defined, or defines itself, as concerned ultimately with the social problem, and whose scientific research is oriented toward providing information relevant to it.[1] Initially, however, there is likely to be wide variations among scientists working in areas which may subsequently be defined as interconnected, because of their commonality in the social problem, in the degree to which they see their work as relevant to that problem. Yet, reformulation of the commonalities among their research problems, in terms of their shared relevance to a particular social problem, may lead to greater consensus among them regarding the non-scientific relevance of their work.

This argument could be tested in a situation in which problems formerly defined as primarily scientific are undergoing a reformulation because of claims regarding their social relevance. Such a situation currently exists with respect to problems of environmental quality in Israel, as well as elsewhere [4]. Although scientific research has been carried out for many years in Israel on problems of water quality and other topics of environmental relevance, it is only in the past few years that "environmental quality" has become a potentially broader social issue [5, 6]. One of the consequences of this transformation has been repeated calls for interdisciplinary research on problems of environmental quality, instead of research restricted to one of the traditionally defined fields (water quality; air pollution; soil pollution; etc.). The call for an interdisciplinary approach to problems of environmental quality is rooted, of course,

[1] Many examples of this phenomenon are found in the field of medical research on diseases such as infantile paralysis, cancer, heart disease, etc.; the concentration of research effort, and the financial allocations required are justified in terms of the consequences for the society of the diseases going unchecked, and not primarily in terms of the intrinsic scientific interest such study involves. Another example would be the work on road safety, because of concern about traffic accidents.

in an "ecological" view of the problems, and a recognition of the interrelationships existing in the ecosystems which are likely to be disrupted by pollution of one kind or another [7]. In terms of the argument presented here, however, it is possible to look at the calls for interdisciplinary research as representing pleas to widen the definition of the scientific problem, and to include variables which have not typically been included in "intradisciplinary" research projects.

This leads us to the following hypothesis: *Researchers who define their work as relevant to problems of environmental quality will be more likely to engage in interdisciplinary research than are those who do not define their work as relevant to problems of environmental quality.* This formulation assumes, of course, that the phrase "problems of environmental quality" represents the social problem aspect of the topic on which the scientist is working, and that his agreement with this description of his research provides evidence of a social problem orientation on his part; a test of the assumption will be presented below.

Description of Research

DATA COLLECTION

The data used in this analysis were collected by means of a mailed, self-administered questionnaire sent to a sample of scientists engaged in research of potential relevance to problems of environmental quality.[2] The sample was drawn from two sources:

Water Quality Research in Israel, 1972—a special publication prepared for the Sixth International Conference on Water Pollution Research held in Jerusalem in June, 1972, which included a list of research activities in the fields of water quality management and water pollution control being carried out by governmental bodies, universities, and other research organizations in Israel. Information on the activities was obtained from reports supplied by the organizations themselves, in response to a request from the Committee for Research on Water Quality and Pollution of the Israel National Committee for Research and Development.

Environmental Research in Israel, 1969-1972—a publication prepared by the Israel National Council for Research and

[2] "potential" rather than "actual" relevance, in order to allow the researcher himself the final say as to whether this research was relevant.

Development, listing all environmental research projects in progress during the years 1969-1971 (except for those dealing with water resources, covered in the first report). Information on the existence of research projects was obtained from the institutions in which the projects were being carried out. Since the inclusion of a particular research project in either of the before mentioned reports depended on information on the project having been provided by the institution solicited, it is possible that some projects were not included, although the compilers of the reports indicated that their coverage was almost complete.[3]

A total of 359 separate research projects were reported in the two publications. In a number of cases, a particular researcher had participated in more than one project; similarly, many projects had been carried out by more than one researcher. Since the aim of the present study was to obtain information about research projects, a researcher who participated in more than one of the projects on the list was asked about only one of the projects in which he participated; the particular project about which the researcher was asked to provide information was specified in the cover letter sent with the questionnaire. Researchers whose names appeared in connection with more than one project had one of their projects "selected" for specific reference by a random method. (This resulted in a smaller likelihood of inclusion of any particular project carried out by any researcher who was involved in more than one project.) Using this method it was possible for two researchers on a particular project to have been asked independently to refer in their answers to that project; it was also possible for a particular project to have gone unreferred to by any of the researchers who had worked on it; in practice, both of these possibilities seldom occurred.

A total of 411 separate names appeared in the two lists; of these, 347 were sent questionnaires by mail in December, 1972.[4] The final return was 133 usable questionnaires; thirty-nine were returned by the post office as undeliverable. It is likely that other undeliverable questionnaires were not returned, but were discarded if the addressee was no longer employed at the institution indicated on the lists.[5]

[3] Personal communication.

[4] Although the names of the researchers appeared on the lists with their organizational affiliation, it was not always possible to identify the specific university departments to which they belonged, and after cross-checking with the compilers of the lists, and with lists of university personnel, some potential respondents remained unlocated. It is likely that these were graduate assistants, rather than researchers with academic appointments.

[5] The 133 usable questionnaires represent 43 per cent of the total number of questionnaires which can be assumed to have been delivered (347-39).

The two lists employed probably provide as complete coverage as could have been obtained of the population of researchers in Israel currently engaged in research relevant to problems of environmental quality. In the absence of available figures for comparison, it is difficult to estimate what differences, if any, exist between those researchers who returned the questionnaire, and those who failed to do so.

DEMOGRAPHIC AND PROFESSIONAL CHARACTERISTICS

Almost all the researchers who responded to the questionnaire were men (90%), aged thirty to forty-nine (76%). More than half (54%) had received a PhD; an additional 29 per cent reported that the MA was the highest degree that they had attained (though some of these would be expected to continue for the doctorate). Of the remainder, 6 per cent had but a BA or BSc, 5 per cent had received engineering degrees, and 5 per cent reported holding medical degrees. The median length of time since receiving the highest degree was 8.1 years. Most (65%) had received their degrees abroad. When asked to describe their profession 68 per cent named a natural science field; 20 per cent named an engineering field, and the remainder were scattered among the social sciences, architecture and medicine. Slightly more than half (53%) were employed at the time of the survey in a university setting, while 42 per cent were on the staff of institutions engaged primarily in research. The respondents themselves were primarily engaged in research; only 39 per cent reported that they were engaged in research and in teaching to about the same degree, while almost all the rest (59%) reported that their major involvement was in research. As might be expected, researchers employed in research organizations, as opposed to universities, overwhelmingly (92%) reported that they were engaged mainly, or almost completely, in research; among those in universities two-thirds reported being "equally" engaged in research and in teaching, while almost all the others (32%) reported being more heavily engaged in research than in teaching. Only one per cent of the university researchers were engaged primarily in teaching.

In short, the sample of Israeli researchers engaged in work which is potentially relevant for problems of environmental quality is composed of relatively young men, whose last degree was obtained abroad rather than in Israel. They are slightly more likely to be employed in university settings than in research organizations not located in universities, are overwhelmingly natural scientists and engineers, engaged primarily in research, and only secondarily in teaching.

ENVIRONMENTAL RELEVANCE OF RESEARCH

Since the major interest of the current study centers on the relation between the environmental relevance of a particular research project and its interdisciplinary character, it was necessary to evaluate the environmental relevance of the projects. One possible approach was to carry out a content analysis of the research proposals, in order to determine whether specific mention was made of the relevance of the project to problems of environmental quality; a second possibility was to examine the completed report for specific reference to the relevance of the work for problems of environmental quality; a third approach would have been to evaluate the scientific content of the report in terms of its relevance to problems of environmental quality, suitably defined. These approaches were rejected in favor of a simpler, more direct procedure: the researcher himself was asked in the questionnaire to evaluate the relevance of his work for dealing with problems of environmental quality.

Perceived environmental relevance of the research project was measured by four items:

1. "the subject was relevant to environmental quality," included as one of a series of eleven possible reasons for the researcher's working on the particular project;
2. "Would you say that the research . . . was relevant for problems of environmental quality?";
3. "To what degree was the relevance of the research to problems of environmental quality an important factor in its planning?";
4. "Is there specific reference in the research report to the connection between the project and problems of environmental quality?"

For 65 per cent of the researchers, the relevance of the subject to environmental quality was a "very important" (34%) or an "important" (31%) factor in choosing to work on it; 61 per cent felt that the research was "very relevant" to problems of environmental quality, and another 30 per cent believed that it was relevant "to a certain degree"; the environmental relevance of the research was a "very important" factor for 36 per cent of the respondents, and an "important" factor for another 26 per cent; and in one third (34%) of the reports there is "a great deal" of specific reference to the connection between the research and problems of environmental quality, while in an additional 26 per cent there is "a certain degree" of specific reference to the connection.

Table 1. Intercorrelations[a] Among Responses to the Four Items Dealing With Environmental Relevance of the Research

Item content	*(1)*	*(2)*	*(3)*	*(4)*
1. "Subject relevant to environmental quality" as reason for choice	1.00	.80	.72	.56
2. Evaluation of project as relevant to environmental quality		1.00	.91	.71
3. Relevance to environmental quality as a factor in planning			1.00	.71
4. Specific reference in report to relevance to problems of environmental quality				1.00

[a] Mu-2 coefficient of weak monotonicity (Guttman, 1970b).

Table 1 shows the intercorrelations[6] among responses to the four items dealing with the environmental relevance of the research. They are almost all high (.56 to .91), indicating that the four items can be viewed as referring to a common content of environmental relevance. That the coefficients are all positive indicates that environmental relevance in choice of subject in planning, and in drafting of the report are directly related to each other in the work of the researchers.[7]

REASONS FOR WORKING ON THE PROJECT

As anyone who has worked on a research project knows very well, there are many considerations affecting the likelihood of any particular researcher being involved in any particular project. Considerations of intrinsic interest as well as bureaucratic convenience affect the researcher's decision. The social relevance of the problem may also have an effect. In order to characterize researchers

[6] The correlations are based on Guttman's [8] coefficient of weak monotonicity, mu-2, defined as

$$\mu_2(x,y) = \frac{\sum_h \sum_i (X_h - Y_i)(Y_h - Y_i)}{\sum_h \sum_i |X_h - X_i||Y_n - Y_i|}$$

briefly, the coefficient indicates the extent to which values in one variable increase or decrease monotonely with increases in another variable, without specifying the exact nature of the regression function.

[7] A new variable, "Environmental relevance of research," was created, based on the four-category Guttman scale resulting from dichotomizing items 54-56; the scale had a CR = .95. The distribution of scale types was (Type 1 represents "highest reported relevance"): 1-56%; 2, 3-12%; 4-32%.

according to their reasons for working on the specific projects included in the sample, and to demonstrate that a concern for "environmental quality" was, in effect, a concern about a social problem, a list of eleven possible reasons for coming to work on the project was included in the questionnaire. The respondents were asked to indicate the importance of each of the reasons for their coming to work on the given project.[8]

A simple technique for representing the relationships among the different reasons is Smallest Space Analysis (SSA) [9], in which a matrix of correlations among variables is represented in a two-dimensional space in which the variables are represented as points, and the distance between them are inversely proportional to the relative size of the correlation between them. This technique provides a map of the interrelationships among a set of variables, and depending on the fit between the matrix and the mapped two-dimensional space, enables the observer to see almost at a glance the relative intercorrelations among all variables simultaneously.

The SSA map of the relations among the reasons appears in Figure 1, and it is immediately evident that there are in fact three subgroups corresponding to scientific, bureaucratic, and social relevance reasons. The relative closeness to one another of the points representing the reasons within each sub-group and the relative "farness" of points in one sub-group from points in each of the others, corresponds to the higher correlation coefficients among variables in each group, compared to the correlations between variables in different groups. The mean correlations within and between groups are as follows: "scientific" with "scientific"—.47; with "social relevance"—.09; with "bureaucratic"—.07; "social relevance" with "social relevance"—.37; with "bureaucratic"—.09; "bureaucratic" with "bureaucratic"—.59. The original matrix also sheds additional light on "polarities" among reasons for coming to work on a particular project: the highest negative correlations in the matrix are between "interesting from a scientific standpoint" and "assigned to me" (-.56), and "interesting from a scientific standpoint" and "funds were available" (-.43). In both of these cases the major difference is in the degree of control that the

[8] The reasons presented included: *Scientific*: "It was a continuation of a problem on which I had previously worked; It interested me from a scientific standpoint; It was part of a larger research project on which I was working; It was a field in which I had always been interested; It represented an important scientific problem"; *Bureaucratic*: "The work was assigned to me; There were funds available for research in this field; As a source of income; It was included in my research functions where I worked"; *Social Relevance*: "The subject was relevant to environmental quality; The subject was relevant to social problems."

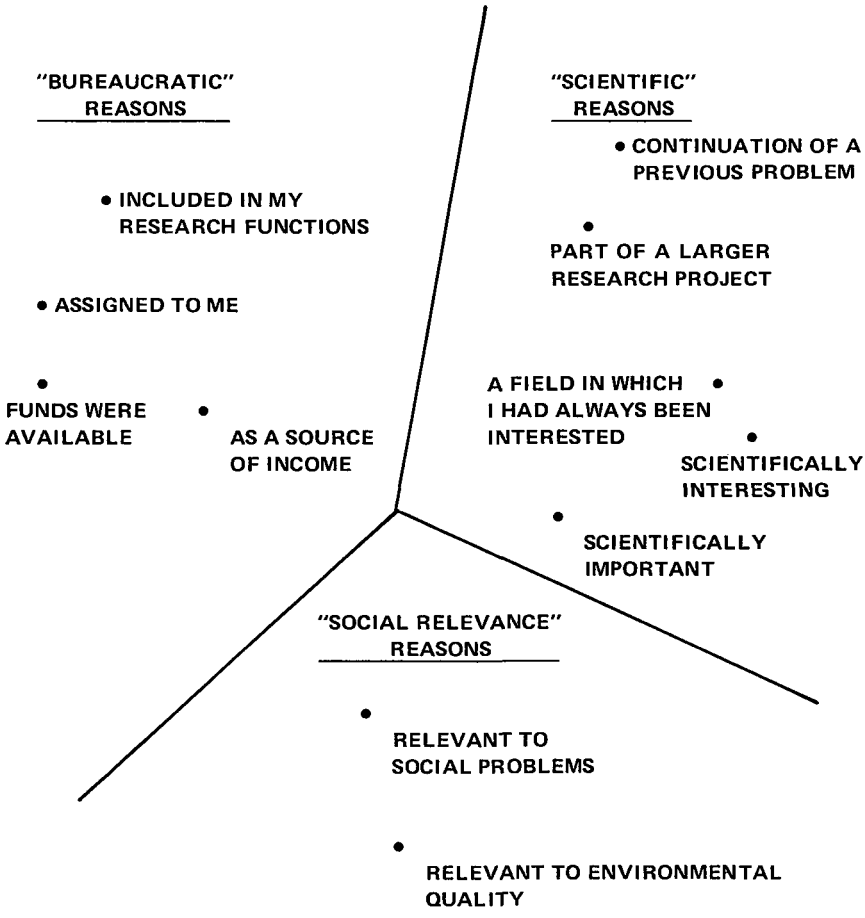

Figure 1. Smallest Space Analysis (SSA) of relations among responses to eleven items dealing with reasons for coming to work on a particular project. (Coefficient of alienation = .15; cf. Schlesinger and Guttman, 1969.)

researcher has over his choice of projects—on the one hand, pure scientific interest, and on the other, assignment by considerations completely extraneous to such interest, and probably in opposition to it.

The most important finding in Figure 1, from the point of view of the present analysis, is the closeness of the two points representing the "social relevance" reasons. This closeness demonstrates that a researcher who gave "relevance for environmental quality"

as a reason for working on the project was concerned with environmental quality as a *social* problem. This supports the argument presented earlier with reference to the transformation of a scientific concern and its additional formulation in terms of a social concern. It also justifies combining the four items measuring the environmental relevance of the research into a single measure of the researcher's "social problem" orientation.

ATTITUDES TOWARD INTERDISCIPLINARY RESEARCH

According to the hypothesis, researchers who define their work as having relevance to problems of environmental quality should be more likely than those who do not so define it to engage in interdisciplinary research on the problems they are studying.[9]

An adequate test of this hypothesis requires that we take into consideration the researcher's attitude toward interdisciplinary research in general, since this attitude is likely to affect whether he engages in, and thus describes his research as interdisciplinary or not. In order to measure attitudes toward disciplinary research, a series of statements was prepared, based on the following faceted design [10, 11].

				A
				(INCREASED)
THE DEGREE TO WHICH AN INTERDISCIPLINARY APPROACH				( )
			LEADS TO	(DECREASED)
B		C		
(CLARITY)		(THEORY)		(HIGH)
(GENERALIZABILITY)	WITH RESPECT TO	(METHODS)	——————→	(:)
(AGREEMENT)		(FINDINGS)		(LOW)

One positively phrased statement and one negatively phrased statement was prepared for each combination of Facets B and C (e.g., "There is no possibility of reaching agreement on a unified theoretical approach for interdisciplinary research," represents a negatively phrased statement about *agreement* with respect to *theory*; the corresponding statement positively phrased, read: "The advantage of interdisciplinary research is the necessity of reaching

[9] It could be argued that *both* defining one's problem as environmentally relevant, and describing one's research as interdisciplinary, are alternative measures of some more general attitude toward, or expression of, "relevance" on the part of the researcher; i.e., partaking of current fashions in rhetoric in which both environmental relevance and interdisciplinarianism are valued. The data available do not permit this argument to be tested.

agreement on a unified theoretical approach.") There were eighteen such statements, and researchers were asked to agree or disagree with each of them.

The measure of attitudes toward interdisciplinary research was constructed by summing the number of items on which the respondent gave a strongly favorable response (i.e., he "definitely agreed" with the positive statement, or "definitely disagreed" with the negative statement).[10] After grouping the responses into four categories, the distribution was as follows: 0-6 strongly favorable responses: 36 per cent; 7-8 strongly favorable responses: 14 per cent; 9-11 strongly favorable responses: 25 per cent; 12-18 strongly favorable responses: 26 per cent. The grouping was done in this way in order to enable analysis of extreme groups without reducing the number of cases in each of them below that which would make such analysis impossible.

The validity of the measure of attitudes toward interdisciplinary research can be examined by cross-tabulating the favorableness score with three items from the questionnaire which, on their face, seem related to the same underlying dimension: the number of journals read; number of co-authors on the article; and responses to the question, "Is the research referred to interdisciplinary?" For two of the three items (number of journals read, and researcher's report that the research is interdisciplinary), the value of chi-square represents a probability of less than .05; for the third, the chi-square value represents a probability of less than .2. It seems reasonable to conclude that the measure is a valid one.

TESTING THE HYPOTHESIS

The original hypothesis leads us to expect that researchers who define their work as relevant to problems of environmental quality will be more likely than those who do not to engage in interdisciplinary activity. Table 2 shows the results of the test. Among those with favorable attitudes toward interdisciplinary research, there is no relationship between the perceived environmental relevance of the particular project and the likelihood that the researcher defines it as interdisciplinary. Among those unfavorable toward interdisciplinary research, however, there is a very strong relationship between the perception that the research is environmentally relevant, and the likelihood that it is defined as being interdisciplinary.

[10] No-answer responses to any of the eighteen items were not compensated for; thus, the measure as constructed underestimates the potential favorable attitude.

Table 2. Interdisciplinary Character of Research Project, by Perceived Environmental Relevance of Research and Attitudes Toward Interdisciplinary Research (Per cent of Respondents Reporting That the Research Project Is Interdisciplinary)

	Environmental relevance of research			
	Relevant		*Not Relevant*	
Attitude toward interdisciplinary research	*(Per cent reporting that the research project is interdisciplinary)*			
Very favorable (12 or more strongly positive responses)	85%	(20)	82%	(17)
Lease favorable (6 or fewer strongly positive responses)	71%	(28)	39%	(18)

Note: Chi-square for least favorable group (with Yates' correction) = 3.53; $.1 > p > .05$; 1df; (without Yate's correction = 4.7; $.05 > p > .04$; 1df.)

What seems to be happening here is that researchers who are favorable toward interdisciplinary research need no additional push to engage in it; whether or not they perceive their problem as socially relevant, their commitment to an interdisciplinary approach is great enough to lead the vast majority of them (more than 80%) to report employing such an approach. Among the less favorable, however, the perceived social relevance of the project seems to provide an additional stimulus, and despite their unfavorable attitudes toward interdisciplinary research, those scientists who view their projects in the context of a social problem are more likely than those who do not to report their work as being interdisciplinary.

Why should this be the case? Although it is just speculation, it may be that a project's relevance to some wider social problem brings workers on that project into contact with others who are also concerned with the same social problem, but from different perspectives. This contact need not necessarily be face-to-face; it may occur via publications, or word-of-mouth. But the effects of the social-problem definition may be to broaden the individual researcher's intellectual horizon, and make him more open to the work of others in the same social problem area, even though it falls outside of his particular scientific problem area.

Summary

Research into the sociology of science has demonstrated the effects of the social organization of scientific work on the topics chosen for research [12], and the effects of changing scientific conceptions on the choice and definition of research problems [13]. The present analysis has shown that the organization of the scientific project is also affected by non-scientific factors such as the prevailing definitions of social problems in the wider society in which the scientist is working. In the case studied, the researcher's tendency to define his problem as socially relevant was related to his tendency to describe the organization of his research as interdisciplinary. Assuming that this correlation is not an artifact resulting from some more general attitude, the finding suggests that success in organizing interdisciplinary research depends not only on the favorableness of researchers toward such arrangements, but also on the connection which the researchers perceive between the scientific problem on which they are working, and some social problem to which it is potentially relevant. The more that scientific problems are defined as socially relevant, the less basis there is for restricting research into such problems to the confines of individual disciplines.

It is possible to imagine other areas of research in which a definition of their subject matter as relevant to social problems can have effects similar to those found here.[11] The existence of such effects provides additional evidence of the close connection between scientific endeavor, and the "social climate" in which it is carried out.

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[11] e.g., the controversy over racial differences in intelligence; safety factors in automobile design.

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