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by

Todd R. La Porte and James L. Wood

Internal Working Paper No. 106

September, 1969

UNIVERSITY OF CALIFORNIA, BERKELEY

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This research was supported in part by the National Aeronautics and Space Administration under General Grant #NGL 05-003-012 under the University of California.

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One of the central concerns in modern social science is the examination of conditions under which various types of social systems maintain their existence.[1] As industrialized society developed, the complex formal organization emerged as a pervasive and important type of social system whose maintenance has been widely studied. The development of complex organizations was paralleled by a more recent characteristic of modern society, the rapid professionalization of these complex organizations.[2] The dual problems of systems maintenance and the relationship of professionals in complex organizations are closely related for the organizations that are the object of this study, i.e., large scientific research organizations, probably the most professionalized of modern organizations.

The complexity of goals in scientific organizations often requires technically educated personnel to achieve them. It is clear that major technological activities, such as the space program and the development of atomic power, require highly skilled scientists and engineers working in large-scale organizations. It is also apparent that technically educated individuals are drawn to seek employment in large bureaucracies due to the availability of resources and facilities there. Thus, reciprocal needs exist between many technical professionals and complex organizations.[3]

This report is informed by a view of social systems generated from the tradition of Parsons and modified by others as it has been applied to

formal organizations.[4] It assumes that organizations are "open and partial systems" related to the social structure surrounding them in various degrees of interdependence. Organizations are partial in the sense that, unlike organic structures in which elements of the system are joined continuously together, members of organizations are only partially integrated into the social network, entering and leaving in the course of the day, having other commitments, etc. We also assume that all interaction involves exchange relationships between individuals and groups which attempt to attain some form of equilibrium.[5] Parsons and others have asserted that all social systems must solve four problems in order to maintain their existence: adapt to changing situations, accomplish some level of goals, provide for the integration of members, and deal with internal tensions and latent pattern maintenance.[6] Applied to research organizations, this means that they must gather resources, fulfill organizational goals, unite quite different roles, and ensure the attachment of members to research and organizational values. In each case, the processes and procedures employed by the organization, represented by managers, affect the professional in achieving his own values and in interacting with others in the organization.

This paper examines the extent to which two activities used by professionals to shape their immediate work situation contribute to solving these four functional problems, and affect professional relationships with the organization. These two "enabling mechanisms" are "bootlegging" and "entrepreneurial" activities. Bootlegging is engaging in research projects not formally specified in the contract or grant funding the organization's work. Entrepreneurial activity is the attempt to gain resources

for the professional's project. Both of these activities are familiar tactics which permit scientists to carry out research of personal interest within the constraints of large, complex organizations.

Although professionals and organizations can meet each others' needs to a certain extent, there are also conflicting interests between them.[7] The scientific role, for instance, includes an obligation to pursue knowledge as a goal in itself.[8] The employee role, on the other hand, includes an obligation to achieve organizational goals.[9] To the extent these two types of goals diverge, we can expect strain and conflict to appear. A number of studies suggest that the goals and obligations of these various roles are somewhat incompatible. As a result, it may be difficult for an individual to play both roles effectively.[10]

Even though evidence indicates that the goals of scientists and managers are potentially conflicting, there is also evidence suggesting that this potential conflict does not often reach explosive proportions and can be kept at a manageable level.[11] At least it is not often general enough to result in large-scale breakdown of technically based organizations. Nevertheless, it is clear that potential antagonisms do exist between an individual's role as professional and his role as organization member. And the consequences of these antagonisms can seriously affect efforts to solve the continuing problems of integration, adaptation, goal attainment, and pattern maintenance.

As potential difficulties in carrying on either organizational or research activities are recognized, various mechanisms of adjustment to strain are likely to develop.[12] In research organizations, for example, such mechanisms are promotion of professionals to managerial positions,

manipulation of incentives and rewards, recruitment and displacement of professional members, division of potentially conflicting roles into separate and non-interactive units, and socialization of the professional to organizational values through formal or informal training programs. Two other mechanisms, bootlegging and entrepreneurship, can be carried on by the professional to counter organizational pressures to do less professionally salient work.

In general, when a person is confronted with a situation in which he expects to experience certain valued conditions and does not, he is likely to search out ways of reducing the difference between his expectations and experiences. This may be done by changing his expectations so they more nearly correspond to his experience. However, if there is strong reenforcement for his expectations, such as professional values sanctioned by long education and an active scientific community, the person is likely to attempt to change his situation and reduce the discrepancy between expectation and experience. In this paper we assume a strong sense of professional support for scientific values and the conditions thought necessary to realize them.

Entrepreneurial and bootlegging activities are both behaviors that can alter the scientist's immediate work environment.[13] First, by attempting to gain support for his work from inside or outside the organization, he reduces his dependency on managers and increases the likelihood of sufficient resources; and second, by engaging in research activities which are self-defined, even if they are not formally specified in the organization's contract or grant, he changes the conditions of his work.

It is our central hypothesis that opportunities to engage in either of these activities result in significantly higher levels of professionally valued experience. In addition, we predict that engaging in these activities helps solve the four functional problems of research organizations, especially the problem of integration.

Method

Data were collected from three large-scale research organizations, an industrial research laboratory (IRL), a non-profit university laboratory (NUL), and a military defense laboratory (MDL).[14] Each employed approximately 4,000 people, and they were engaged in roughly the same technologies. Informal as well as formal interviews were carried out with scientists, engineers, technical managers and business-type administrators. A non-proportional stratified random sampling procedure was employed for the selection of the sample, which was given a formal questionnaire. The same questionnaire was used in each organization with minor modifications to account for different terminology among the laboratories. The primary concern of this paper is with scientists in different organizational settings, although occasional reference will be made to engineers for purposes of comparison. The number of useable scientist questionnaires in the three organizations was 117, 109, and 81, respectively.

Findings

The data taken from the three research organizations are analyzed in terms of the degree to which opportunities to engage in one or the other of the two enabling activities appear to contribute to solving four functional problems. In addition, evidence of the probability that this reduces

role strain and conflict are discussed below within the context of organizational integration.

Organizational Integration. One of the major problems which organizations as social systems must continually address is the integration of its members. This involves providing the necessary requisites to assure cooperative relationships between the occupants of major roles within the system.[15] In research organizations, this means, at least, maintaining cooperative relations between scientists and managers. In spite of differing interests, these two groups must blend their various activities into a coherent process for the organization to perform the delicate activities of research and development.

A good deal of the literature on research organizations seems to deal with this particular problem.[16] This suggests that the problem of integration is one of the fundamental concerns for this type of organization. It is quite probable that in organizations with highly differentiated internal role structures occupied by highly specialized professionals integration receives more attention than in less differentiated and specialized organizations. Integrative efforts and conditions seem clearly necessary for the symbiotic relationships between scientists and managers to be carried out effectively. However, since their relative interests are not the same, role strain and conflict may be expected to occur.

Of the several types of integrative problems organizations face, this paper deals with only two, i.e., role strain and role conflict. Role strain occurs when a role occupant has "difficulty in meeting role demands,"[17] whereas role conflict refers to a struggle between incumbents of two or

more roles.[18] Role strain is concerned with an individual's inability to easily meet competing demands from two or more roles he occupies, e.g., as in our case of scientist and organizational employee. On the other hand, role conflict refers to a struggle between individuals who are incumbents in two different roles, e.g., between scientists and managers over the type of research work to be done.

Role Strain. The traditional view of scientists sees them engaging in the pursuit of knowledge for its own sake.[19] However, their inclusion in formal organizations means that they also have obligations as employees. Organizational obligations tend to be more immediate and overt than scientific ones, and are directly related to organizational needs. For example, an organization's mission, hence obligation, may be to develop a highly reliable launching system for a lunar orbitor. In comparison, a scientist may see himself having an obligation to work out a complete theory of metallic structures under conditions of extreme heat and cold. While these may be related activities, they are also likely to be defined in quite different ways by the two role occupants. Scientists do not always recognize that they are faced with dual sets of obligations held with equal intensity, although many of them do become aware of this as they have extended experience in non-academic laboratories. This dual set of obligations can easily be the source of role strain for organizational scientists when the obligations are contradictory and when it is difficult to carry them out simultaneously.

In addition, Kahn has pointed out that role strain tends to impair the employee in performing his role, and in relating to others around him.[20] In fact, it can greatly reduce the effectiveness of many organizational

activities when levels of role strain are sufficiently high. As a result, managers attempt to reduce the strain on the employees by changing their expectation to be more in accord with organizational demands, through job classification and testing, re-organization, distribution of rewards, in-service training, etc. Other mechanisms are employed by professionals in their attempt to reduce the effect of organizational demands as a source of strain.

Bootlegging and entrepreneurial activities both aid scientists in working out projects of their own interest. These are devices which rather explicitly acknowledge the potential strain and conflict between professionals and managers, and they are aimed at permitting scientists to fulfill both their professional and organizational obligations. Opportunities to engage in these activities enable the scientist to pursue his own work without leaving the organization. If he is able to employ one or the other of these devices, it is more likely he will be able to alter the constraints he feels either in doing the kind of work he values, or in providing resources so he can do that work. In either case, the scientist's organizational position is not as great a source of contradictory demands to him; hence the sense of strain would diminish.

Both the concepts of role strain and role conflict are abstractions and must be operationalized for particular organizations and circumstances. We have included six different conditions representing those experiences associated with scientific professionalization including: contributing to scientific knowledge, freedom in selecting the project you work on, freedom from day-to-day supervision, opportunity to publish research findings,

promotion as a researcher, and doing predominantly basic research work. It was our expectation that engaging in one or the other of the two enabling activities would be associated with high probabilities of scientists experiencing what they valued (i.e., these six conditions).

Table 1 presents the analysis of data. It was constructed by first eliminating all those scientists who did not particularly value the item. If there is no particular value attached to a condition then it is not reasonable to assume that anything will be done to increase the frequency of experiencing it. Then we asked, to what degree does each of the enabling activities appear to change the probability of experiencing what is valued. For example, if there was no effect of bootlegging on the opportunities to contribute to scientific knowledge, then there should be little difference in probability of experiencing that opportunity between those who have frequent opportunities to bootleg and those who do not.

(Table 1 about here)

A straight comparison of those who can engage in either of these activities and those who cannot shows all but two comparisons in the predicted direction, although some differences are very small. However, there is very small chance of falsely asserting the hypothesis to be true. Using the binomial distribution test, with a 1/2 chance in each observation of validation, 34 out of 36 returns, a $Z = 5.13$, $p > .00003$.[21] In general the hypothesis seems to be supported, but there are quite dramatic differences within the comparisons. If a simple X^2 analysis were used, far fewer items with significant distributions are found. This suggests that, as one

Table 1

Enabling Activities and Role Strain
Probabilities of High Expectation Met

Source of Strain:	ORGANIZATIONS											
	IRL				NUL				MDL			
	Bootleg		Entrep.		Bootleg		Entrep.		Bootleg		Entrep.	
Frequent Opportunity:	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
1. Contribute to Scientific Knowledge	.93 (68) ++	.71 (15)	.96 (69) ++	.68 (17)	.99 (81) ++	.56 (10)	.98 (52) ++	.83 (40)	.86 (54) ++	.46 (5)	.91 (43) ++	.63 (19)
2. Select own Research	.71 (50)	.47 (8)	.77 (53) ++	.32 (6)	.90 (66) ++	.09 (1)	.88 (43) +	.67 (24)	.65 (34) +	.22 (2)	.78 (28) ++	.33 (9)
3. Free From Daily Supervision	.89 (66)	.85 (17)	.89 (65)	.88 (21)	.95 (77) ++	.62 (13)	.93 (53)	.83 (38)	.89 (49)	.78 (7)	.93 (37)	.77 (20)
4. Publish Findings	.97 (72)	.90 (17)	.97 (69)	.92 (23)	.97 (70) ++	.72 (13)	.94 (46)	.91 (38)	.95 (55)	1.00 (11)	.98 (41)	.90 (26)
5. Professional Promotion	.82 (56)	.71 (15)	.86 (57) +	.64 (16)	.73 (45)	.63 (12)	.77 (34)	.61 (23)	.74 (43)	.70 (7)	.88 (35) ++	.55 (16)
6. Does Primarily Basic Research*	.48 (42)	.27 (7)	.45 (38)	.43 (12)	.89 (75)	.81 (17)	.84 (47)	.92 (46)	.48 (31)	.15 (2)	.48 (23)	.31 (10)

\+ Indicates X^2 significant $p > .05$
++ Indicates X^2 significant $p > .01$
* This item is not a report of expectation met, rather of those scientists reporting actually carrying out primarily basic research work.

might expect, the enabling activities have differential effects in reducing strain among various valued conditions. It also appears that this is true between the organizations as well. If, however, the number and degree of significant differences using X^2 analysis can be an indication of intensity of effect, it is clear that the two most prized conditions in scientific professional work are strongly affected by opportunities to engage in either of these activities. Perceived opportunities to contribute to scientific knowledge and to select one's own research projects are much greater for those who engage in either of the two enabling activities. In other words, those who had opportunities to seek resources and bootleg also perceived greater freedom to select their research and contribute to scientific knowledge. Freedom from supervision in day-to-day conduct of research, opportunities to publish and research promotion all appear to be at least moderately affected by enabling opportunities, with publication opportunities the least affected.

The final item used as an indicator of role strain was the degree to which scientists were engaged primarily in doing basic research. Presumably, this is required for scientists to have a feeling that they are able to contribute to scientific knowledge. However, comparing the percentage of scientists in each organization who reported opportunities to contribute to scientific knowledge with the percentage doing primarily basic research work shows that there were apparently many other opportunities to contribute to scientific knowledge, even when the scientist was not engaged mainly in basic research. For scientists in all three organizations, then, these enabling mechanisms seemed to play a role in permitting basic research activities in organizations primarily concerned with applied research. This suggests that there were conditions in each lab, presumably encouraged by

managers, who on the face of it were sensitive to the values of scientists and allowed for their satisfaction.

Role Conflict. A closely related integrative problem research organizations face is the conflict between roles.[22] In this case scientists and managers are seen to have potentially differing or conflicting views of what activities scientists should perform. The emphasis for role strain was intra-personal, i.e., the same individual had contradictory obligations from his differing roles. An emphasis on role conflict sees the manager in inter-personal relationships with scientists, due to his responsibility for scientists performing organizational duties. Both types of integrative problems refer to the scientist attempting to maintain a professional identity in the face of bureaucratic constraints. Thus we can expect the enabling mechanisms to operate in a roughly similar manner for role conflict as they did for role strain.

(Table 2 about here)

In Table 2 the data for three indicators of potential role conflict are summarized. The first pair of items, frequent consultation from managers about decisions that affect scientists' work and organizational recognition by name for research accomplishments, are quite direct indications of regard and notice from management. Statements of satisfaction by scientists with their immediate supervisors refers to a condition which summarizes the overall perceived adequacy of the relationship of the scientist with his immediate manager. Presumably if a scientist were not satisfied with his manager this would be an indication of conflict between them.

The overall pattern of data provides support for the hypothesis. Out of 18 observations some 17 are in the predicted direction ($Z = 3.77$,

Table 2

Enabling Activities and Role Conflict
Probability of High Expectation Met

Source of Conflict	ORGANIZATIONS											
	IRL				NUL				MDL			
	Bootleg		Entrep.		Bootleg		Entrep.		Bootleg		Entrep.	
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Consulted by Manager	.60 (43)	.48 (10)	.66 (49) ++	.29 (6)	.45 (28)	.35 (6)	.58 (26) ++	.23 (8)	.57 (29)	.46 (5)	.69 (25)	.40 (10)
Organization Recognition	.84 (53)	.71 (12)	.90 (56) ++	.53 (10)	.75 (47)	.71 (10)	.86 (37) ++	.59 (20)	.87 (34)	.78 (7)	.96 (26)	.71 (15) +
Satisfaction with Immediate Supervisor*	.58 (50)	.65 (17)	.64 (54)	.54 (15)	.66 (55)	.59 (43)	.73 (41)	.54 (27)	.83 (54)	.54 (7)	.79 (38)	.75 (24)

* Data for this item does not include a control for high expectation. Percentages indicate proportion reporting high satisfaction.

\+ Indicates X^2 significant, $p > .05$

++ Indicates X^2 significant, $p > .01$

$p > .0001$). However, a closer look shows that when the X^2 indication of intensity of effect is used, bootlegging activities are far weaker than entrepreneurial ones. This is probably to be expected because bootlegging is an illegal activity in the main and hence likely to receive less management notice than seeking funds for work.[23] Entrepreneurial activity does, indeed, have a strong effect, particularly in the two items of direct indication of role conflict between scientists and managers. Therefore, if increased probability to experience consultation from managers and to receive organizational recognition from managers are indications of reduced role conflict, engaging in entrepreneurial activity is markedly effective in all three organizations.

Our indirect indicator of reduced role conflict between managers and scientists presents a curious data array. In the Industrial Lab bootlegging activities seem to have a slight negative effect, with those who bootleg being less satisfied with their immediate managers. This is reversed for the other two organizations with the Military Lab the most pronounced. Frequent entrepreneurial activities produce results in the predicted direction but more marked in the two labs with the <u>least</u> bootlegging effects. Only weak support for the general hypothesis is derived from these data; however, the data suggest that the context of the organizations may be quite important in explaining the differences. For example, the Industrial Lab has many sources of funds, probably making bootlegging less attractive. One interpretation for this lab could be that if a scientist feels he has to bootleg he does not have enough latitude to do his work without it and hence his manager is not doing the expected job. The other organizations only have one source of funds and

bootlegging may be more necessary in order to gain the desired sense of latitude.[24]

In sum, insofar as the reduction of role strain and conflict are indications of integration within a formal organization, opportunities to engage in bootlegging and entrepreneurial activities appear to contribute to solving the "functional" problem of organizational integration.

Adaptation. A second problem confronting organizations is the adaptation to conditions in their environment.[25] That is, a formal organization faces situations external to it, and generally relates to this external reality in ways that increase the likelihood of maintaining itself. External conditions place constraints on organized action, e.g., by enforcing laws prohibiting exploitive behavior, as well as provide sources of resources required for attaining organizational goals. For research organizations adaptation means, in part, securing resources such as funds, equipment, personnel, authorization and social-political legitimacy in order to carry out research activities.

In the "external reality" of American research organizations, there are a number of institutions from which resources may be obtained; however, the preponderance of resources is available only from the Federal government. And, as in most demand situations, there invariably is a relative scarcity of resources for research. As a result research management and technical professionals often feel the need to "sell" their particular research projects to the government or other sources of funds, such as industrial companies or foundations. Attempting to persuade agencies to support research is the definition of entrepreneurship we have used.

Potential sponsors may be located within or outside of the organization which employs a scientist. When sponsors are outside the organization, the effect of successful entrepreneurship is to give support for the enterprising scientists and raise the resource base for the whole organization. In some organizations, this is clearly expected of technical professionals in order for them to remain in the organization. When the sponsor is located in the organization, the effect of entrepreneurial activity is to alter the distribution of resources for specific research projects. This is generally an informal activity, sometimes falling under the perjorative title of "internal politics." The aim of both inside and outside oriented persuasion of this sort is to secure resources to carry out goal-directed activities. Only outside entrepreneurial activity, however, is likely to aid the organization in adaptive problem solving, and this is the focus of this section.

In attempting to answer the question of how engaging in either of the enabling activities aids in meeting the problem of adaptation, we shall deal exclusively with adaptation in the resource adequacy sense.[26] One indication of adaptation is the perception by members of the organization that they experience adequate resources. Whether it is "really" adequate is always partially a matter of subjective judgment keyed to what the member, manager, or professional, believes is the adequate level of resource for him to contribute effectively. In this sense we are paralleling W.I. Thomas' dictum, "If men define situations as real, . . . they are real in their consequences."[27] If scientists think resources are adequate, they are very likely to be adequate. In research organizations functional adequacy is a most thorny matter.[28] It must be keyed to "adequacy" for accomplishing research goals. . .who is better able than scientists to report this?

Entrepreneurial activities are most likely to be directly related to obtaining funds for research and used for salaries and purchase of equipment; indirectly they are related to authorizations for hiring technical personnel to assist scientists. Each of these resources is an important aspect of conducting research. In general, we expected that frequent opportunities to engage in entrepreneurial activities would increase the perceived adequacy of research resources and hence indicate partial assistance in dealing with problems of organizational adaptation.

(Table 3 about here)

Table 3 summarizes the data for the three organizations and shows, in general, moderate support for the hypothesis. Eight out of 9 observations are in the predicted direction, although the levels of intensity are mixed. The industrial lab is clearly the best example of apparent entrepreneurial effect. The greatest differences in perceived adequate resources for those with frequent opportunities for entrepreneurial activity are evident there. In the other labs, however, while showing moderate to small differences in the predicted direction, the effect is not particularly strong. This suggests that there is a substantial difference in the character of the "external reality" of the three organizations prompting these variations. As we suggested above, one of the most probable differences may be the number of expected sources of funding among the three organizations. The IRL has a number of potential sources of funds from several government agencies. This is not the case for either of the other labs; both are largely dependent upon a single government agency. Plausibly, the more possible sources of support, the more effect entrepreneurial activity may have.

Table 3

The Effect of Entrepreneurship
On Perceiving Adequate Resources for Research

	ORGANIZATIONS					
	IRL		NUL		MDL	
	Entrep.		Entrep.		Entrep.	
Resources	High	Low	High	Low	High	Low
1. Report of Sufficient Research Funds	51% (43)	32% (9)	79% (45)	70% (35)	94% (45)	58% (18) +
2. Report of Adequate Technical Assistance	66% (56) +	41% (11)	52% (28)	52% (26)	64% (30)	62% (20)
3. Report of Adequate Laboratory Equipment	63% (53) +	41% (11)	89% (48)	79% (38)	94% (44)	88% (28)

+ Indicates an X^2 significance, $p > .05$.

The relationship of entrepreneurial activity and different resources is also mixed. Its relationship to funding is most clear cut, but for the other resources the effect seems to be most evident in the industrial multi-source organization. It can be argued that the process of obtaining funds is significantly different from obtaining either technical personnel assistance or equipment, and the organizational context is likely to be more constraining in these latter two than for funding from outside. Since personnel and equipment acquisition is probably a two-step process, i.e., first obtaining funds, then using them for purchase of equipment and hiring people, variations due to administrative policy are likely to be more evident. In sum, seeking outside resources is only moderately effective in aiding organizations in their adaptive efforts. The context of the funding relationships and administrative policy may be important intervening conditions altering the effectiveness of the entrepreneurial activities of technical professionals in obtaining resources.[29]

Goal-attainment. Another major problem faced by formal organizations is the attainment of goals -- the given ends of the organization. Some utilitarian analyses of organizations tend to focus almost exclusively on the accomplishment of goals, e.g., the maximization of profit, maintaining police protection, serving welfare recipients, etc. This is viewed as the only really "interesting" aspect of organizational life to examine. However, a more functionally-oriented analysis views attaining goals as one of several major tasks an organization must fulfill in order for it to continue gaining support from its environment.

There are various levels of abstraction in approaching the study of organizational goals, and our discussion will emphasize the more con-

crete goals of research organizations. Some of the more important goals of research organizations are fostering basic scientific discoveries, solving problems of immediate concern to the sponsors of the organization, and communicating scientific discoveries to the scientific community. Due to limitations of data and measurement, only the latter goal is discussed in this paper. Our focus is on the effects of the enabling activities in attaining organizational goals insofar as communicating through scientific publications is an organizational goal.

Table 4 summarizes the data relating bootlegging and entrepreneurial activity to number of publications based on research in each laboratory. A review of this table shows a relatively strong relationship between bootlegging and number of publications. This is not the case for those who had frequent opportunities to be entrepreneurs. It should be kept in mind that bootlegging is rather direct work on research projects not formally sanctioned by the organization's contract and is considered somewhat "illegal."[30] This suggests that those who have opportunities to bootleg are more likely to work on projects they are interested in and to do work of publishable quality. The relationship between bootlegging and publication is not direct. Rather, we suspect it enables scientists to work on things <u>they</u> define and hence are likely to feel of substantial interest to the scientific community of their peers. If this is the case, we could expect that they would attempt to publish the results in hopes of garnering the accolades of those other scientists whose opinions they value. The data suggests this is the case; in fact, of those who cannot bootleg, nearly 50 percent in each of the organizations have no publications at all.

Table 4

The Effect of Accommodating Mechanisms on Number of Publications

Publication Level	ORGANIZATIONS											
	IRL				NUL				MDL			
	Bootleg		Entrep.		Bootleg		Entrep.		Bootleg		Entrep.	
	High	Low +	High	Low	High	Low	High	Low	High	Low	High	Low
6+ Papers	22% (19)	8% (2)	22% (19)	7% (2)	21% (18)	9% (2)	19% (11)	20% (10)	23% (15)	15% (2)	23% (11)	19% (6)
3-5 Papers	28% (24)	12% (3)	25% (21)	25% (7)	31% (26)	23% (5)	30% (17)	28% (14)	29% (19)	23% (3)	31% (15)	25% (8)
1-2 Papers	24% (21)	31% (8)	25% (21)	29% (8)	24% (20)	18% (4)	25% (14)	20% (10)	23% (15)	15% (2)	21% (10)	25% (8)
No Papers	26% (23)	50% (13)	28% (24)	39% (11)	24% (20)	50% (11)	26% (15)	32% (16)	25% (16)	46% (6)	25% (12)	31% (10)

+ Indicates a X^2 significance, $p > .05$.

(Table 4 about here)

It seems clear that the opportunities to "go illegal," or bootleg, contribute to the attainment of individual scientists' research goals as they work in complex organizations. How this attainment of individual goals is related to organizational goals is still in question. For a variety of reasons, individually related activity such as bootlegging has a number of positive organizational consequences. It is apparent that research findings which are of interest to a particular scientist can also be of interest to the organization. Other studies have shown that companies which permit basic research (generally the type that is of publishable character), have a greater chance of goal attainment in the long run.[31] Remembering that one of the primary goals of research organizations is the contribution to scientific knowledge, opportunities to bootleg appear to facilitate this goal.[32] They also enable a scientist to work on unexpected turns of scientific development unforeseen at the time of contract formalization.

Of much lesser importance to this aspect of goal attainment is entrepreneurship. Table 4 shows that there is little or no relationship between entrepreneurial activity and publication. The only organization which even indicates a slight relationship is IRL. In this organization the scientists often must seek resources for their research, and the successful entrepreneurs seem to improve their chances at conducting and publishing research. Thus it could be argued that having sufficient resources constitutes a limiting, or necessary, condition for attaining

goals, but that other factors such as bootlegging seem to play a greater role in separating the high from low producers.

In sum, the two enabling activities have a quite different effect in their contribution to goal attainment as we have discussed it. Opportunities to engage in non-formal research, or bootlegging, appear to have a definite effect in meeting this aspect of goal attainment. Entrepreneurial opportunities do not. It is curious that apparently managers may find it to their advantage in the long run to tacitly encourage essentially illegal activities in the narrow sense in order to provide an enabling environment for producing scientists.

Latency. Finally, complex organizations confront the problem of latent pattern-maintenance and tension reduction, abbreviated as latency.[33] Among the various patterns which must be maintained and renewed are the patterns of organizational values, for without a relatively high degree of common values regarding the objects of commitment the survival of the organization in form recognizable by past members is unlikely. It is a problem that calls for structural supports encompassing numerous conditions which re-enforce desired values.[34]

For research organizations the maintenance and renewal of values means ensuring a commitment to the values of research and organizational values. Value commitments are by no means automatic, especially those clearly related to organizational objectives. Professional scientists, mainly committed to scientific values learned during the extensive socialization of post-graduate education, often feel thwarted in meeting the rigorous standards of their profession when they must also deal with the

demands for speed and economy characteristic of most organizations. In many situations, scientists have been made to feel that they are required to opt for one set of values or the other. Managers are often aware of this dilemma faced by scientists and employ various mechanisms to reduce it, such as equivalent promotion scales for both administrative and research positions.

As we complete our examination of the effects of our two enabling activities, our interest is in the degree to which they aid in supporting the basic values of the organization and research, and reduce tension. We expected that these mechanisms, as well as the obvious mechanism of organizational socialization, would have some positive effects in dealing with the latency problem. Our data include several direct and indirect indicators of commitment to organizational and research values and a more removed item dealing with general satisfaction. Table 5 summarizes these data.

(Table 5 about here)

There is some support for the conclusion that the enabling activities increase the attachment of scientists to organizational values. In terms of the most direct indication of commitment to organizational values, i.e., high obligation felt by scientists toward organizational goals, we see a recurring pattern from our analysis above. Entrepreneurial activities were strongly associated with felt obligation in the industrial laboratory, and bootlegging activities make a less dramatic difference in the military lab, with the nonprofit lab about midway between the other two. This pattern is repeated with greater intensity for the indirect indicator of

Table 5

The Effect of Accommodating Mechanisms on the Latency System-Problem

	ORGANIZATIONS											
	IRL				NUL				MDL			
	Bootleg		Entrep.		Bootleg		Entrep.		Bootleg		Entrep.	
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
1. Expect to Work for Same Organization in 10 Years	54% (44)	68% (17)	64% (51) +	38% (10)	75% (55)	72% (13)	84% (42) +	64% (27)	83% (49) +	54% (7)	82% (37)	69% (20)
2. High Obligation Felt Toward Organization	41% (36)	38% (10)	48% (41) +	14% (4)	49% (40)	54% (12)	59% (33)	39% (19)	60% (39)	46% (6)	54% (26)	56% (18)
3. High Satisfaction With Job in General	49% (43)	54% (14)	55% (47)	39% (11)	77% (65)	59% (13)	77% (44)	70% (35)	75% (48) +	31% (4)	72% (34)	56% (18)
4. High Importance of Contributing to Scientific Knowledge	85% (72)	88% (21)	85% (72)	89% (25)	99% (82)	82% (18)	93% (53)	96% (48)	98% (63)	85% (11)	96% (46)	94% (30)
5. Primary Identification With												
a) Organization	67% (17)		88% (21)		71% (15)		57% (12)		45% (17)		63% (24)	
b) Profession	60% (52)		67% (62)		81% (67)		52% (43)		63% (27)		57% (24)	

+ Indicates X^2 significance, $p > .05$.

scientists' expectations to remain in the organization for the next decade. In this instance entrepreneurship had greater strength than in relation to the direct indicator. Another indirect indication of organizational commitment was the degree to which scientists feel highly satisfied with their jobs in general. Again, entrepreneurial activity was generally associated with a bit more satisfaction, and for the two labs with only one sponsor, NUL and MDL, bootlegging opportunities also tend to be associated with general satisfaction. A final indicator which directly linked organizational and professional values was a forced-choice item instructing scientists to indicate which they felt primarily identified with, the organization or their profession. Faced with this choice, both enabling activities were associated with organizational identification in the industrial lab, with entrepreneurial activities having less effect in the other two. It should be noted that for all the labs, scientists as a group had only moderate identification with organizational goals or the organization as a whole, however.

These findings suggest that there is some relationship between opportunities to carry on enabling activities and attachment to the organizations, although they have differential effects among the three organizations. Opportunities to engage in those activities which, for a particular organization, were associated with accruing other positive and valued conditions, increased the likelihood that scientists felt able to shape their situation more to their liking. To the degree this is the case, scientists could be expected to feel more positive toward organizational values, seeing less tension between their research values and organizational demands.

The effect of enabling opportunities upon relative attachment to research values is another matter. Our most direct indicator of research value is the reported importance to scientists of "contributing to scientific knowledge."[35] There was little systematic relationship between either of the enabling activities and attachment to scientific values. In each lab, this was relatively high for all scientists and the data analysis is indeterminant. The only indication that either activity might increase the likelihood of attachment to research values is found in the force-choice item already noted, in which bootlegging was somewhat associated with commitment to the profession in the two labs with only one source of funds, NUL and MDL.

It can be concluded that the enabling activities contribute only slightly to the solution of latency problems in these research organizations. This, however, is in only one direction, that of attachment to and satisfaction with organizational values, and does not extend to research oriented values. Parsons and others are probably correct in suggesting that other structural conditions, such as previous socialization, are more important for solving this problem than more immediate day-to-day activities.

Conclusion

In this paper we have examined the degree to which opportunities to engage in two enabling activities, bootlegging and entrepreneurship, contribute to resolving four functional problems asserted by social theorists as crucial for organizational survival. We reasoned that these are the two most direct activities technical professionals can employ in altering their immediate work situation. This provides them with the chance to do those

things which would increase their research effectiveness and make it possible to meet their own expectations without leaving the organization. The assumption is that those members central to the operation of an organization will have at least an intuitive recognition of what is necessary for organizational maintenance. Thus, opportunities to seek funds provides a vehicle for scientists to reduce their immediate scarcity of resources and stimulate visibility to management. Bootlegging, though semi-illegal, provides latitude for professionals to work on technical problems they define whether or not they have formal "sanction" from laboratory management. This may reduce the discrepancy between their research expectations and experience.

In general, the enabling activities contribute most clearly to organizational integration by reducing role strain of scientists, and to a lesser degree role conflict between managers and scientists. They are most strongly related to scientists' frequent experience of contributing to scientific knowledge and the selection of research projects. For other valued conditions, the two mechanisms have less dramatic effects, although they are almost all in the predicted direction. The varied degrees of intensity are very probably due to peculiarities in the various organizational contexts.

There is also evidence that points to contributions to adaptation and goal attainment, and to a slight degree latent pattern maintenance. Contributions to adaptation were examined solely in relation to the adequacy of input resources, funds, personnel and equipment. Entrepreneurial opportunities were clearly related to these in the industrial organization, less

so for the others. Goal attainment contributions dealt exclusively with publication as one of several organizational goals. Bootlegging in general has a stronger relationship than entrepreneurial opportunities. Publication contributes to goal attainment, we argue, on the grounds that complex knowledge is a necessary condition for the success of research organizations, although many of the conditions associated with generating new knowledge are inimical to the interests of managers faced with the problems of control. This knowledge, however, is crucial for the long-term maintenance of these organizations, and, since this is recognized by managers, often leads to a redefinition of the control functions of supervisors.

Contributions to latent pattern maintenance are much more problematic. The most that can be said is that entrepreneurial opportunities seem to re-enforce some attachment to organizational values, with bootlegging contributing to this mainly in the military laboratory. Both enabling activities have indeterminant effects on cleaving to the research value of contributing to scientific knowledge.

Research organizations are forms of cooperative association of an extraordinarily complex nature. The demands of innovative work, both for quality of effort and for new directions, erodes the conditions upon which traditional bureaucratic authority patterns have been established. Punitive sanctions do not often stimulate high quality efforts for very long, nor does management have sufficient information to direct subordinate scientists in detailed ways. Both these conditions suggest that organizational integration is of especially significant moment for effective goal attainment and internal continuity. To the degree both these enabling activities contribute

to integration, it behooves management consciously to consider processes which make it possible to carry them on. In two of the organizations, entrepreneurial activities were not encouraged by managers. There was no official support of bootlegging, though it was tacitly recognized in all three. However, there were apparently ample opportunities in all three for doing either one of the activities. This suggests that management either had not actively sought to establish or had not been effective in preventing them from occurring. In effect, they had absorbed the increments of control loss which is the outcome of undirected research activities and actively seeking outside support in the interests of increased internal integration. Our data do not allow us to determine the degree to which these enabling activities were irritants to managers or how much they resisted efforts of scientists to do either one. Managers who do devote relatively large amounts of efforts in suppressing these activities, by restricting contacts with potential funders or stressing the illegality of bootlegging, may be acting quite unwisely.

One of the major implications of these findings for research management is to devise procedures which at least do not punish scientists for seeking outside support, and to reduce the clandestine character of carrying on work not formally specified in the research contract. When scientists attempt to bootleg or secure resources for their research, they may find it difficult to do so. Although we do not have data measuring attitude changes toward the organization, it is reasonable to expect that scientists' regard for the organization will go down as they receive rebuffs on either count. Difficulty in carrying on entrepreneurial activity can result in

reduced expectation for doing it. This probably leads to increased use of bootlegging as an avenue to more compatible work programs. If this also fails, scientists' frustrations can become acute. One major alternative for them, then, is to leave the organization. On the other hand, if both entrepreneurial and bootlegging opportunities are quite real, scientists can use them to alter their immediate situation, and at the same time contribute to resolving one or more of the central problems of research organizations as social systems.

FOOTNOTES

* This is one of two papers examining the effects of two enabling mechanisms in complex research organizations within the context of a larger study. We would like to express our appreciation to Charles Y. Glock for his comments on an earlier version, to Robert P. Biller and Phyllis L. Stewart for their splendid assistance on the field portion of the study and Judith Stahl Amtzis for her help in data analysis. We gratefully acknowledge the support of the Air Force Office of Scientific Research, Contract No. 49(638)-1028 on a Sub-contract with Stanford Research Institute for support of the field study and the Social Science Project, Space Sciences Laboratory, University of California, Berkeley, under its General Grant #NGL 05-003-012, National Aeronautics and Space Administration.

1. For a discussion of some of the many systems studied in relation to the "problem of order," see Neil J. Smelser, Social Change in the Industrial Revolution, (Chicago: The University of Chicago Press, 1959), pp. 8-9. For this issue specifically in terms of formal organizations, see Chester I. Barnard, The Functions of the Executive, (Cambridge, Mass.: Harvard University Press, 1958, originally published, 1938); and Talcott Parsons, "Suggestions for a Sociological Approach to the Theory of Organizations -- I," Administrative Science Quarterly, 1 (June, 1956), pp. 63-85. See also A. J. Gregor, "Political Science and the Uses of Functional Analysis," American Political Science Review, (February, 1968), pp.

2. See H.M. Vollmer and D.L. Mills, eds., Professionalization, (Englewood Cliffs, N.J.: Prentice-Hall, 1966), esp. Ch. 8; F.C. Mosher, Democracy and the Public Service (New York: Oxford University Press, 1968); and D.K. Price, The Scientific Estate (Boston: Harvard University Press, 1965).

3. General discussions in Vollmer and Mills, op. cit.; W. Kornhauser, Scientists in Industry (Berkeley: University of California Press, 1962); S. Marcson, The Scientist in American Industry (Princeton, N.J.: 1960); and T. La Porte, "Technical Professionals in Complex Organizations: A Structure-Process Perspective, Part I," Working Paper No. 75, Space Sciences Laboratory, Social Science Project (Berkeley: University of California, 1967).

4. Parsons, op. cit.; Barnard, op. cit.; D. Katz and R. Kahn, The Social Psychology of Organization (New York: Wiley, 1966); and J.D. Thompson, Organizations in Action (New York: McGraw-Hill, 1967).

5. P. Blau, Exchange and Power in Social Life (New York: Wiley, 1964).

6. T. Parsons and N.J. Smelser, Economy and Society (New York: Free Press, 1956), pp. 48-85, and Katz and Kahn, op. cit.

7. The literature demonstrating this difference also often includes a delineation of conditions under which the conflict is minimized. See, for example, Kornhauser, op. cit.; Marcson, op. cit.; T. La Porte, "Conditions of Strain and Accommodation in Industrial Research Organizations," Administrative Science Quarterly, 10 (June, 1965), pp. 21-38.

8. For discussions of scientific goals and values, see M. Weber, "Science as a Vocation," in From Max Weber: Essays in Sociology, trans.

and ed. by H.H. Gerth and C.W. Mills (New York: Oxford University Press, 1946), pp. 129-158; and R.K. Merton, Social Theory and Social Structure, Rev. Ed. (Glencoe, Ill.: Free Press, 1957), pp. 537-561; for empirical data concerning scientists' interest in basic research, see T. La Porte, "Conditions of Strain. . .," op. cit., and R. Tagiuri, "Value Orientations and the Relationship of Managers and Scientists," Administrative Science Quarterly, 10 (June, 1965), pp. 52-64.

9. See, for example, E.V. Rostow, "To Whom and For What Ends are Corporate Managements Responsible," in E.S. Mason, ed., The Corporation in Modern Society, (Cambridge, Mass.: Harvard University Press, 1959), pp. 46-71.

10. See Note 7 above and B.G. Glaser, "Attraction, Autonomy, and Reciprocity in Scientist-Supervisor Relationships," Administrative Science Quarterly, 8 (December, 1963), pp. 379-398; and W.M. Evan, "Superior-Subordinate Conflict in Research Organizations," ibid., 10 (June, 1965), pp. 52-64.

11. Tagiuri, op. cit.; La Porte, "Conditions of Strain. . .," op. cit.

12. C. Argyris, Integrating the Individual and the Organization (New York: Wiley, 1964). See also with reference to research organizations, H.M. Vollmer, Adaptations of Scientists in an Independent Research Organization (Menlo Park, Calif.: Stanford Research Institute, 1963).

13. Bootlegging is discussed by D.S. Greenberg, "'Bootlegging': It Holds a Firm Place in Conduct of Research," Science, 153 (August 19, 1966), pp. 848-849; and Kornhauser, op. cit., p. 65. Entrepreneurship is discussed by H.M. Vollmer, "Professional Adaptation to Organizations," in Vollmer

and Mills, op. cit., pp. 275-282. Our definition is more specific than in some other work. See R.A. Peterson and D.G. Berger, "Entrepreneurial Intrusions in Complex Organizations," paper presented to American Sociological Association, San Francisco, California, 1967, for a different definition of entrepreneurship emphasizing the risk-taking aspects.

14. These are fictitious names, of course, though we wish to gratefully acknowledge the enthusiastic assistance of the many managers and scientists who participated in this study.

15. Among many see T. Parsons, et al., Working Papers in the Theory of Action (Glencoe, Ill.: Free Press, 1953); Katz and Kahn, op. cit.

16. Notes 3, 7, 10.

17. W.J. Goode, "A Theory of Role Strain," American Sociological Review, 25 (August, 1960), p. 485.

18. See L.A. Coser, The Functions of Social Conflict (Glencoe, Ill.: Free Press, 1956), p. 8; Kornhauser, op. cit. For a slightly different definition of role conflict, closely related to the phenomenon we label role strain, see N. Gross, R. Mason, and A. McEachern, Explorations in Role Analysis (New York: Wiley, 1958); and R. Kahn, et al., Organizational Stress: Studies in Role Conflict and Ambiguity (New York: Wiley, 1964).

19. Note 8.

20. Kahn, op. cit., Ch. 4.

21. Corrected for continuity. If each activity is treated separately, 17 out of 18 observations for each are in the predicted direction. With a 1/2 probability of validation, $Z = 3.78$, $p > .0001$.

22. Although there is some overlap in the approaches, Kornhauser, op. cit., tends to emphasize role conflict whereas Kahn, op cit., tends to emphasize role strain.

23. In several instances we have been told by managers that "no bootlegging goes on here. It is illegal." There is, however, a good deal of tacit recognition by many managers that it occurs although they generally overlook it, if the scientist's other work is satisfactory. Clearly there is a good deal of bootlegging opportunity in all three organizations.

24. Further analysis examining the effects of varied organizational context is reported in T. La Porte, "Enabling Activities, Professionals' Experience and Resource Relationships: The Efficacy of Entrepreneurial and Bootlegging Activities," Working Paper No. 105, Space Sciences Laboratory, Social Science Project (Berkeley: University of California, August, 1969).

25. Adaptation, in general terms, is " an accommodation of the system to. . .'reality demands.'" T. Parsons, et al., Working Papers. . ., op. cit., p. 183.

26. Since bootlegging is almost exclusively a quite "private" activity of scientists as they reorder their individual work priorities, these activities are not likely to be directly related to obtaining funds. They may, however, result in breakthroughs that can be exploited so as to gain legitimating contracts from outside sponsors; but this is only occasional and indirectly functional.

27. Quoted in R.K. Merton, Social Theory and Social Action, Rev. Ed., (Glencoe, Ill.: Free Press, 1967), p. 421.

28. See Gregor, op. cit.

29. Discussed in La Porte, "Enabling Activities. . .," op. cit.

30. Note 23.

31. Marcson, op. cit., pp. 41-44; Kornhauser, op. cit., p. 62; see also D.C. Pelz and F.M. Andrews, Scientists in Organizations (New York: Wiley, 1966), Ch. 2.

32. See A. Etzioni, Modern Organizations (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1964), pp. 77-78. The problem of the scientists working in bureaucratic organizations is often phrased in terms of pursuing either scientific or organizational goals. We submit that the scientist can often pursue scientific and organizational goals.

33. Social systems are "confronted by the necessity, as a precondition for (their) continued existence of maintaining and renewing the motivational and cultural patterns which are integral to (their) interaction as a system," Parsons, et al., Working Papers. . ., op. cit., p. 185.

34. See Parsons, "Suggestions for a Sociological Approach to the Theory of Organizations -- I", op. cit., pp. 67f; and Smelser, op. cit., p. 11.

35. This should not be confused with the use of perceived opportunity to actually contribute to scientific knowledge. It is the difference between attributing importance to a condition and actually experiencing it.