limitations are essentially the same for both the unperturbed and perturbed stratospheric calculations, it can be assumed that the *differences* between the results for the two cases will be more reliable than their absolute values. Future refinements in the model structure are being planned. These include primarily increased model resolution and incorporation of an enlarged chemical package, so that NO_x distributions can be predicted explicitly. This will permit a greater measure of confidence in the climatological results and should lead to a more detailed picture of the distribution of O_3, both in the natural stratosphere and in a hypothetically perturbed stratosphere.

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Technology Observed: Attitudes of a Wary Public

Supportive of science yet guarded about technology, the public is uneasy about future technological developments.

Todd R. La Porte and Daniel Metlay

The relatively recent prominence given to issues concerning the environment, notably the debate on supersonic transport, and to the so-called energy crisis reflects a growing uneasiness about technological matters among a generally acquiescent public. There no longer appears to be a broad consensus on the automatic benefits of technological development; its consequences are increasingly perceived as problematical. This new situation could affect both scientists and engineers in terms of the legitimacy accorded their work, the limits within which they may do it, and the level of resources made available for it. For even though a direct relationship between public attitudes and the way decision-makers behave is difficult to establish, the public's mood does create boundaries within which officials generally act.

This article presents findings concerning the public's attitudes toward technology and science which suggest that considerable refinement of our past generalizations is necessary. Evidence suggests that (i) the public makes a distinction in their evaluations of the outcomes of scientific work and technological work; (ii) the public's reaction to the impact of technology upon society is one of wariness and some skepticism; (iii) the public applies a rather wide range of sometimes contradictory values to its evaluation of technology; (iv) the public has a distrust of the institutions associated with decision-making in technical policy areas; and (v) a clear element of political ideology is present in the evaluations of technology made by an important segment of the public.

Only recently has there been sufficient evidence concerning potential public uneasiness about science and technology to stimulate systematic attempts to gauge prevailing opinion on these matters. Most commentaries on these attitudes have been largely impressionistic. They note that the "golden age" of science and technology has passed. They agree that the widespread conviction about the inevitable benefits to come from scientific advance (a conviction pointed to as early as 1830 by de Tocqueville as imprinted on the American genius) has been severely eroded. Edward Shils sums up the case (*1*):

> Whereas it was once believed that every new technological possibility was automatically and inevitably beneficial, the great achievements in outer space [among others] have helped to dim the light once cast by technological progress. . . . Science, engineering and technology have all become amalgamated into a single entity which is conceived as a source of damage and costly waste. The research workers, engineers, military men, industrialists, and politicians are seen as homogeneous groups with each section pursuing its own advantage at the expense of the rest of society.

This slackening in public approval has been attributed to a number of factors. Robert Morrison, for example, cites the distrust of the way power holders manipulate the world; the concern over maldistribution of resources; anxiety about the ethical implications of further technological advances in some areas of medicine and the biological sciences; and growing awareness that much scientific research lacks social relevance (*2*). The picture of the public mind presented in such commentaries

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Table 1. Should science and technology be controlled?

Statement*	Strongly agree 1	2	Agree-disagree 3	4	Strongly disagree 5
	Science				
1. Allow studies; obtain future benefits	54.2	32.1	3.8	5.9	4.0
2. Science good, use of science bad	45.9	29.0	5.4	13.5	6.6
	Technology				
3. Control invention and life worsens	14.7	22.5	11.0	29.8	21.9
4. No interference with right to buy justifiable	18.1	26.8	8.3	27.1	19.6
5. Insufficient knowledge for regulation	21.4	25.1	10.8	27.4	15.3

* The full wording of the statements for agreement or disagreement were as follows: 1. Unless scientists are allowed to study things that don't appear important or beneficial now, a lot of very beneficial things probably won't ever be invented. 2. Basically all scientific discoveries are good things; it is just how some people use them that causes all the trouble. 3. Any attempt to control which inventions are widely produced or made available will make our lives worse. 4. No one should attempt to regulate which inventions are produced because it interferes with the individual's right to decide what he wants to buy. 5. No one should attempt to regulate which inventions are produced because they do not know how to do it. All data are expressed as percentages (percent across; $N = 980$). Those expressing no opinion ranged from 1.5 to 2.0 percent for statements 1 and 2, and from 4.1 to 5.6 percent for statements 3 to 5.

is painted in tones of suspicion and guarded pessimism. Cognizant of this decline in the prestige of science, still other writers appeal for circumspection lest negative public reaction lead to "harmful restrictions on all scientific research" (*3*).

But a somewhat different picture emerges from reports of recent work done by public opinion researchers (*4–6*). That the scientific community, and other interested publics, have fallen victim to "quick overgeneralization and grand simplifications as to the scope, source, and direction of anti-science sentiments" (*4*) is the finding of at least two studies (*4, 5*). These reports note that (i) most people feel that science and technology have made life better; (ii) the prestige of scientists and engineers is relatively high; and (iii) there is a high degree of confidence in the ability of science and technology to solve a wide range of social problems. The conclusion invited by such findings is that the American public is generally friendly toward the scientific community and that scientists and engineers may proceed with at least cautious optimism about the public fate of their activities.

That conclusion is predicated on the assumption that the public makes no distinction between science and technology and, further, that if the public generally is friendly toward scientists, then technologists—those who implement technological systems—need fear no animated opposition (*7*). But although a single web of logic and theory undergirds both scientific knowledge and technological implementation, our appreciation of their sociopolitical contexts is not enhanced by attributing to the public at large an implicit melding of their social effects.

Public opinion data do not speak for themselves. What they say depends upon the questions put to them. In the study reported here we sought answers to questions about the "general climate . . . for the development *and use* of scientific knowledge" and about the "choice of ends" to which they are directed (*5*, p. 96). Our findings suggest that the themes of available systematic studies as well as of the more pessimistic impressionistic accounts must be somewhat modified. They also tell us that equally misleading is the charge that those who are uneasy about or hostile toward technology are antirational or anti-intellectual. To accept this claim does nothing to assist in the discovery of what may be behind such antagonisms or to determine whether they are justifiable.

The Study Context

As part of a larger study of technology and social change, we set out in 1972 to probe public opinion on a wide range of technology-related topics. Accordingly, a survey was commissioned to gather information on the perceived importance of technology as a feature of social change; on criteria considered important in technology assessment; on approval or disapproval of 12 specific future technological capacities; on perceptions of technology's effects on the quality of life; and on attitudes toward scientific work as distinguished from technology. Using a multistage sampling design, we interviewed 980 adult Californians.

Since most policies with respect to science and technology are national in scope, the question of the generality of our results should be raised; for strictly speaking "the public" referred to in what follows is the California population. However, that we can have confidence in the generality of the data we collected is indicated by national estimates of demographic characteristics such as age, income, sex, race, and occupational distributions obtained from the 1970 census: these estimates deviate no more, and usually somewhat less, than 4 percent from the California profiles. On only one characteristic, education, do national averages differ significantly from California's. The percentage of Californians (31.4 percent) with at least 1 year of college education is about 35 percent greater than the national average (23.3 percent). This slight skewing of educational distribution extends to our sample as well; 47 percent had at least 1 year of college. This higher education level suggests that Californians in general and our sample in particular may be, on the average, more likely than respondents in a national sample to be informed about science and technology. Over a wide range of attitudes we found no significant difference, however, among groups with different educational attainment (*8, 9*).

Moreover, when we compare our survey to that recently sponsored (*5*) by the National Science Foundation (NSF), several items common to both surveys show a reasonably high degree of correspondence in distributions (*10*). In short, evidence available from indirect indicators concurs that California does not deviate from the rest of the nation in important ways with regard to attitudes toward science and technology. Indeed, since the population of California is nearly one-tenth that of the entire United States and since its economy includes a large proportion of the total scientific and technological work done in this nation, our findings may have greater policy relevance than would be the case for data gleaned from any other single state or region.

Research in public opinion is beset with some formidable measurement problems. The data gathered are "opinions" and as such may be transiently held, possibly changing with time and circumstance. This may be particularly true when the attitudes examined are not central to the person interviewed; such is often the case with the data gathered here. In addition, the opinions measured may not be founded on correct factual information; thus, they can be altered by additional information from educational efforts or other sources. Nevertheless, if we are interested in what the public at large thinks about science and technology, this technique with all its limitations is the only one available.

Table 2. How disenchanted are people with technology?

Statement*	Low disenchantment		Intermediate	High disenchantment	
	1	2	3	4	5
1. To go back to nature desirable	32.3	24.6	8.7	22.1	12.2
2. Life too complicated	24.5	33.3	8.0	24.3	10.0
3. Overdependence on machines	9.2	12.8	5.7	34.3	38.0
4. Technology can solve problems	5.5	10.3	5.2	30.9	48.3

* The full wording of the alienation-confidence statements was as follows: 1. It would be nice if we would stop building so many machines and go back to nature. 2. Technology has made life too complicated. 3. People have become too dependent on machines. 4. People shouldn't worry about harmful effects of technology because new inventions will always come along to solve the problems. All data are expressed as percentages (percent across; $N = 980$). The numbers of people expressing no opinion ranged from 1.5 to 2.6 percent.

Social Perceptions in Technology

Over the past 10 years an increasing volume of work has purported to describe some of the social effects of technology on people's lives, outlook, and values (*11, 12*). Some observers have argued that technology has become the source of disquieting changes in the human condition and that it (and science) is running rampant, beyond control. This argument is perhaps most strongly put by Jacques Ellul in his description of the "technological phenomenon," a pervasive situation where decision-making processes are so structured as to admit of only one outcome —the rather blind, never-ending implementation of new techniques (*12*). If such misgivings were widespread they could provide a milieu in which the control of science as well as technology would be sought. But such a situation hinges on a general public belief that scientific discovery and consequent technological implementation are nearly indistinguishable aspects of a continuous process.

Table 1 presents data related to several aspects of the public's evaluation of the social roles of science and of technology. For the purpose of this survey, we have chosen to define science and technology as follows (*7*): Science is, implicitly, the activity of discovering new knowledge and includes the development of prototype inventions. Technology, on the other hand, is the activity which leads to the widespread availability of products based predominantly on such scientific knowledge. The data show that there was considerable agreement that scientific activities are intrinsically beneficial and should not be controlled, but that the use to which scientific knowledge is put can make trouble. They also demonstrate that the standard defenses of technological autonomy are rejected by a substantial fraction of those interviewed. More people disagreed that regulating technology would affect the quality of life adversely than those who believed it would. Again, more people felt that the advantages of regulating technology outweighed the benefits of a laissez-faire approach. Interestingly, the sample was almost evenly split with respect to judgments about whether or not the regulation of technology was possible. Taken together, these data imply that the public at large does not find the outcomes of scientific activity a problem. Rather it is the outcome of technological implementation that is the source of concern, thereby creating a potential both for the demand and for the expectation that those outcomes should be regulated. A plausible corollary to these findings, somewhat at odds with other survey research, is that if the public came to see science and technology as indistinguishable on the practical level, the very large consensus favoring unregulated scientific activity might diminish rapidly.

Alienation and Confidence

Uneasiness about technology can have a more nearly Luddite character: the belief that further techno-industrial advance will result in net social loss. Expressions of longing for a return to nature or to a more simple life unencumbered by machines typify that troubled attitude as, to a lesser extent, does reduced confidence in technology's power to solve man's problems. People most disenchanted with technology tend to accept these notions. Table 2 presents the pattern of responses to four questions probing the degree to which the "alienated" attitude they convey is held by the public. It shows opinion to be divided on the desirability of returning to a more natural state and on whether life has been made too complicated by technology. While a little over half of those questioned did not agree with those notions, a third of the sample did. Thus, although the typical notions associated with technological alienation did not predominate among our sample, they were accepted by a strong minority.

More clearly evident were attitudes expressing a limited confidence in technology. Strong majorities, over 70 percent, agreed that we had become too dependent upon machines and that it is not sensible to expect technology to develop solutions to problems caused by technological development. These relatively high percentages seem to signal deep wariness about overdependence on or overconfidence in technology as a means for dealing with social problems associated with technological development. Perhaps more significant is the fact that only 5 percent expressed no "disenchanted" sentiments, 70 percent expressed at least two, and 50 percent three or four such notions.

In a sense, the data in Tables 1 and 2 provide evidence that Ellul's vision of a populace enamored with technique and unable to resist technological development for its own sake does not hold for our sample. An undercurrent of skepticism about dependence on technology does restrain wholehearted enthusiasm about its effects, and it is likely that if such skepticism grows, so will pressures for regulating technical development.

Technology, Past Benefits, and Value Criteria

Against this background, what can be said about the public's evaluation of specific existing technological developments? Our sample was asked to indicate whether each of five such developments have made life in general better or worse. The technologies in question were highly visible ones, widely implemented and quite well known to most people: household appliances, automobiles, automated factories, the space program, and atomic weapons. These things formed a measure of respondents' overall evaluation of present technology (*13*).

Figure 1 presents the distribution of this index. It reflects a distinctly positive evaluation of present technology and is consistent with the results of the NSF survey (*5*). The data, therefore, show positive public response to past and present technological development, overlaid with a set of concerns about the more general consequences of that development. This combination of attitudes appears to reflect a tension in values, visible in the priorities held by the public which determine whether a technological development is "advantageous."

Respondents were asked to rank a number of social values—ranging from highly utilitarian values to more humanistic and egalitarian concerns—and to indicate the importance they should be given in evaluating technology's impact. Not unexpectedly there was no strong consensus on what values should be given priority. Yet a relatively high degree of support was expressed for a wider range of priorities than simply the economic values of employment and taxes which are often presented as the basis for decisions on technology-related public policy. Table 3 presents the percentages of respondents indicating what values were considered "extremely" important, as well as the average rank accorded them by the whole sample.

Not surprisingly, the impact of technological development on employment was ranked as the most important consideration, though pollution effects drew the highest percentage of "extremely important" designations. Perhaps the most interesting result is that four of the seven values were believed to be extremely important by a majority of the sample. That the public considers a wide-ranging combination of values to be important criteria for evaluating the consequences of technical development complicates both the activities of technologists and the task of policymakers, for some of these values seem clearly to be in tension. (Notably, neither the importance of the U.S. image abroad nor leisure time struck a particularly responsive chord in the public.)

Thus our data show that a plurality of the public seems to approve of the regulation of technology, that many more desire a wide range of values to be taken into account in its implementation, and that in varying degrees an uneasiness about the social consequences of this implementation is present. Now we ask what level of confidence our public expressed in the technology-related decisions made by its institutions of governance. The degree to which it regards those engaged in decision-making as legitimate provides an approximate answer.

Table 3. What are the important values to be considered in the implementation of technology?

Goal	No. who considered goal of "extreme" importance (%)	Mean ranking	Standard deviation	*N*
To increase employment	60.6	3.00	1.55	933
To reduce pollution	72.3	3.16	1.74	929
To make life enjoyable	47.0	3.33	1.99	929
To reduce taxes	56.3	3.71	1.91	933
To improve the lot of poor people	59.7	3.76	1.69	929
To improve the U.S. image abroad	32.6	5.05	1.71	931
To increase leisure time	17.8	5.96	1.41	929

Table 4. Attitudes and characteristics of the "potential public" for technological politics.

Index	Matrix of association (Pearson's *r*)							
	1	2	3	4	5	6	7	8
1. Evaluation of technology								
2. Confidence in technology	.302							
3. Alienation from technology	−.402	−.349						
4. Effect on standard of living	.273	.279	−.255					
5. Public under-representation	−.311	−.229	.207	*				
6. Party/ideology	−.348	−.256	.358	*	.328			
7. Age	.211	.270	−.289	*	*	−.303		
8. Pollution rank	*	*	−.234	*	*	*	*	
9. Regulate technology	*	*	.300	*	*	*	*	*

* Correlation coefficients below ± .2 and not significant.

Technology and Decision-Makers

Six situations in which decisions are made about how to implement a particular technology were set before respondents (*14*). The respondents were then asked to indicate which of eight actors or institutions would actually have the most (and the least) say in making each kind of decision (*15*). In addition, our respondents were asked to indicate who ought to have the most (and least) say in the same decisions. Estimates were then made of the degree to which the respondents felt that those actors whom they saw as actually making the decisions in these various technical areas were, in their opinion, really entitled to do so. Similarly, the degree to which respondents saw illegitimate involvement in decision processes can be estimated.

The specific results varied somewhat from one decision area to another, but several consistent patterns emerged. (i) Technical experts rated highly; they were seen as exercising legitimately a great deal of influence over decisions in each of the technical areas. (ii) Top government leaders drew considerably less support. Those interviewed perceived government leaders to be involved in all six areas, but in only two, space travel and military uses of space, was their presence seen as warranted. (iii) Business leaders received little or no confidence from our sample. While they were perceived to be influential in four of the six areas, they were not welcomed in any of them. (iv) The public saw itself as the "actor" most entitled to be involved in all decision areas in question. At the same time it saw itself as accorded least access to them—again in all six areas.

These data are consistent with a number of recent findings. Certain Harris Poll results have shown that the public places "a great deal of confidence" in scientists and engineers; the NSF-sponsored study (*5*) indicates that a substantial minority feels that "the degree of control which society has over technology should be increased." And many polls show a significant increase in the public's distrust of all public and private institutions. Apparently the institutions established to represent the values which people want used as criteria in decisions to be made about technology's use have not kept up public confidence. At the same time, technical experts, scientists, and engineers, have been able to maintain it, at least until now, even in the face of apparently substantial mistrust of the technological decision-making processes themselves.

This public confidence seems a signal accomplishment for the scientific and technological communities. It may rest on the public's perception of the technical expert's role as a man of knowledge; he is viewed as competent. Similarly, people's distrust of business and government could be a reaction to what they perceive as the inability of these groups to get things done correctly; what they consider failure on the part of businessmen and politicians to meet public commitments they may attribute simply to incompetence.

An alternative explanation can be found in the distinctions noted by Herbert Simon between factual and valuational premises as components of decision-making (*16*). The ability to render a competent decision requires factual knowledge. A person's knowledge about a decision situation legitimizes his involvement in it; hence, as we have just noted, the trusted stature of technical experts in the public's mind. But valuational elements also are an integral part of any decision process. Advocating certain social values, political and business leaders claim the right to participate in decisions on technological issues. In so doing—in setting goals and establishing priorities—they are expected to reflect the public's value interests; otherwise, they lose that right and their involvement in technological decision-making will begin to be considered invalid. That those interviewed in our survey evinced just such a mistrust of business leaders and government officials opens doubt that these decision-makers were really representing the public's value preferences. At the same time, the public clearly accorded itself legitimacy to participate in decisions on technological matters while feeling far removed from any access to the decision process.

These findings have direct implications for scientists and engineers: (i) As opposing value preferences continue to compete in the decision process, the scientific and technological communities will almost inevitably be drawn deeply into political controversy. Technical experts could be pressed to represent social values as well as to provide factual information for policy decisions (*17*). (ii) That members of the public are seriously disquieted about the existing decision processes related to technological development could result in strong pressure for its public control. (iii) Should that occur, and should the public begin to link scientific discovery determinantly to the negative effects of technology, the relative autonomy of science could diminish.

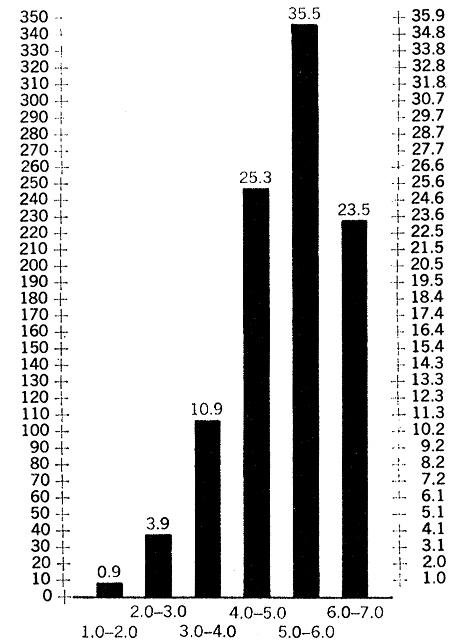

Fig. 1. Frequency distribution of Guttman index of evaluations of implemented technologies (mean, 4.846; variance, 2.100; standard deviation, 1.449).

Technology and the Potential Public for Political Action

Whatever the public's attitudes, they are not likely to become the basis for public policy unless crystallized into articulate demands for change. Efforts to voice demands, to organize pressure for or against policies and political candidates come only from those portions of the general population motivated to action. Those people most likely to become involved in activities calculated to prompt policy action on technology-related matters we shall call here the "potential public" for technological politics (*18*).

Certain aspects of social life seem a priori to make people aware of and interested in policy for science or technology. More highly educated people, people who have voted in past elections, and people who hold jobs closely involved with some type of technology are likely to number disproportionately among the citizenry concerned with such policy. To the extent that the public enters into controversies involving technology, participants and leaders in the debate are likely to come from the segment so described. To the extent that decision-makers monitor public attitudes, they will feel the views of this potential public disproportionately. How then did our respondents feel about the social effects of technological development?

Using the factors noted above, we developed a scale by means of which respondents scoring on its upper half were designated the potential public. Thirty-one percent of the sample (303 respondents) fell into this group. This number represents a fairly substantial proportion of our total sample, probably higher than the putative national figure, because of the higher education level of Californians. Comparison of the potential public with the remainder of the sample showed that the only major differences in demographic and political characteristics were that the potential public was somewhat younger, made several thousand dollars more per year, and on the average had 2 more years of education (about 2 years of college). While the potential public was a bit more "pro-technology" with respect to the variables reported above, the differences were too small to be substantively significant (*19*). In short, the potential public for technological politics is generally similar to the rest of our sample over a wide range of opinion.

A very interesting difference between the potential public and the rest of the sample, however, is the degree to which their attitudes are interrelated. For those not included in the potential public, most attitudes appear to be haphazardly organized. That is, they display no consistent pattern of internally coordinated opinion. But the potential public does exhibit a patterned and cohesive set of attitudes toward the outcomes of scientific work and toward technological activities. While we do not wish to suggest that the attitudes of the larger group are unimportant, its relatively random responses do indicate that it is not likely to be a source of much criticism. The issue area apparently lacks salience for these people. They are therefore likely to be acquiescent to policies governing technology, unless of course they are personally confronted with visible outcomes of such policies or lack of such policies as was the case for gas station owners, truckdrivers, and others during the recent fuel distribution emergency.

Nine indices were used to analyze relationships among this potential public's

Table 5. Regression coefficients from the "potential public," calculated for primary attitudes and other factors.

Index	Evaluation	Confidence	Alienation	Living standard	Representation	Party	Age	Pollution	Regulate	R
Evaluation of technology		.11	−.20	.15	−.16	−.17	*	*	*	.53
Confidence in technology	.11		−.24	.17	−.10	*	.15	*	.17	.49
Alienation from technology	−.18	−.21		−.11	*	.18	*	−.15	.24	.60

* Not significant at $P < .05$. The standard error in all instances ranged from .05 to .06; for regression, $N = 262$.

attitudes: (i) a technology evaluation index, as described in Fig. 1; (ii) an index of confidence in technology, composed of the last two items in Table 2; (iii) an index of technological alienation, in which we used the first two items in Table 2; (iv) an index of an effect on standard of living, indicating the degree to which it was believed that there would be "a decline in the standard of living if there were less technological development"; (v) an underrepresentation index, summarizing the degree of perceived illegitimate exclusion of the public in the decision-making process for three forms of public technology—rapid transit, military technology, and space exploration; (vi) pollution rank, indicating the importance placed on environmental concerns compared with other criteria; (vii) an index of technology regulation, in which we used the last three items in Table 1; (viii) age; and, (ix) a six-point scale combining party and ideological identification ranging from "liberal Democrat" to "conservative Republican" (*20*).

Our primary interests here are those attitudes toward technology which fall into three areas of opinion: (i) attitudes associated with evaluations about specific benefits of present technology; (ii) attitudes associated with confidence or lack of it about depending on technology to solve social problems; and, (iii) attitudes related to a feeling of disenchantment with, or alienation from, some of the general conditions prompted by technology. Such opinions would indicate how the potential public sees specific uses of technology for the near future and what its feelings are about the longer term, broader consequences of technological development.

The data show that the potential public, like the entire sample, was generally positive about the benefits of present technological development: over 65 percent indicated that these developments had been appreciably beneficial, while only 16 percent believed that they had not been. There was much less confidence in the idea that our depending on technology as a solution to present problems is sensible: only slightly over one-third (35 percent) felt quite sure that it is sensible, while almost half (49 percent) felt that it is not. Finally, while the feelings of the potential public did not extend to widespread alienation by the more general conditions prompted by complex technologies, 45 percent reported some sense of alienation.

The first three indices display a consistent set of relations. Table 4 shows that those who regarded present technology as beneficial also tended to express confidence in technology and to hold fewer alienated attitudes. Similarly, those who expressed confidence in the efficacy of technology also expressed less disaffection. Each of these indices had other correlates. Those people who positively evaluated present technologies also tended to believe that technology is necessary for maintaining our standard of living ($r = .273$) and to be less inclined to feel that the public is underrepresented in decisions about government-supported technologies ($r = -.311$). People who gave positive evaluations were, notably, somewhat older ($r = .211$) than those who did not and, probably associated with this age factor, they were relatively conservative politically. The intervening variable of ideology correlates ($r = -.348$) with the positive evaluations. The degree to which our respondents were confident or dubious about depending on technology for solving problems displayed a similar set of associations. For this variable, however, we observe a somewhat stronger relationship with age and a bit less pronounced association with political ideology.

The more general attitudes which we have summarized as a feeling of "alienation"—attraction to the idea of a less complicated and more natural world—were associated with the greatest number of other attitudes. Those who tended to express a disaffection toward technology also tended to put a lower evaluation on the benefits of technological development and to have less confidence in technology as a problem solver. They were also more skeptical about the necessity of technological development for the sake of maintaining present standards of living ($r = -.255$) and were concerned about public representativeness in technological decision-making ($r = -.207$). In addition, their alienation was related to the conviction that the effects of pollution should be more taken into account whenever technological decisions are being made ($r = -.300$) and, perhaps more significantly, to an increasing propensity to consider seriously the need for regulating technology ($r = -.234$). Those tending toward feelings of alienation were relatively young ($r = -.289$). This age factor was probably associated with their partisan and ideological persuasions for they were also preponderantly Democratic and liberal ($r = -.358$). Thus in the potential public a number of attitudes based on judgments about the relationship of technology to economic well-being, on concerns for the environment and for democratic decision-making, and on approval of regulation of technology were consistently related to a more generalized condition of technological dissent.

To complete our analysis, regression coefficients were calculated for the primary factors to determine the proportion of variance explained by the set of attitudes discussed above (see Table 5). Some of the associations considered in Table 4 proved to be dependent upon an intervening variable. Nevertheless, age, political differences, dissatisfaction with decision-making, and value judgments remain important predictors of attitudes toward technology (*21*).

Summary

Our analysis of the interviews with a sample of the California public about a range of their attitudes toward technology shows that a modification of our understanding of the collective state of mind on this subject is in order. The current assessment of the public as largely, and somewhat vacantly, enamored with science and technology does not hold. Nor does a picture of a public generally hostile and alienated by technology. Neither panglossian optimism nor prophecies of doom can be supported by these interviews. Rather a more mixed picture emerges. Out of that picture, a potential public can be isolated, whose mood it behooves science policy-makers to watch. This group tends to associate a number of related conditions with technological development; moreover, it is likely to make assessments on those relationships so perceived.

To the degree this group has "anti-technological" feelings, these feelings are clearly linked to the group's awareness that the social consequences of technology can produce conditions which threaten important values. The particular distribution of age and political identification suggests that those who are young and who identify themselves as "liberal" form the core of potential opposition to technological development and that such opposition is at least in part a function of different value preferences. The associations between political identification and attitudes about technology, distrust of decision-making, and concern for environmental impacts all make this point. In short, "technological dissent" cannot be written off as anti-intellectual and without foundation. It is, in fact, preeminently sensible.

What the alignments visible within the potential public portend for the future is not clear, although they do not allow us to accept an inference drawn from past studies—that because the young retain confidence in scientists and engineers all is well for the general climate of science and technology. We can only speculate whether, as these younger people grow older, they will carry their uneasiness about technology with them. Were they to do so, and were this group to be joined by still younger people who also hold these wary attitudes, the context of scientific and technological work could become much more fraught with political controversy. Another point emerging from our interpretation is how very crucial to continued free scientific inquiry is the distinction between scientific work and technological activities apparently now made by a sizable portion of the public. Should this distinction become lost, perhaps through continual merging of science's role with technology's by the popular press, attitudes now mainly associated with technology could spill over to scientific research as well.

Yet our data also provide evidence of the successes of the scientific and technological communities. They have become such a critical part of life that people are seriously concerned with their future development. The opportunity is present for both communities to find ways of responding to the situation so that thoughtful action can be taken to implement technology for the benefit of the commonweal.

References and Notes

1. E. Shils, in *Civilization and Science: In Conflict or Collaboration*? CIBA Foundation Symposium (Elsevier, Amsterdam, 1972), p. 42.
2. R. Morrison, *Science* **165**, 150 (1969).
3. P. Abelson, *ibid.* **173**, 285 (1971).
4. A. Etzioni and C. Nunn, *ibid.* **181**, 1123 (1973). See also *Science Indicators* (*5*, pp. 96–100).
5. National Science Foundation, *Science Indicators* (Government Printing Office, Washington, D.C., 1973).
6. For a review of other studies relating to public attitudes toward technology, see G. R. Funkhouser, *Public Understanding of Science: The Data We Have*, Workshops on Goals and Methods of Assessing the Public's Understanding of Science (Materials Research Laboratory, Pennsylvania State Univ., 1972); and I. Taviss, *Technol. Culture* **13**, 606 (1972).
7. Our conceptions of science and technology include both the definition of their activities and the people who are mainly engaged in carrying them out. The definitions in both cases are familiar; see J. K. Fiebleman, *Technology, Culture* **2**, 305 (1961); and C. Mitcham and R. Mackey, Eds., *Philosophy and Technology* (Free Press, New York, 1972). The people who animate science are, of course, scientists. Technology is carried out by engineers, architects, physicians, and technical experts of many kinds.
8. Other evidence bearing on the question of educational level and opinion response is mixed. Devine (*9*) reports no systematic differences between high and low educational groups on a range of policy questions, while others do find some differences of opinion [see, for example, S. Verba and N. Nie, *Participation in America* (Harper and Row, New York 1972)].
9. D. Devine, *The Attentive Public* (Rand McNally, Chicago, 1970).
10. In particular, *Science Indicators* (*5*) contains four questions that were designed to probe dimensions which we also examined in our California study: (i) the relative prestige and confidence adhering to a number of professions including business people, scientists, engineers, and national legislators; (ii) the need for increased social control of science and technology; (iii) the benefits of a number of technical capabilities including space exploration, military technology, health care, and mass rapid transit; and (iv) evaluation of present technologies. On the first three variables, both studies uncovered similar attitudes. Small differences are evident, but these could be attributable to method variance or sample error. On the fourth variable, much the same concordance is observable, though the California sample is somewhat less favorable to present technology than is the national sample. But, again, the differences could be due to measurement method: Our study used a scale of questions to measure the respondent's evaluation, while the NSF study simply asked the subject, "Have science and technology changed life for the better or for the worse?" Interestingly, however, if we cross-tabulate response on this variable with such demographic characteristics as race, education, sex, income, and age we find the same general patterns emerging in both studies.
11. See especially Ellul (*12*); H. L. Neiburg, *In the Name of Science* (Quadrangle Books, Chicago, 1966); V. Ferkiss, *Technological Man: The Myth and the Reality* (Braziller, New York, 1969); L. Mumford, *The Myth of the Machine*, vol. 1, *Techniques and Human Development* (Harcourt Brace, New York, 1967); W. Sypher, *Literature and Technology: The Alien Vision* (Random House, New York, 1968). See also, J. D. Douglas, Ed., *The Technological Threat* (Prentice-Hall, Englewood Cliffs, N.J., 1971); M. Brown, Ed., *The New Technology and Human Values* (Wadsworth, Belmont, Calif., 1966); P. Goodman, *The New Reformation: Notes of a Neolithic Conservative* (Random House, New York, 1970); and L. Winner, *Public Policy* **20**, 35 (1972).
12. J. Ellul, *The Technological Society*, translated by J. Wilkinson (Knopf, New York, 1956).
13. While the choice of these technologies was arbitrary we feel that they reflect the variance of opinion concerning technologies and that they are suggestive of the broad notions of technology seen as capability. These presuppositions were supported by the fact that the five items form a well-defined Guttman scale and when factor-analyzed they loaded strongly on a single factor. The scale had a coefficient of reproducibility 0.93, Menzel's coefficient of scalability is 0.67.
14. These included decisions on the regulation of energy consumption, mass public transportation, genetic engineering, data banks, and civilian and military uses of outer space.
15. These were congressmen, executive branch officials, the courts, consumer groups, business leaders, technical experts, the public in general, and no one.
16. H. Simon, *Administrative Behavior* (Free Press, New York, 1957), pp. 45–60. See also J. Thompson, *Organizations in Action* (McGraw-Hill, New York, 1967), pp. 134–149.
17. While this could conceivably occur we do not suggest that technical experts would be more able than any other group to do so with extraordinary effectiveness.
18. Our reasoning closely follows the arguments of those who distinguish between the generally uninvolved public and those who, by virtue of their education or personal association with issues, or both, are aware of them and hence likely to be motivated to act on them. See P. Converse, in *Ideology and Discontent*, D. Apter, Ed. (Free Press, New York, 1964); G. Almond, *The American People and Foreign Policy* (Praeger, New York, 1960); and Devine (*9*).
19. Even an *F*-test was just barely statistically significant at $P = .05$ for many of these variables.
20. The items for each index constructed loaded strongly on only one factor when the principal components solution was rotated to a varimax solution.
21. The most important cases were the relationship of age and party or ideology to technology evaluation and alienation on the one hand and to confidence in technology on the other. In the former case, the relationship has party or ideology intervening between age and the attitude in question. In that instance age does not have an independent effect; it disappears when party and ideology is controlled for. In the latter case, age has an independent effect which remains even after controlling for party and ideology. No attempt was made to develop a causal model because of the likelihood that the three major attitudinal variables are reciprocally related, a condition which would make any causal model underidentified.

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