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Public Attitudes Toward Present and Future Technologies: Satisfactions and Apprehensions

Todd La Porte and Daniel Metlay

During the past thirty years, the United States has witnessed the emergence of massively complex organizations bent on technological accomplishments touching the lives of virtually everyone. The results have been mixed. Remarkable achievements have been won, the direct impacts of which have been astonishing; yet as the magnitude of technology's long-term effects is recognized, there grows an increasing uneasiness about the social, political, and environmental consequences of unbridled technical development.

Some observers have sensed this paradox in technology as a social force, and have eloquently challenged the tendency to accept new

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The data reported in this paper were collected as part of a larger project. This broader study of technology and social change, and of the social assessment of technology, is supported by Ames Research Center, National Aeronautics and Space Administration (Grant no. NGR 05-003-0471). Further support from the International Technology Assessment Program, Institute of International Studies, made the wide scope of the 1972 survey (described in this paper) possible. Support from the National Science Foundation in part enabled us to return to the field in 1974. We gratefully acknowledge the encouragement and assistance of Professors Ernst Haas, Peter Sperlich and William Bicker of the Department of Political Science; Dr. Trievie Tanner, of Ames Research Center; and Mr. Robert Heyer, of the Field Research Corporation (the firm which conducted both the 1972 and 1974 surveys). The staff of the Institute of Government Studies, through which the project was administered, has lent research and editorial assistance; our particular thanks are due to Donald Chisholm and to Mary Fenneman. (All academic units cited are of the University of California, Berkeley.)

technologies simply because they are possible.¹ People in the United States and other advanced industrial societies have begun to reassess unreservedly positive commitments to increased technological development. A number of technological programmes – supersonic transport (the SST), nuclear power generation, fluoridation – have become political issues in the United States. Undoubtedly, the greater part of these emerging disputes will be settled, like most other policy questions in this country, by the interaction of interested elites.

Elite competition is implicitly sanctioned in the expectation that out of it will issue an advance in 'the public good', however imprecisely defined or open to varying interpretation that phrase may be. And in the process of competition, contending elites often take up one position or another in the name of an asserted 'public preference'. Yet, despite the claims of many advocates, we have little information about how the public-at-large views its interests, or about how it evaluates past technological feats and what hopes it holds for future technological development.² This paper presents data on the structure and stability of those attitudes. In particular, it examines:

- (a) the perceived importance of technology as a feature of social change
- (b) evaluations of a range of presently implemented technologies

¹ See especially Jacques Ellul, trans. J. Wilkinson, *The Technological Society* (New York: Knopf, 1956); H. L. Neiburg, *In the Name of Science* (Chicago: Quadrangle Books, 1966); Victor Ferkiss, *Technological Man: The Myth and the Reality* (New York: Braziller, 1969); Lewis Mumford, *The Myth of the Machine*, vol. 1: *Techniques and Human Development* (New York: Harcourt Brace, 1967); Wylie Sypher, *Literature and Technology: The Alien Vision* (New York: Random House, 1968). See also J. D. Douglas (ed.), *The Technological Threat* (Englewood Cliffs, N.J.: Prentice-Hall, 1971); M. Brown (ed.), *The Social Responsibility of the Scientist* (New York: Free Press, 1971); J. G. Burke (ed.), *The New Technology and Human Values* (Belmont, Calif.: Wadsworth, 1966); Paul Goodman, *The New Reformation: Notes of a Neolithic Conservative* (New York: Random House, 1970); and Langdon Winner, 'On Criticizing Technology', *Public Policy*, 20 (Winter 1972), 35-59. (Editor's Note: a wide range of literature is reviewed in R. Williams, *Politics and Technology* [London: Macmillan, 1971].)

² For a summary of the scant information available, see G. R. Funkhouser, 'Public Understanding of Science: The Data We Have', a paper prepared for *The Workshop on the Goals and Methods of Assessing the Public's Understanding of Science*, Materials Research Laboratory, Pennsylvania State University (September 1972), and Irene Taviss, 'A Survey of Popular Attitudes Toward Technology', *Technology and Culture*, 13 (1972), 606-21.

- (c) faith in the efficacy of technology for solving social problems and
- (d) attitudes toward twelve specific technical capabilities which at some future time may be widely implemented.

These opinions are discussed in terms of demographic, social, political, and attitudinal variables.

We shall attempt to demonstrate that:

- (1) People associate technology with significant social changes.
- (2) A rather stable positive evaluation of presently implemented technologies generally prevails, though a potential trend is discerned in which those who had positive evaluations are more frequently associated with certain political ideologies and income levels.
- (3) The public is ambivalent about the utility of technology as a means for resolving a number of social issues.
- (4) With regard to the relative impact of technologies which might be implemented in the future and the probability of their beneficial or harmful effects, the public displays a propensity for making distinctions; further, sharp distinctions in evaluations of future technologies persist over time.
- (5) Some of the current stereotypes of people holding anti-technological views require substantial modification.

DATA BASE AND METHODOLOGY

In 1972, a public opinion survey was commissioned to fill some of the gaps in our knowledge of how the public regards technology. A total of 980 adult Californians were interviewed in their homes for approximately one hour. These people were selected using a multi-stage sampling design which closely approximates a random selection procedure.³

We had hoped, from the outset of the research, to provide at least a partial base line for future study of the effects of technological development upon social and political change. A record of changes in perceptions of technologies over time could enable a more thorough examination

³ Details of the sampling procedure are given in the Appendix at the end of this paper, p. 398.

tion of the character of the shifts in public values and in social and political attitudes associated with various types of technological development. The energy crisis in the winter of 1973-4 offered us opportunity for pursuing that possibility. A second survey was undertaken in the spring of 1974, almost two years after the first. Its design was somewhat more elaborate. We wanted to contact as many as possible of the people who had comprised our 1972 sample, and were able to reinterview 472 (48 per cent) of them. In addition, we interviewed a fresh cross-section of the population - 316 in number - chosen by a sampling design similar to the one employed two years earlier. Because its responses were distributed in a manner almost identical to distributions for the whole 1972 sample, the reinterviewed panel can be assumed to be highly representative overall of that earlier cross-section. Distributions of responses for the reinterviewed panel and for the new, smaller cross-section are also quite similar. Because some differences did arise when bivariate or multi-variate relationships were examined, in this paper we compare only those relationships which we found in the two independently drawn cross-sections. The panel of reinterviewed persons is, however, considered in our examination of attitudinal stability; we believe that it is a relatively-unbiased selection of the 1972 respondents, useful for determining such stability. (Evidence of stability is also derived from the two cross-sections.)

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 this paper is the California population. We have presented evidence elsewhere which supports the proposition that had a national sample been taken in the United States the results would closely parallel those that follow here, at least for the 1972 data.⁴ We have no way of assessing the validity of that proposition either for the 1974 data, or for the magnitude of observed changes. However, since the California population is nearly one-tenth that of the entire US, and since its economy includes a large

⁴ See T. La Porte and D. Metlay, 'Technology Observed: Attitudes of a Wary Public', *Science*, 188 (11 April 1975), 121-27. It should be noted in addition that, as a precaution against disproportionate oversampling of some groups, the N's for the cross sections cited in the statistical work herein have been weighted for age, sex, and geographic location. We can, of course, make no assertion as to the generality of our findings for other industrial countries. See the work of the Centre d'Etude de la Vie Politique Française Contemporaine, *Recherches sur les attitudes de l'opinion publique à l'égard de la recherche scientifique*, document de travail nos. 6, 7, 8, 9 (1972, 1973, mimeo).

proportion of the total scientific and technological work done in this nation, our findings may have greater importance than would be the case for data gleaned from any other single state or region.

PERCEPTIONS OF TECHNOLOGY AND SOCIAL CHANGE

Those who think and write about the relationship between technology and society hold in common the belief that technical developments are central to many of the social and political changes evident over the past half-century. But to what degree does the general public share this assumption? In the 1972 survey, respondents were asked an open-ended question about their perceptions of major changes in society since 1945, specifically:

What are some of the things that have changed the most in the life of the average citizen of this country - things such as social and political movements, our way of life, science and technology, or developments in business and industry?

Almost everyone questioned cited at least one change - 18 per cent noting one, 42 per cent two, and 35 per cent three or more. In all, respondents mentioned 40 kinds of change, ranging from the deterioration of the environment and increased leisure time to space exploration and the increased cost of living. Nearly one-quarter of all the changes cited had to do with technology or science. More significantly, almost half of the people questioned named at least one technological change; over 10 per cent mentioned two or more. Some of the changes mentioned by the respondents duplicated others. For ease of presentation we combined them into twenty-five categories of change, organized within four comprehensive areas, listed in Table 1.

Many of the responses listed in Table 1 are to be expected: changes in life style and in moral standards, increase in the cost of living, and changes in various political customs are things which people experience first hand. Technological advances, too, appear to be quite directly experienced by many people. Changes linked to increased industrialization and to science and technology in general combine for 24 per cent of the total responses. It is noteworthy that a number of specific technologies elicited special comment: the space programme, medicine, transportation, and communications (including television). The degree to which science/technology is associated, in this more or less spon-

Table 1. What Are the Important Changes in Society Since 1945? (1972 survey)

<i>I. Social Changes</i> (56.9% ^a n = 556)	
1. Changes in life style generally and among the young	21.7% ^b
2. Improvements in education, interpersonal relations, leisure time	10.9
3. Life less settled; more pressures	8.9
4. Breakdown in education, family life and interpersonal relations	12.5
5. Change, or decline, in moral standards, more crime	19.3
6. Population explosion and environmental deterioration	4.7
<i>II. Technological Changes</i> (47.8% n = 475)	
1. General scientific and technological change	14.9%
2. Increased industrialization and mechanization	9.2
3. New products and inventions	5.4
4. Medical advances	9.2
5. Space Programme	10.0
6. Advances in TV and communications	6.7
7. Advances in transportation	8.3
8. Increased pollution	4.1
<i>III. Economic Changes</i> (38.6% n = 377)	
1. Improved standard of living, more employment	15.1%
2. Increased cost of living, more unemployment	23.4
3. Increased taxes	7.2
4. Growth of large business enterprises	3.8
<i>IV. Political Changes</i> (31.8% n = 310)	
1. General social and political change	5.7%
2. More radical politics	4.9
3. Increased political involvement	8.3
4. Increased governmental control	4.2
5. Politics dirtier, less trustworthy	4.3
6. Improved race relations	4.8
7. More liberal court and prison systems	5.0

^a Per cent indicates the fraction of the sample mentioning one or more of the items in designated area of change.

^b Per cent indicates the fraction of the sample which mentioned listed change.

taneous manner, with important social changes marks the relative centrality of the subject to our sample. In fact, the public as a whole assigns technological changes a more salient place than economic or political changes in the shaping of modern society. This is not to say that the benefits of technological advance necessarily are perceived as being delivered equally to all people, nor that the implicit beliefs of our statesmen of science about technology's beneficence and promise are shared by the public. We turn now to a consideration of the extent to which the public perceives that promise to have been realized.

EVALUATION OF PRESENT TECHNOLOGIES

One series of questions used in both the 1972 and 1974 surveys deals with the perceptions of benefits associated with several actual technological developments. Respondents were asked to indicate 'how much of a change for the better or worse in life in general' has been made by each of the following: household appliances, automotive vehicles, automated factories, atomic weapons, and the space programme. These five were selected as representative of a large range of presently-employed technologies that are highly visible, widely implemented or available, and familiar to the public. The data presented in Table 2 show that there is a considerable range of opinion about these technologies in both the 1972 and 1974 samples. Table 2 also presents data for three technologies appearing in the 1974 survey only. The results of both surveys indicate that the public judges most of these technologies quite positively: the one exception is the atomic bomb. The data shows that less than half of the 1972 sample believed the atomic bomb to have resulted in better social conditions. In the 1974 sample this proportion had declined sharply to only 26 per cent of the sample.

The stability of these responses is of further interest. Table 3 presents evidence that the attitudes recorded in Table 2 are not transient. Consider first the fraction of the panel whose response in 1974 was within one opinion-category of their response in 1972.⁵ These are the people who maintained their identical position – or, if they altered

⁵ The range described in Table 2 is derived from a seven-stage opinion scale offered to the respondent.

Table 2. How Does the Public View Present Technologies?

	As making life very much worse to slightly worse		'In between'		As making life slightly better to very much better	
	'72	'74	'72	'74	'72	'74
Appliances	3.5%	8.5%	3.4%	5.0%	93.2%	86.5%
Automobiles	15.9	16.4	11.4	12.0	72.9	71.6
Automation	19.2	18.5	17.7	14.1	64.2	67.4
Space Programme	19.6	16.2	19.6	18.5	60.8	65.2
Atomic Bomb	45.7	55.8	5.4	21.7	48.9	25.6
Computers*	--	14.5	--	12.1	--	73.3
Birth control pills*	--	11.8	--	12.6	--	75.5
Television*	--	12.9	--	12.6	--	74.6

*asked in 1974 survey only

Table 3. How Stable Are Attitudes Toward Present Technology?

	Per cent $\pm$ 1 of original response (panel)		'72* Means S.D.		'74* Means S.D.		N	
	'72	'74	'72	'74	'72	'74	'72	'74
Appliances	81.1%		6.15 $\pm$ 1.14	6.05 $\pm$ 1.37	974	314		
Automobiles	64.0		5.26 $\pm$ 1.61	5.27 $\pm$ 1.71	974	313		
Automated Factories	65.6		5.01 $\pm$ 1.61	5.04 $\pm$ 1.72	969	302		
Space Programme	66.3		4.91 $\pm$ 1.87	5.16 $\pm$ 1.74	972	308		
Atomic Bomb	56.6		3.57 $\pm$ 2.02	3.12 $\pm$ 2.01	966	314		

* Means and standard deviations for 1972 based on the total sample; for 1974 on new cross section only (sample minus reinterviewed panel). If the entire sample gave a technology the highest rating, the mean would be 7.00: if they gave the lowest rating, the mean would be 1.00.

it at all, moved only into a contiguous category within the positive or negative range, or moved from a neutral point in either direction. That at least two thirds of the responses to four of the questions remained stable is shown in the first column of Table 3. Even in the case with the greatest change, the atomic bomb, over half the reinterviewed sample did not stray far from their original position. Not only did individual beliefs of the panel hold firmly, but, in the two cross-sections, only attitudes towards nuclear weapons showed any significant change over the two year period. This constancy is borne out by the means and standard deviations appearing in the remainder of Table 3. This

stability, which is repeated on other attitude measures as well, enhances the intrinsic importance of this data. For while we recognize that these attitudes, like all others, are a product of both educational processes and manipulation, the constancy of the responses over a two-year period is reassuring and is suggestive of more than lightly held opinion.⁶

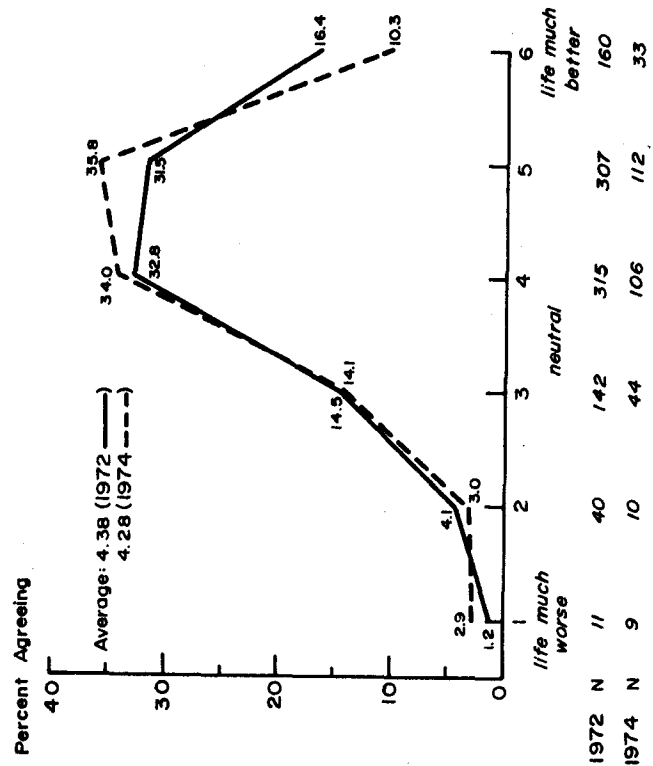


Figure 1: Do Presently Available Technologies Make Life Better or Worse?

Figure 1 presents the distribution of an index constructed by adding together the scores on the five individual items and then dividing the resulting variable at six equal intervals. It shows the predominantly favourable attitudes of both the 1972 and 1974 samples toward existing technologies. The average values of the two cross-sections are remarkably close to each other.⁷

⁶ The over time correlations are roughly the same as the over time associations of political attitudes reported in Philip Converse, 'The Nature of Belief Systems in Mass Publics', in D. Apter (ed.), *Ideology and Discontent* (New York: Free Press, 1964).

⁷ For the 1972 data, the distribution in this figure is slightly different from the distribution reported for the same data in La Porte and Metlay, *op. cit.* note

When this index is analysed in terms of demographic and political characteristics, there are very few systematic differences associated with occupation, education, sex or race. However, political orientation and income seem to make some difference. Figure 2 indicates that a minority of strongly liberal citizens form the core of those who question the overall benefit of these technological developments. Figure 3 shows that the more affluent find greater benefits in present technologies than do poorer Californians. In each case, despite some dips

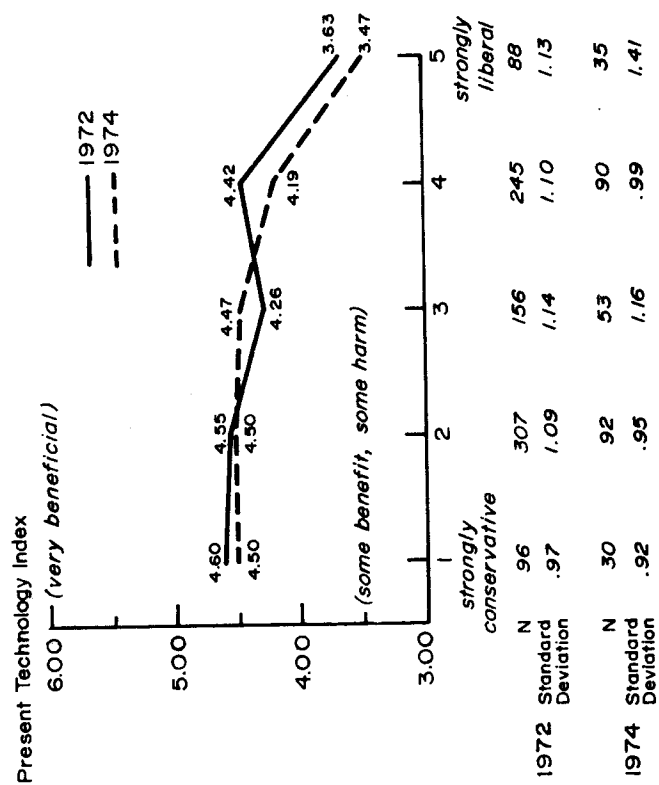


Figure 2: Political Ideology and Perceptions of Technology's Benefit/Harm

4, because of a difference in index construction. For the index presented in the earlier paper, a Guttman Scaling technique was used to demonstrate the cumulative character of the attitudes toward the various technologies used in the scale. Both sets of distributions demonstrate the clear positive bias toward past technological development. Not shown in Figure 1, over 86 per cent of the reinterviewed panel's 1974 responses were within one opinion-category of what they had been in 1972. The over time correlation was a healthy .353.

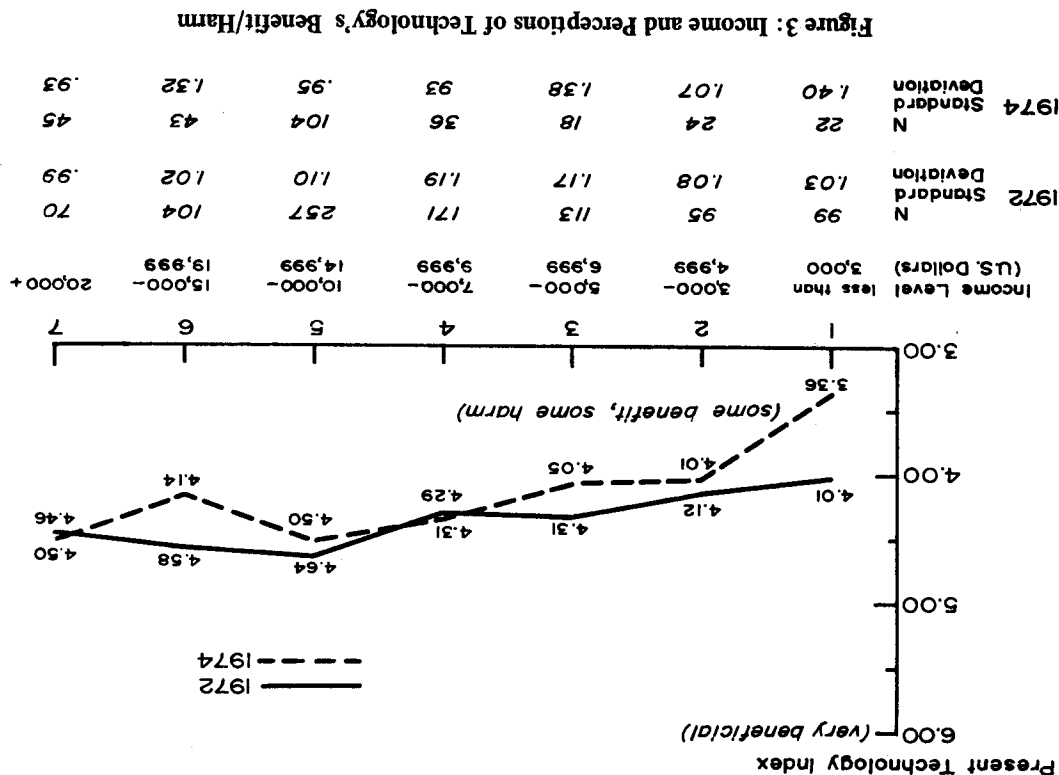


Figure 3: Income and Perceptions of Technology's Benefit/Harm

and bumps in the graphs, the general monotonic relationship stands out. More importantly, there is some indication that the differences between rich and poor may have increased over the two years separating the surveys. Were this difference to increase, the quite stable evaluations of present technology held by various groups along the continuum of political ideology could become more polarized.

THE SOCIAL UTILITY OF TECHNOLOGICAL DEVELOPMENT

In the 1974 survey a series of questions was asked to determine how helpful people thought increased technological development would be in solving a range of important social problems. A list of ten areas of public concern was presented to the respondent, who was then asked to indicate which of them he thought or talked about often. In addition, the respondent was asked to give his opinion as to whether additional uses of technology would improve, aggravate, or have no effect on chances of solving the particular problem. Table 4 presents the results of this inquiry. Solid majorities saw technology aiding in half of the issue areas presented — the development of mass rapid transit, solving

Table 4. How Useful Is Further Technological Development in Solving Social Problems?

Issue Area	Percentage actively concerned with it	Degree of Usefulness of Technology				Standard deviation	N
		Positive	Neutral	Negative	Mean*		
Mass Rapid Transit	36.3%	84.2	11.6	4.2	1.200±	.495	262
Energy Crisis	72.1	78.4	15.1	6.6	1.282±	.579	286
Environment	66.5	71.9	16.2	12.0	1.401±	.694	284
Population Growth	6.0	59.3	37.0	3.7	1.444±	.568	280
Education	59.6	66.3	21.9	11.7	1.452±	.647	280
Crime Rate	66.9	49.3	42.6	7.8	1.582±	.633	283
Providing Jobs	41.4	48.7	26.9	24.4	1.758±	.821	281
Drug Addiction	58.5	30.2	60.2	9.7	1.795±	.598	286
Cost of Living	92.2	33.6	42.9	23.5	1.922±	.750	288
Privacy of Personal Records	39.7	32.0	25.8	42.2	2.102±	.857	278

* This index is constructed so that a unanimous positive evaluation would give a mean of 1.000, and a unanimous negative evaluation a mean of 3.000.

the energy crisis, protecting the environment, curbing population growth, and education. But this belief in technology's social usefulness did not extend to a number of other areas of public concern. On both the 'pocket book issues' — providing jobs and reducing the cost of living — almost one-quarter of the sample expressed the opinion that further use of technology would only aggravate the problem. Significantly, reducing the cost of living was important to virtually all of the people interviewed. It is interesting that in only three of the six issue areas which drew expressions of greatest concern from over 50 per cent of the sample — the energy crisis, the environment, and education — was technology believed to be of considerable potential assistance. Concern about maintaining the privacy of individual personal records led to the sharpest opposition to the use of technology. Over 40 per cent of the sample felt that here technology poses a definite threat to an essential civil liberty. The 'invasion of privacy' issue was the only one about which the public felt that a technology's potential usefulness is definitely outweighed by its possible adverse effects. No relationship was discovered between how important an individual believed a problem to be and how useful he thought technology would be for solving it.⁸

PERCEPTIONS OF FUTURE TECHNOLOGIES

An extraordinary range of technological possibilities confront us. Some capacities, such as energy technologies and new designs in free-way construction, can have a marked and direct personal impact. Others, such as genetic engineering, seem remote and uncertain in their effects.

Since the social meaning of a technology resides not in its machines and systems as such but in the new or improved capacity it makes available to people, the questions the survey asked about new technologies which may emerge in the future accordingly focused on use. Each capability was selected to represent a particular type of technological development — transport, energy collection or conveyance,

⁸ Nor (on a scale constructed by aggregating the individual issue areas) could any systematic differences be detected by cross-tabulating them with a host of demographic and political variables. A relationship ($r = .279$) was found between perceptions of technology's social utility and evaluations of presently-available technology, which are summarized in Table 2.

FIGURE 4
TWELVE TECHNOLOGICAL CAPACITIES

- Transport
 1. High speed trains or monorails covering metropolitan areas to transport large numbers of people quickly from one part of the area to another. (Urban Rails)
 2. Passenger airplanes that travel at high speeds and which can also land and take off in very short spaces so that they can transport people closer to the places they want to go. (STOL)
 3. Power plants that use atomic energy to produce electricity. (Nuclear Energy)
 4. Power produced from satellites orbiting the earth which collect energy from the Sun and send it back to Earth where it is converted into electrical power. (Solar Energy)
- Biological Discovery
 5. Surgical procedures to transplant different body organs from one human being to another so that people's diseased or injured organs could be replaced. (Organ Transplants)
 6. Altering people's inherited genes to change certain of their characteristics which they will pass on to their children so that the mental and physical capabilities of future generations can be improved. (Genetic Engineering)
 7. Altering brain responses with special drugs so that the behaviour of people who have mental disorders can be improved or controlled. (Brain Drugs)
- Information/Communication
 8. An expanded number of television channels carried into the home by cable so that in addition to regular TV shows from networks, more programmes for special interest groups could be made available. (Cable TV)
 9. Storing large masses of information about the characteristics and behaviour of the public on computers so that government and business administrators can quickly get up-to-date, factual information on which to base their decisions. (Data Banks)
 10. Missiles which can intercept and destroy enemy rockets launched against this country before they get near enough to cause serious damage. (ABM)
- National Prestige
 11. Large passenger airplanes travelling at very high speeds (several times the speed of sound) to transport people across the country or to other parts of the world in a few hours. (SST; also Transport)
 12. Space ships which can take people to other planets in the Solar System, such as Mars or Venus. (Space Travel)

biomedical innovation, communications/information, national defence, and those technologies (such as space vehicles) which may enhance international prestige — and to provide a range from the familiar to the somewhat esoteric. Each of twelve specific potential technological capabilities was described to both 1972 and 1974 respondents in terms of its promised functional capacity (see Figure 4 for the exact phrasing). The significance of an urban rail transit system is not its automated trains as such, but the fact that it is intended to transport large numbers of people quickly from one part of a metropolitan area to another. Similarly, the main intention of a nuclear generating plant is to produce electricity to be used by people.

Because it is quite likely that people can simultaneously foresee both beneficial and harmful consequences in one and the same technology, each respondent was asked, for each of the twelve technological potentials, both 'How sure do you feel that this development would have beneficial results?' and 'How sure do you feel that this development would have drawbacks or bad results?' Since it is also quite likely that people might think that a technology's effects on themselves would differ from its effects on others, respondents were also asked 'If a development like [this] were to be put into operation, how much would it change your own life?' and 'How much do you think such a development would change life for most people?'

Table 5. How Are Future Technological Capacities Perceived?

Technological Capacity	Evaluation ^a		Impact on Self ^b		Impact on Others		Certainty Ratio Helpful:Harmful		Percent Uncertain on both	
	72	74	72	74	72	74	72	74	72	74
Urban Rail	1.83	1.60	3.10*	2.77	4.09	3.97	5.11	3.15	14.0	24.8
Solar Energy	1.42	1.50	2.97*	3.47	3.67	3.82	4.80	5.82	31.0	24.4
Transplants	1.35	1.35	2.74	2.79	3.89	3.95	2.97	2.22	26.7	23.3
Nuclear Power	1.23	1.37	3.16	3.38	3.51* 3.83		2.54	2.48	29.9	22.2
Cable TV	.99	.76	2.76	2.74	3.33	3.51	2.44	2.35	31.5	31.4
STOL	.88	.87	2.51	2.60	3.58	3.68	1.47	2.15	26.4	25.6
ABM	.87	.67	2.94	2.87	3.31	3.34	1.64	1.48	25.3	26.5
SST	.50	.17	2.20*	2.62	3.58	3.57	1.45	1.44	26.8	31.5
Brain Drugs	.30*	-.23	1.97	1.87	3.23	3.27	1.10	.82	37.8	43.7
Space Travel	-.25	-.16	2.07	2.11	2.87*	3.02	.90	1.62	42.0	45.7
Genetic Engineering	-.70	-1.08	2.04	2.18	3.34*	3.69	.57	.38	38.7	33.8
Data Banks	-.79*	-1.38	2.92*	3.14	3.57*	3.95	.43	.34	31.5	20.1

^a Range from +3 to -3.

^b Range from 5 high impact to 1 low impact.

* Responses in the two years are significantly different at $p < 0.05$.

Several patterns can be discerned when the responses from the 1974 survey are compared with those elicited two years earlier (see Table 5). First, the degree of variation in public support for particular technologies, as indicated by the means for both the 1972 and 1974 cross-sections, is considerable. Past studies have suggested that the public is likely to be unfamiliar with, and relatively passive toward, complicated public issues.⁹ To the extent that this unfamiliarity and passivity is the case, we would expect judgments to be somewhat randomly distributed among social groupings and not to differ markedly for any particular technology. But the evidence suggests that our respondents in the aggregate exercised considerable discrimination — note, for instance, the high degree of support they accorded the potential of urban rail transit as compared to their overwhelmingly negative reactions to the potential of computerized data banks.

Attitudes about future technologies, like those about *present* technological systems, have remained highly stable over the two-year period. The mean values and rank ordering of the variables in Table 5 suggest that this stability applies for the population as a whole. Additional evidence is provided by a source where individual change can be monitored — the reinterviewed panel of respondents. The percentage of those whose response in 1974 was within one opinion-category of their 1972 response, averaged over the 12 capacities, is as follows: for 'impact on self', 71.5 per cent; 'impact on others', 75.3 per cent; 'certainty of advantage', 90.0 per cent; 'certainty of disadvantage', 88.2 per cent; and for support or opposition, 60.6 per cent.

The changes observed in the 1974 rank orderings suggest that much of the discussion carried on in the media concerning the beneficial or harmful effects of these technologies has been absorbed by the larger audience. The technologies which met with a high degree of support in our survey — urban rail transit, solar and nuclear power generation, organ transplants — have been the objects of considerable expert attention as credible solutions to problems of growing proportions. Likewise, those technologies which evoke the most negative public responses are those which have aroused considerable controversy in Congress and among scientific elites — the SST, the space programme, genetic engineering, and data banks. That the public appears to have been influenced by these technology-centred disputes may force a modification of some common notions about the attention paid to

⁹ See, for example, Converse, *op. cit.* note 6, and Lester Milbrath, *Political Participation* (Chicago: Rand McNally, 1965).

public issues: people may be willing and able to absorb information and make distinctions about controversial issues. The implications for education and persuasion are obvious.

Consider now the relative strengths of the five independent variables which, we suggest, influence evaluation of these emergent technologies:

- (1) respondents' perceptions of the technology's impact on their own lives;
- (2) their perceptions of its impact on the lives of others;
- (3) their certainty of its advantages;
- (4) their certainty of its disadvantages; and
- (5) their evaluations of presently-implemented technologies.

Using these independent variables, and making degree-of-support-for (or opposition-to) each technology the dependent variable, a series of least-squares regression estimates was made for both the 1972 and 1974 surveys.¹⁰ Both standardized and unstandardized regression coefficients were calculated: the former should be used to compare the strength of association *within* a given equation, the latter to compare differences *over time*. In Table 6 the standardized appear above, the unstandardized below.

It is not surprising that, as the estimates in Table 6 show, the people questioned in both our surveys support technological proposals which they believe are relatively certain to return beneficial results and oppose those which seem certain to return harmful ones. But what is surprising is the relative *lack* of strength of the 'impact' variables overall. In most instances, the estimates for these predictors were not significantly different from zero; when they were, they were consistently less than one-third as strong as for variables indicating perceptions of benefits and disbenefits. Finally, in the majority of cases, attitudes about presently available technologies appear to have exerted some influence. This relationship suggests that an individual's experience with present technological systems may influence his estimate of the likely benefits or harm of future ones. We believe that the influence will be a general one, and not limited to future technologies which are similar to present ones.

¹⁰ For a good discussion of regression analysis, see Jan Kmenta, *Elements of Econometrics* (New York: Macmillan, 1971), 9, 197-306, 347-408. While we are not strictly dealing with cardinal level data and are uncertain of the strictly linear causal structure, we believe our approximations are good. By allowing for interactive effects, we can increase our explained variation by roughly 8 per cent.

Table 6. How Do Each of Five Independent Variables Influence Support for Different Technological Capacities?†

	Technological Capacity	Impact on Self	Impact on Others	Certainty of Advantage	Certainty of Disadvantage	Evaluation of Present Technology	R ²
Urban Rail	.72	.74	.72	.74	.72	.74	.72
Solar Energy	.72	.74	.72	.74	.72	.74	.72
Transplants	.72	.74	.72	.74	.72	.74	.72
Nuclear Power	.72	.74	.72	.74	.72	.74	.72
Cable TV	.72	.74	.72	.74	.72	.74	.72
STOL	.72	.74	.72	.74	.72	.74	.72
ABM	.72	.74	.72	.74	.72	.74	.72
SST	.72	.74	.72	.74	.72	.74	.72
Brain Drugs	.72	.74	.72	.74	.72	.74	.72
Space Travel	.72	.74	.72	.74	.72	.74	.72
Genetic Engineering	.72	.74	.72	.74	.72	.74	.72
Data Banks	.72	.74	.72	.74	.72	.74	.72

† For explanation, see text. The figures are least-squares regression estimates: standardized (above) and unstandardized (below).

There is a high degree of congruence in the patterns of estimates in both the 1972 and 1974 samples. In both, the major deviations which appear in the estimates are for the two 'impact' variables and for the 'present technology' index. In most instances this similarity is probably due to the fewer number of cases available for analysis in 1974. Thus, estimates which were barely significant in the first survey have become insignificant in the second. For the most part, however, replication of results confirms the basic thrust of the original analysis.

It seems clear enough that a person's evaluation of any particular technological capacity is readily predictable when he is certain either about its advantages or about its disadvantages. What about cases when he is certain about both or uncertain about both? What factors then influence his evaluation?

To identify such interactions we applied a programme called AID (Automatic Interaction Detection) to the 1972 data. This multivariate technique is essentially a 'one-way analysis of variance' model. It divides the sample into a series of mutually exclusive subgroups (defined by their scores on the independent variable), the means of which explain more of the variation in the dependent variable than any other set of subgroups.

Starting with the total sample, the programme selects the one predictor variable which, when the sample is split into two groups, maximizes the ability to predict the dependent variable. The independent variable is split to achieve greatest homogeneity within, and greatest difference between, the two subgroups. The two groups generated by the first split then become candidates for further subdivision through an iteration of the above procedure. The process continues until no further splits can be made unless the split explained at least .1 per cent of the variance. Moreover, no split would occur unless the difference in the resulting means of the two subgroups was significant at the five per cent level (using a t-test).

Figure 5 illustrates this process for the solar energy technology. The first subgroup (those certain about benefits) was partitioned along the variable 'impact on others' lives' because this variable 'explained' more of the variation in evaluation than any other variable. One new group contained those who were certain about advantages *and* saw a large impact on others; the other group contained those who were certain about advantages but felt there would be little impact on the lives of others. Partitions were again attempted between every two values of the independent variables. The split which best reduced the variation in the dependent variable (certainty of advantage in one case and uncertainty

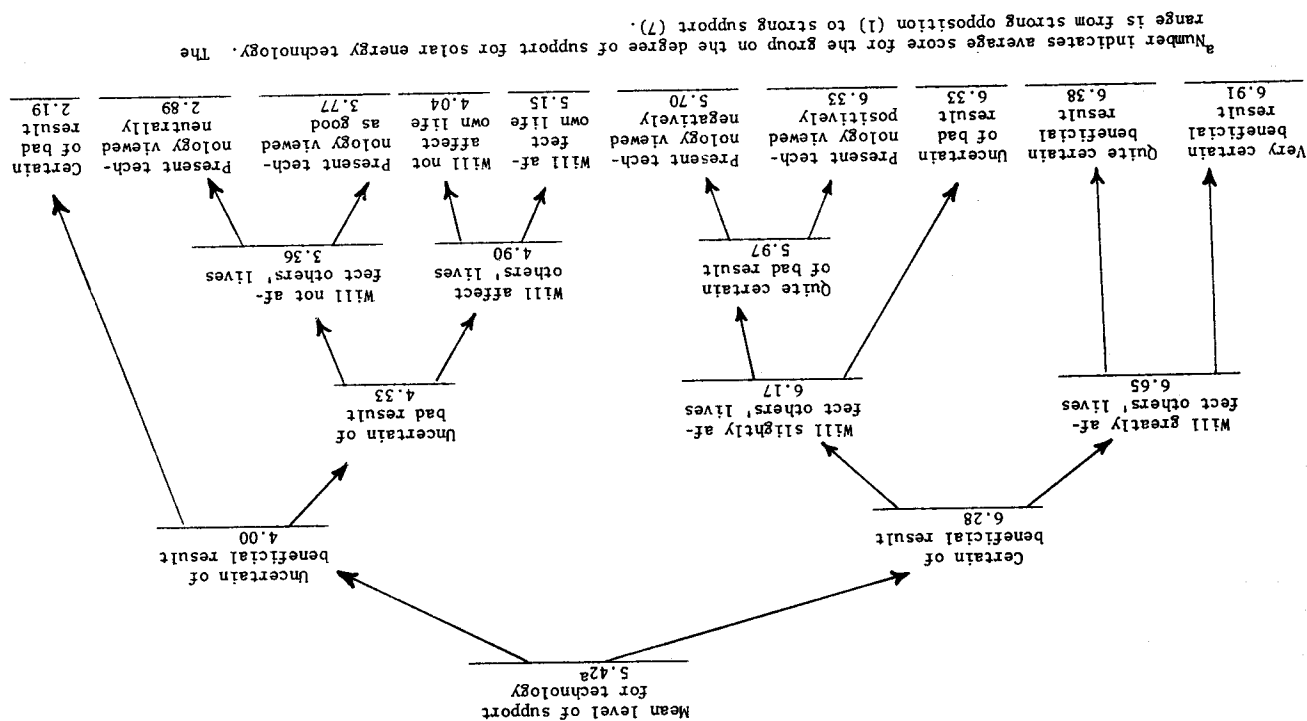
of disadvantage in the other) was selected to produce the fourth generation groups. The process continued until no further partitioning was possible. The order of splitting mirrors the importance of each variable in estimating a person's score on the dependent variable.

Returning now to the questions posed earlier, we find that for a person who is certain that there will be both benefits and costs, the advantages invariably suppress the weight of the disadvantages: there was no case which split on 'certainty of disadvantages' once it had split on 'certainty of advantages'. In other words once someone believes that there is a high probability of benefits attending a technology, his opinion about its disadvantages is largely unimportant in determining his evaluation. Other variables consistently had more explanatory power than the probability of costs. Yet even they produced only rather marginal differences among those who felt fairly confident that the technology would be beneficial.

When we considered what effect a person's uncertainty both about a technology's advantages and its disadvantages would have upon his evaluation of it, the story was quite different. The group uncertain about advantages was consistently split along the variable measuring the perceived probability of harmful consequences. The group uncertain about both advantages and disadvantages was subsequently split along each of the other variables.¹¹

It is apparent that the notions people have of a technology's impact, and their attitude about present technologies, make a difference in how they evaluate future technologies only when people are relatively uncertain about the generalized costs and benefits of future technologies. Yet, at the same time, people quite uncertain about the effects of technologies will still express opinions on them. Such opinions do not necessarily 'cancel each other out', by being half for and half against an emerging technical capability. Since the 'uncertain' represent a sizeable minority of the population (on average, about 30 per cent) the weight of their opinion can make a systematic difference. In the example shown in Figure 5, a shift from uncertainty about both advantages and disadvantages to uncertainty about advantages and certainty about disadvantages reduces support by over 2.2 units — about a 30 per cent change on a 7-unit scale. Similarly, a shift to certainty about benefits and uncertainty about costs increases support by nearly 2 units. Thus,

¹¹ Note on Figure 5 that the range of the final groups derived from those certain of benefits is only 1.3 units, while the range of those uncertain about both costs and benefits is over 2.3 units.



educational or persuasive efforts directed toward the public could make a substantial difference in the climate surrounding consideration of new and emerging technologies.

DEMOGRAPHIC AND POLITICAL CORRELATES OF TECHNOLOGICAL EVALUATIONS

A number of misleading assertions about the correlates of public attitudes toward technology have found their way into the literature. We are told, for example, that liberals, the poor, the uneducated, and the young hold anti-technology biases. Such generalizations, however, ignore the complex pattern of relationships to be found in the groupings which *do* correlate with that attitude. Earlier we presented evidence that, with respect to presently implemented technologies, liberals see things differently from conservatives and that the rich and the poor do not view the fruits of technology in like manner. *We found no evidence that age or education makes any significant difference in the way our respondents evaluated present technologies* as measured by the index referred to above.

When we examine correlates of attitudes toward new and emerging technological capacities, the fallacy of certain popular generalizations is starkly apparent. Data supporting two notable findings are presented in Table 7. First, relationships can take other directions than those which one might be led to expect from the more stereotype-based arguments. That is, liberals, the young, and the uneducated give more approval to some technologies than do conservatives, older people, and the more highly educated. Second, and perhaps more interesting, definite evidence of increasing polarization over time is found for the dimensions of age, education, and political ideology. These variables took on increased importance in 1974 in explaining perceptions about emerging technical capacities.

Consider the following relationships, which are fairly representative. First, political ideology: the politically liberal are more likely than conservatives to see advantages in cable TV, to see disadvantages in the ABM, brain drugs and nuclear energy, and to be less certain about the existence of negative consequences of cable TV. Second, education level: the more highly educated are more certain than less educated people that solar energy and space exploration will be advantageous, and they show less favour toward the ABM and brain drugs than do those with less education. Third, age: the young are more certain than

Table 7. Have Perceptions of Technological Capacities Become More Polarized?

I. Political Ideology	1972	1974
A. Certainty of Advantages		
Cable TV	-.075	-.208
SST	.004	.213
ABM	.221	.169
B. Certainty of Disadvantages		
Nuclear Energy	-.169	-.313
Cable TV	.048	.222
ABM	-.284	-.316
Brain Drugs	-.067	-.205
C. Evaluation		
Cable TV	.071	.285
STOL	-.042	-.202
ABM	-.259	-.319
II. Education		
A. Certainty of Advantages		
Solar Energy	-.173	-.240
ABM	.072	.201
Space Travel	-.038	-.282
B. Certainty of Disadvantages		
Genetic Engineering	-.187	-.212
Space Travel	.017	-.212
ABM	-.170	-.409
C. Evaluation		
Space Travel	.062	.373
Brain Drugs	-.067	-.261
ABM	-.207	-.346
III. Age		
A. Certainty of Advantages		
Cable TV	.028	.230
B. Evaluation		
Cable TV	-.063	-.249
ABM	.268	.247

The figures in this Table are correlation coefficients, representing the extent to which differences in perceptions of technological capacities are related to ranges of political ideology, educational level and age. A small correlation indicates that very little difference across the range is apparent; the larger the absolute value of the coefficient, the greater the gap in perception between one end of the dimension and the other.

older people that advantages will accompany cable TV, and they are less in favour of space exploration and the ABM.

Table 7 also presents evidence of growing polarization. Whereas in 1972 very few of the attitudinal variables could be linked to age, education, or to political ideology, we see that by 1974 those independent variables had become better predictors of responses.

CONCLUSION

This article has presented data supporting the conclusion that technological development is perceived by the public, at least in California, as an important source of social change which on the whole has been definitely beneficial. Positive evaluations of presently implemented technologies persisted from 1972 to 1974. A trend seems to be beginning toward increased perception of benefits on the parts of those with higher incomes, and of those who hold to a quite conservative political ideology. This tendency of evaluations to be associated with political ideology hints that technological matters could increasingly take on the lineaments of controversy as we have known it in American politics. Data also suggest that the public is somewhat ambivalent about the general utility of technological solutions to a number of important social problems. For only about half of those issues occupying the public mind was technology believed likely to improve the situation. Thus, while there is a sense of the importance of technology as a source of social change, and one that has been on the whole quite beneficial in the past, there is the possibility that confidence in technology will diminish.

As for technologies that might be pursued in the future, public enthusiasm has either declined or remained the same as it was two years ago. Also, the public shows itself to be prepared to make judgments about relatively complex technical matters. The marked variation in public support for certain prospective technologies, evident in 1972, persisted into 1974. Stability is apparent in judgments about the importance of various factors associated with the degree of support. In both surveys, people's approval of a technology was influenced by the degree to which they were certain about the beneficial advantages or harmful disadvantages which might result from its implementation. This discrimination suggests that technologies are perceived not merely as impersonal machines but as significant determinants of human experience. Finally, the stereotypes appearing in the literature about

attitudes toward technology require substantial revision. Although the young, the poor, the uneducated, and the politically liberal disproportionately oppose some technologies, they also disproportionately favour others. This 'crossing of lines' (which has been noted in works on technological controversies) confirms that a technology attracts support or opposition from groups differentially affected by it. The growing polarization of judgments about technologies on the basis of these demographic variables adds further evidence that technological matters are headed for the political arena.

These findings have a direct bearing on technology assessment issues and on the behaviour of policy makers. First, it seems apparent that the public, while probably not well informed about the scientific complexities of technical developments, has nevertheless formed stable and definite opinions about their potential utility and benefit. Such opinions are not randomly distributed, but form persistent patterns – patterns associated with socio-economic characteristics which traditionally have been important predictors of political behaviour. Our evidence suggests that policy makers will be seriously misjudging the public's mind if they presume it to be irrationally anti-technological or transient in its attitudes about technical development.

Second, the public responds to technological matters in terms of the experiences it has had with the social consequences of present and past technology, and not simply in terms of its understanding of the machines themselves and of their intended effects. Both the variation and stability of attitudes suggest that they are part of the generalized response to other social experiences. As this social, experiential context becomes more engrained, it is reasonable to expect that an increasing portion of the public will come to associate various technologies with differential benefits for the affluent and the poor. The possibility of various design alternatives having different social effects, and thus being experienced differently by different segments of the population, should be thoroughly explored. One design and its manner of implementation may affect the young more than older citizens; another may have the reverse effect; and so on. By extension, continued adherence on the part of technologists to the old concept of the 'one best way' seems increasingly inappropriate.

APPENDIX: Sampling Procedures

In constructing this statewide sample, the counties of the state were arrayed in geographic order in accordance with the ten state statistical areas established by the State Office of Planning. The current population of each Census County Division from the 1970 Census was listed, and random selection of CCDs was made with probability of selection in proportion to size. The random choices were made by systematic sampling, with random starts, in order to ensure representative geographical distribution. The result is a master sample of *primary sampling units* (PSUs) consisting of distinct geographic population units (CCDs), each PSU designating the general locus of starting points for one or more interviewing Clusters.

Specific locations for a Cluster within a given PSU are determined by random selection of residential addresses from the current telephone directory within which the PSU is contained. Within the designated directories, the desired number of Cluster starting points are selected. A Cluster starting point is a residential address drawn from the directory by use of random designation of page, column, and listing, or through the use of a set of random three-letter combinations. Only residential telephone addresses are drawn. Multiple directory listings per household and non-residential listings are handled with special procedures.

The selected 'key address' designates the starting point for a Cluster of dwellings which provide interviews for the survey. Procedures for the formation of dwelling unit Clusters are such that the inclusion of a given residence in the sample *does not* depend on whether it has a telephone. The probability of a Cluster's initial selection does, however, depend on the ratio of telephone homes to total homes in the area, a circumstance which is taken care of by a telephone density weighting procedure. To form a Cluster, the interviewer lists a pre-designated number of occupied residences encountered on a pre-designated route around the block from the 'key address'. Vacancies, transient quarters, and institutions are excluded from the listing. The interviewer calls on each of the dwellings listed in the Cluster.

Further information on the procedure used in constructing the sample, and on other technical aspects of the survey, may be obtained from Mr. Robert Heyer, Field Research Corporation, 234 Front Street, San Francisco, California 94111, USA.

Astrology and Science in Seventeenth-Century England

Peter Wright

In recent years the task of distinguishing science from other cognitive systems has become much more complex. The traditional view that science is the polar opposite of such systems of thought as witchcraft, magic or astrology has been eroded almost to the point of extinction.¹ On the one hand, historians and sociologists of science have been building up a view of scientific activity strikingly different from the hitherto accepted one; on the other, social anthropologists, in analysing so-called 'alien belief-systems', have drawn attention to many features that appear to be far from alien to much scientific activity.

Nonetheless, although the distinction is far less clear-cut than it was once thought to be, and although most of us would not imbue it with the moral overtones that many of our nineteenth-century predecessors did, it is still a distinction that needs to be made. There is no escaping the fact that, in general, the consequences of what is usually accepted as being scientific activity are enormously different in their impact on other aspects of social existence from those of magical, religious or artistic activities. I do not want to deny that science may well fulfil many functions hitherto, or still, performed by other systems of thought. Still less do I wish to suggest that they are easy to distinguish either synchronically or diachronically: nonetheless, this paper is based on the assumption that the contrast between science and non-science

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¹ This can be clearly seen from the general tone of the papers in R. Finnegan and R. Horton (eds.), *Modes of Thought* (London: Faber, 1973).