Title

Public attitudes toward present and future technologies : satisfactions and apprehensions

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Since the Industrial Revolution, large-scale technological development has been a continual stimulus to rapid changes in social, economic, and political patterns and in personal experience. During the past thirty years, governmental support of technical and scientific development has grown enormously, and the nation has witnessed the emergence of massively complex organizations bent on technological accomplishments touching the lives of virtually everyone. The results have been mixed. Truly heroic 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.

Perceiving this contradistinction in technology as a social force, some observers have eloquently challenged the tendency to accept new 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 programs--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.

Implicit in that elite competition, significantly, is the desire to advance the public good, however imprecisely defined or open to varying interpretations. 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 the importance of technology as a feature of social change; evaluations of a range of presently implemented technologies; faith in the efficacy of technology for solving social problems; and 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 discernible wherein positive evaluations are becoming associated with political ideology 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

The data reported here was collected as part of a larger project assessing the social impact of technology.[3] 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. 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 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 a logical opportunity for pursuing that possibility. To begin charting changes in public opinion, 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%) 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 is highly representative overall of that earlier cross-section. Distributions of responses for the reinterviewed panel and for the new, smaller cross section are quite similar as well. Because some differences did arise when bivariate or multi-variate relationships were examined, in this paper we compare only relationships existing 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 derived also 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 what follows is the California population. We have presented evidence elsewhere which supports the proposition that had a national sample been taken, 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 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 proportion of the total scientific and technological work done in this nation, our findings may have greater importance that 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 percent noting one, 42 percent two, and 35 percent 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 percent mentioned two or more.

Some of the changes mentioned by respondents duplicated others. For ease of presentation, we have combined them into the twenty-five categories of change, organized within four comprehensive areas, listed in Table 1.

In overall emphasis, the frequency of mention of technological changes challenges various social changes, with economic and political changes drawing less attention than either. 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 science and technology in general and to increased industrialization combine for 24 percent of the total responses. It is noteworthy that a number of specific technologies elicited special comment: the space program, medicine, transportation, and communications (including television). The degree to which science/technology is associated, in this more or less spontaneous manner, with important social changes marks the relative centrality of the subject to our sample. And we found, in _this_ context, that no demographic or social variables relate systematically to those mentioning changes in the science technology category or to those who did not. Neither does party identification appear to have any bearing on the number of mentions of science/technology.

Our analysis suggests, then, that the public as a whole perceives general technological advance as an aspect of overall social change occurring since 1945. But

TABLE I

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

I. Social Changes
(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

II. Technological Changes
(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 Program	10.0
6.	Advances in TV and communications	6.7
7.	Advances in transportation	8.3
8.	Increased pollution	4.1

III. Economic Changes
(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

IV. Political Changes
(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

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[a]Percent indicates the fraction of the sample mentioning one or more of the items in designated area of change.

[b]Percent indicates the fraction of the sample which mentioned listed change.

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" each of five different technological developments has made. These five were household appliances, automotive vehicles, automated factories, atomic weapons, and the space program. These were selected as representative of a large range of presently employed technologies that are highly visible, widely implemented, and familiar to the public. The data presented in Table 2 show that considerable variance of opinion about these technologies exists 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 found is in attitudes toward 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% of the sample.

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 Program	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

Of particular interest is the stability of these responses. Table 3 below presents evidence that the attitudes recorded above 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 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 hold firmly, but in aggregate the population has remained fairly steady. This constancy is borne out by the means and standard deviations for both the overall 1972 sample and the later cross section questioned in 1974.

TABLE 3

HOW STABLE ARE THESE ATTITUDES TOWARDS PRESENT TECHNOLOGY?

	Percent ± 1 of original response (panel)	Mean '72	Mean '74	Standard Deviation '72	Standard Deviation '74	N '72	N '74
Appliances	81.1%	6.149	6.047	1.140	1.366	974	314
Automobiles	64.0	5.259	5.265	1.612	1.705	974	313
Automated Factories	65.6	5.009	5.037	1.614	1.718	969	302
Atomic Bomb	56.6	3.568	3.117	2.024	2.012	966	314
Space Program	66.3	4.908	5.163	1.871	1.738	972	308

* Means and standard deviations for 1972 based on the total sample; for 1974 on new cross section only (sample minus reinterviewed panel).

Figure 1 presents the distribution of an index constructed by adding together the five individual items and then collapsing at equal intervals. It shows the predominantly favorable 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. (Not shown in Figure 1, over 86% 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.)

When this index is analyzed in terms of demographic and political characteristics, there are very few systematic differences associated with occupation, education, sex, or race. Political orientation and income seem to make some difference, however. Figure 2 indicates that a minority of strongly liberal

FIGURE I

DO PRESENTLY AVAILABLE TECHNOLOGIES MAKE LIFE BETTER OR WORSE?

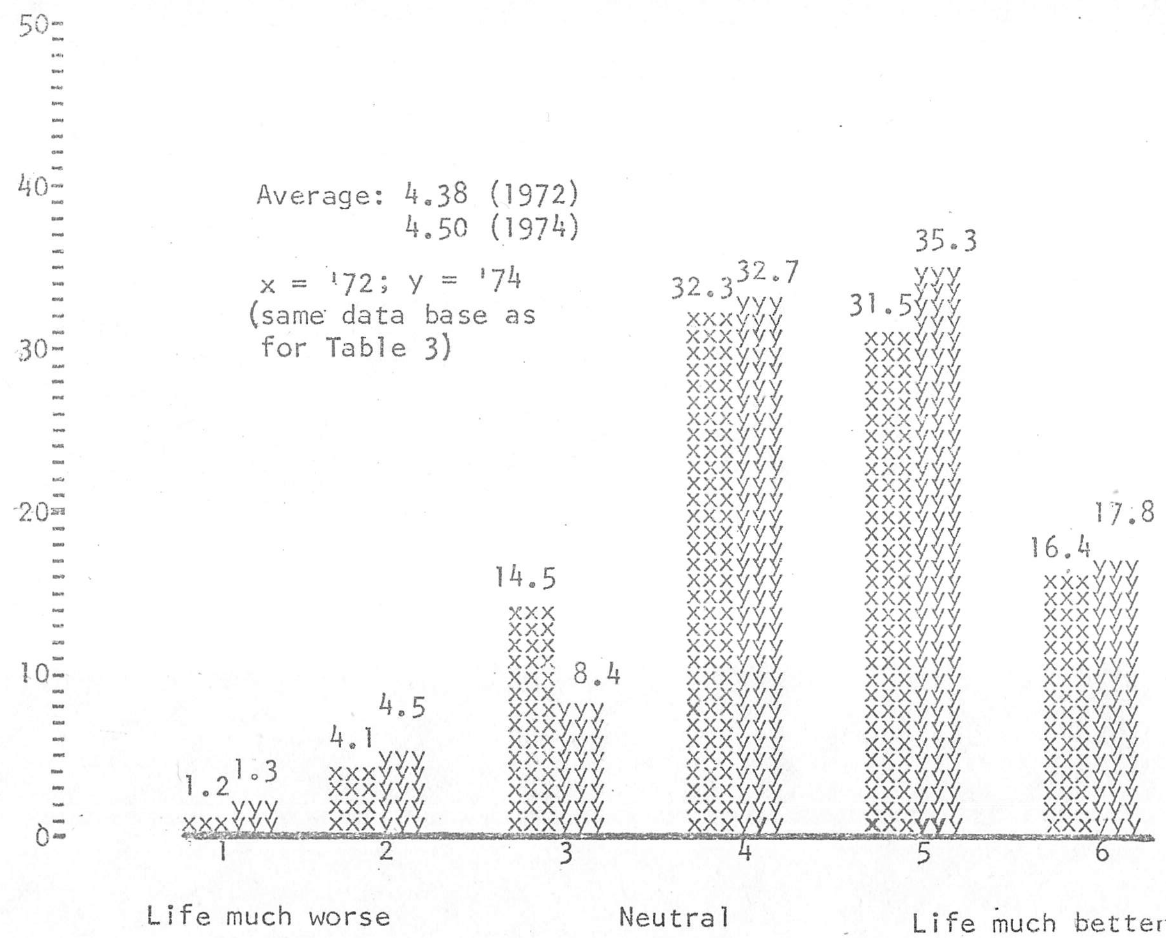


FIGURE 2

PARTY/IDEOLOGY AND PERCEPTIONS OF TECHNOLOGY'S BENEFIT/HARM

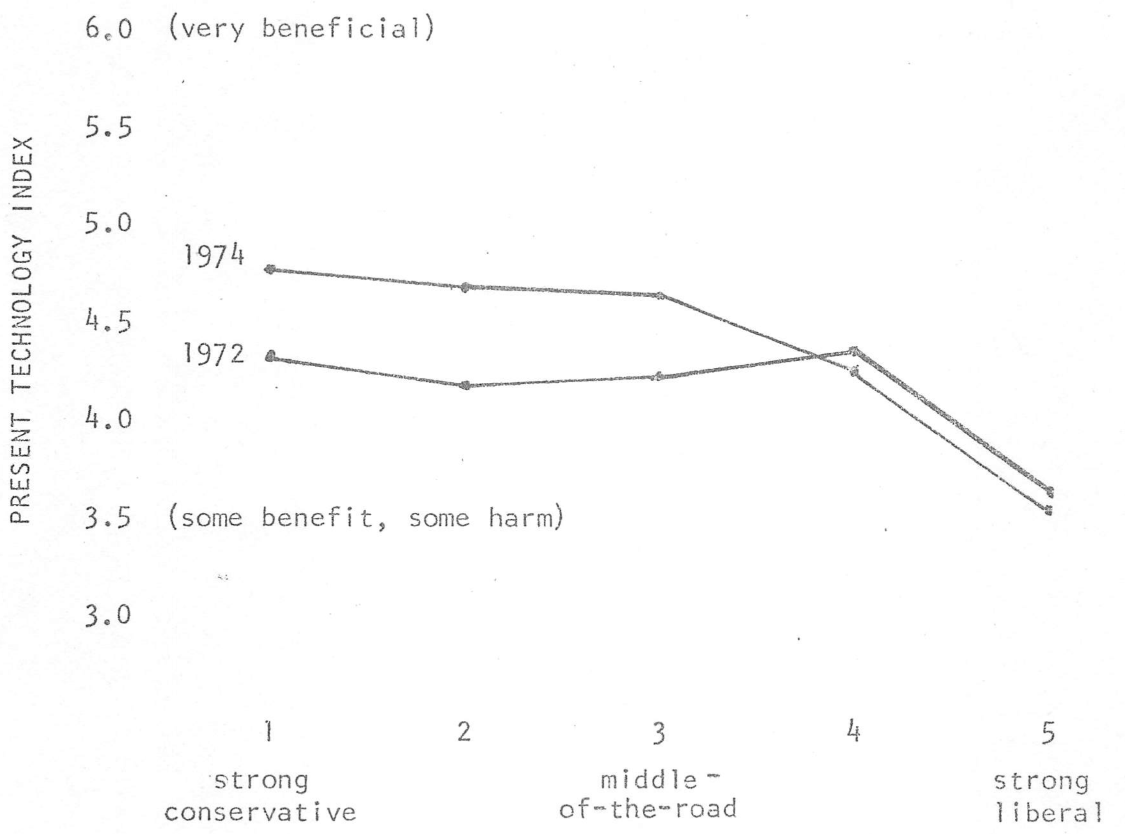
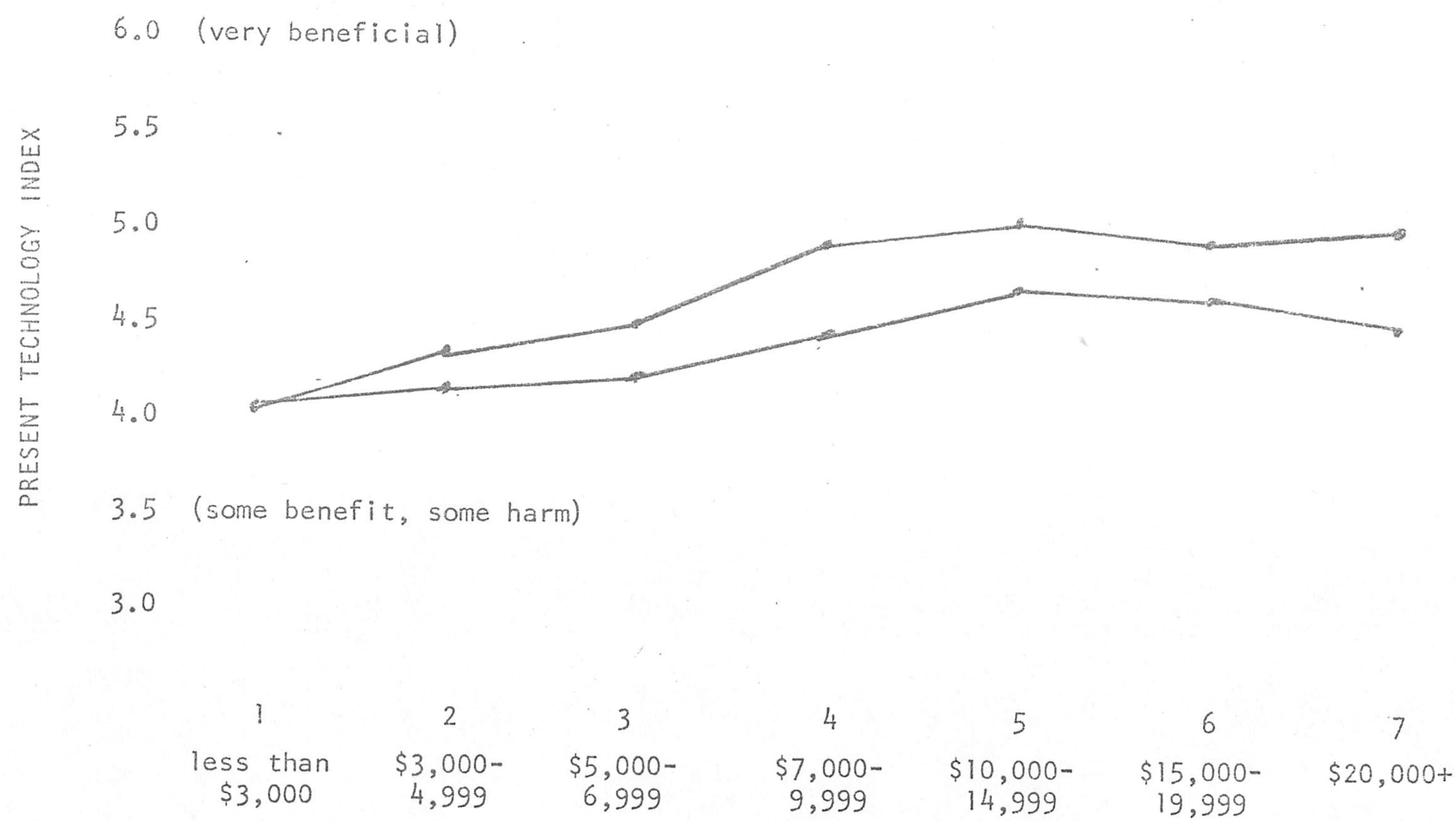


FIGURE 3

INCOME AND PERCEPTIONS OF TECHNOLOGY'S BENEFIT/HARM



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 and bumps in the graphs, the general monotonic relationship stands out. More importantly, the differences between rich and poor, liberal and conservative, have increased over the last two years. Evaluations of present technology have become more polarized in terms of the extremes of political ideology.

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 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 virtually unanimously important to the people interviewed.

It is interesting that in only three of the six issue areas drawing expressions of greatest concern from over 50% of the sample -- the energy crisis, the environment, and education -- was technology believed to be of considerable assistance. Concern about maintaining the privacy of individual personal records led to the sharpest dissent against the use of technology. Over 40% 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.[6]

TABLE 4

HOW USEFUL IS FURTHER TECHNOLOGICAL DEVELOPMENT IN SOLVING SOCIAL PROBLEMS?

Issue Area	Percent actively concerned with it	Degree of Usefulness of Technology: Positive	Neutral	Negative	Average	Standard deviation	N
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)

PERCEPTIONS OF FUTURE TECHNOLOGIES

A great welter of technological possibilities presently confronts our citizens. Some capacities, such as energy technologies and new designs in freeway construction, convey a high degree of personal immediacy to people. Others, such as genetic engineering and organ transplants, seem remote and uncertain in impact.

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 focus directly on those capacities, on what it is that the technology is designed to do. The significance of an urban rail transit system is not its automated trains, but the fact that it can transport large numbers of people quickly from one part of a metropolitan area to another. Similarly, the significance of a nuclear generating plant is that it produces electricity to be used by people. 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). Each capability was selected to represent a particular type of technological development--transport, energy collection or conveyance, biomedical innovation, communications/information, national defense, and technologies, like space vehicles, which may enhance international prestige--and to provide a range from the familiar to the somewhat esoteric.

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 them-

FIGURE IV

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)

Energy

3. Power plants that use atomic energy to produce electricity. (Nuclear Power)

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 behavior 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 programs for special interest groups could be made available. (Cable TV)

9. Storing large masses of information about the characteristics and behavior 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)

National Defense

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)

selves 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?"

Several noticable patterns can be discerned by comparing the responses from the 1974 survey with those elicited two years earlier. (See Table V.) 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.[7] 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--notably the variation in 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.

Other major patterns emerge. The remarkable similarity between the 1972 and 1974 rank orderings of support for or opposition to the 12 future technical options suggests considerable stability of attitude. But while the relative <u>order</u> of support remained intact, overall support for most technical possibilities diminished. Eight out of the twelve drew less approval, and several--brain drugs, genetic engineering techniques, and large data banks--elicited sharply increased opposition. Only two, both of them energy related technologies, won even small increases in support. Somewhat unaccountably, enthusiasm for urban rail transit declined significantly though it still remained the most attractive technical innovation.

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.

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 1972 was within one opinion-category of their 1972 response, averaged over the 12 capacities, is as follows: for "impact on self," 71.5%; "impact on others," 75.3%; "certainty of advantage," 90.0%; "certainty of disadvantage," 88.2%; and for support or opposition, 60.6%.

The changes observed in the 1974 rank orderings argue that much of the discussion carried on in the media concerning the beneficial or harmful effects of these technologies has been picked up 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 program, genetic engineering, and data banks. That the public appears to have been influenced by these technology centered disputes may force a modification of some common notions about the attention paid to 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.[8] 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 will color his estimate of the likely benefits or harm of future ones.

There is a high degree of similarlity 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 likely to be 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,

TABLE 6

HOW DO EACH OF FIVE INDEPENDENT VARIABLES INFLUENCE SUPPORT FOR DIFFERENT

TECHNOLOGICAL CAPACITIES?

Technological Capacity	Impact on Self 72	Impact on Self 74	Impact on Others 72	Impact on Others 74	Certainty of Advantage 72	Certainty of Advantage 74	Certainty of Disadvantage 72	Certainty of Disadvantage 74	Evaluation of Present Technology 72	Evaluation of Present Technology 74	R^2 72	R^2 74
Urban Rail	* *	* *	* *	* *	.18 *.36*	.56 *1.29*	-.22 *-.43*	* *	* *	.12 *.04*	.14	.32
Solar Energy	* *	* *	* *	* *	.49 *1.07*	.37 *.82*	-.21 *.54*	* *	.12 *.04*	* *	.45	.22
Transplants	* *	* *	.12 *.20*	.22 *.35*	.42 *.94*	.38 *.80*	-.19 *-.46*	-.18 *-.45*	* *	.17 *.05*	.39	.31
Nuclear Power	* *	* *	* *	* *	.36 *.86*	.46 *1.06*	-.29 *-.59*	-.27 *-.63*	.10 *.04*	.13 *.04*	.36	.47
Cable TV	.16 *.23*	.40 *.58*	* *	* *	.40 *.88*	.18 *.40*	-.17 *-.40*	-.30 *-.73*	* *	* *	.36	.51
STOL	.06 *.09*	.19 *.28*	.06 *.10*	* *	.34 *.77*	.37 *.92*	-.27 *-.60*	-.38 *.88*	.13 *.05*	* *	.34	.52
ABM	.13 *.19*	* *	* *	* *	.38 *.86*	.37 *.91*	-.39 *.87*	-.46 *-1.10*	.12 *.05*	* *	.53	.60
SST	* *	* *	* *	* *	.46 *1.16*	.46 *1.17*	-.23 *-.52*	-.24 *-.66*	.09 *.03*	.14 *.06*	.43	.39
Brain Drugs	* *	* *	.14 *.26*	.15 *.28*	.36 *.94*	.40 *1.19*	-.33 *-.86*	-.38 *-1.04*	.12 *.05*	* *	.42	.45
Space Travel	.12 *.16*	* *	.12 *.17*	* *	.36 *.84*	.43 *.98*	-.25 *-.62*	* *	* *	.16 *.06*	.40	.44
Genetic Engineering	.10 *.15*	* *	* *	* *	.41 *1.10*	.38 *1.01*	-.34 *-.83*	-.45 *-1.18*	* *	* *	.44	.46
Data Banks	* *	* *	* *	* *	.37 *.92*	.31 *.74*	-.36 *.87*	-.41 *-.94*	.14 *.05*	* *	.46	.39

replication of results confirms the basic thrust of the original analysis.

It seems clear enough that a person's affective 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 program 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 sub-groups (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 program selects the one predictor variable which, when 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 without violating the "reducibility" criteria. This irreducible limit was set at .001 and means that a group would not be split unless the split explained at least .1% of the variance. Moreover, no split would occur unless the difference in the resulting means of the two subgroups was different from zero at the five percent level using a t-test.

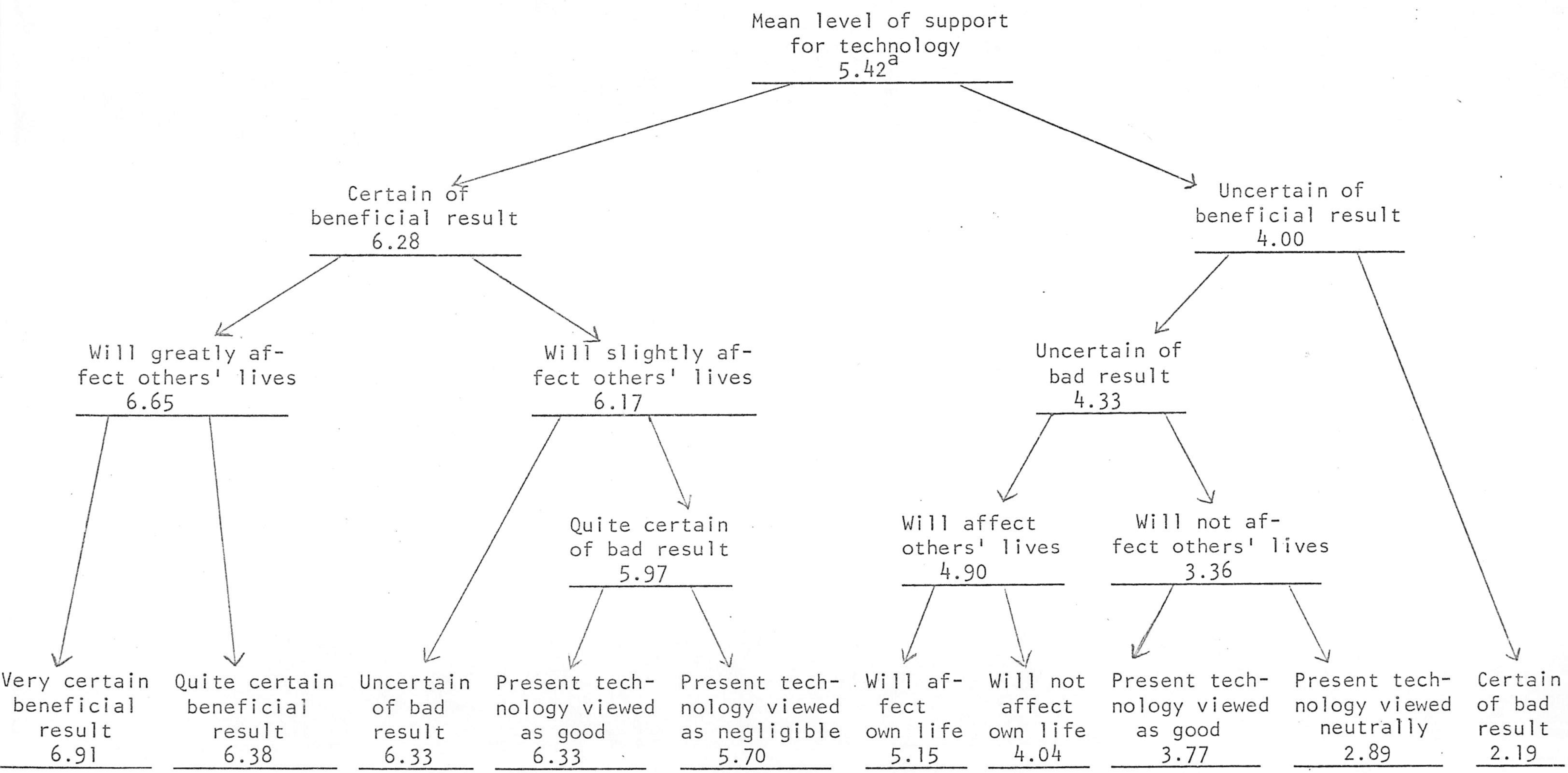
Figure 5 illustrates this process for the solar energy technology. The first sub-group (those certain about benefits) was partitioned along variable "impact on others' lives" because it met the criteria better than any other variable. One new group contained those who were certain about advantages and 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 one which best satisfied the criteria (certainty of advantage in one case and certainty 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: once someone believes that there is a high probability of benefits attending a technology, his opinion about its disbenefits is largely unimportant in determining his evaluation. There was no case which split on "certainty of disadvantages" once it had split on "certainty of advantages." 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.

The story was quite different regarding what effect a person's uncertainty both about a technology's advantages and its disadvantages would have upon his evaluation of it. 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. 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.

FIGURE 5

RESPONDENTS' SUPPORT FOR SOLAR ENERGY COLLECTION PARTITIONED ON THE BASIS OF OTHER VARIABLES



[a] Number indicates average score for the group on the degree of support for solar energy technology. The range is from strong opposition (1) to strong support (7).

It is apparent that people's notions of a technology's impact and their attitude about present technologies make a difference in their evaluations of future technologies only when they are relatively uncertain about generalized costs and benefits of the latter. 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 (about 30% on the average), 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% change on a 7-unit scale. Similarly, a shift to certainty about benefits and uncertainty about costs increases support by nearly 2 units. Thus, 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.

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 what the more sterotype-based arguments lead one to expect. 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 was found for the dimensions of age, education, and party/ideology. These variables take on increased importance in 1974 in explaining perceptions about emerging technical capacities.

Consider the following relationships, which are fairly representative. First, party/ideology: The politically liberal are more likely than conservatives to see advantages in cable TV, to see disadvantages in the ABM and brain drugs, and to be less certain about the existence of negative consequences of organ transplants and of solar energy technology. 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 favor toward the ABM and brain drugs than do those with less education. Third, age: The young are more certain than older people that advantages will accompany cable TV, and they are less in favor 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 party/ideology, we see that by 1974 they have become more exclusive with respect to those independent variables. (The correlation coefficient provides an appropriate means for measuring this polarization. A small correlation indicates that

TABLE 7

HAVE PERCEPTIONS OF TECHNOLOGICAL CAPACTIES BECOME MORE POLARIZED?

	1972	1974
I. Party/Ideology		
A. Certainty of Advantages		
Cable TV	-.100	-.249
Brain Drugs	-.012	.224
B. Certainty of Disadvantages		
Organ Transplants	.016	.286
Solar Energy	.038	.237
Brain Drugs	-.067	-.205
ABM	-.226	-.309
C. Evaluation		
Cable TV	.071	.285
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

very little difference across the range is apparent; the larger the absolute value of that coefficient, the greater the gap between one end of the dimension and the other.)

Thus, attitudes toward certain technological developments are not now randomly distributed among the population and greater cohesion of opinions is apparently emerging. Taken together, these two findings have important implications. The cohesion around party/ideology both reflects and portends growing political controversy over technological developments. Significantly, proponents and opponents may not have to seek allies or create coalitions anew. They may simply have to turn to their former allies in other political battles. Needless to say, such a result can only intensify the political climate of technology.

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 firmly persisted from 1972 to 1974, even though provocative changes occurred in the interim. 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, one that has been on the whole quite beneficial in the past, there is the potential for confidence in technology to diminish in the future.

As for technologies that might be pursued in the future, the public appears less generally enthusiastic about the positive prospects of large scale technological development than it did two years ago. Also, the public shows itself quite prepared to make judgments about relatively complex technical matters. The marked variation in public support for or opposition to certain prospective technologies, evident in 1972, has persisted into 1974. Stability is similarly apparent in judgments about the importance of various factors associated with the degree of support. In both surveys, people's approval of or their opposition to a technology was influenced by the degree to which they were "certain" about the beneficial advantages or harmful disadvantages to result from its implementation. This discrimination suggests that technologies are perceived not merely as machines but as significant determinants of human experience. Finally, it seems clear that the stereotypes often imposed by technological enthusiasts on those who hold anti-technological attitudes require substantial revision. Although the young, the poor, the uneducated, and the politically liberal are opposed to some technologies, they favor others. In their turn, conservatives, the affluent, the more educated, and older citizens do support some technologies, but they also oppose others. This crossing of lines strongly suggests that a technology attracts support or opposition from groups differentially affected by it. There is a hint here of growing polarization on judgments about technologies, adding further evidence that technological matters are headed for the political arena.

These findings have direct bearing on technology assessment issues and on policy maker behavior. 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 behavior. 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 seems to be responding to technological matters in terms of the experiences it has had with the social consequences of technology and not simply in terms of the machines themselves. 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 consumers and citizens 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, etc., For technology assessors and policy makers, therefore, a very close look at the social consequences of alternative ways of implementing the same technological capacity is in order.

By extension, this study seems to signal an emerging recognition by the public that the behavior of those who support, design, and implement new or improved technologies has an effect on the public's experience with that technology.

Insofar as this connection is made and associated with the differential benefits derived from various technologies, they may become much more subject to political debate and controversy.

NOTES

1. See especially Jacques Ellul, The Technological Society tr. J. Wilkinson (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)1; 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: 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 (Winter 1972), pp. 35-39.

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), pp. 606-621.

3. That study of technology and social change and the social assessment of technology is supported by the 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 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 and William Bicker of the Department of Political Science, Dr. Trieve 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 Governmental Studies, through which the project was adminstered, has lent clerical and editorial assistance to our efforts. (All academic units cited are those of the University of California, Berkeley.)

4. See T. La Porte and D. Metlay, "Technology Observed: Attitudes of a Wary Public" Science (forthcoming). It should be noted that, as a precaution against disproportionate oversampling of some groups, weighting for age, sex, and geographic location is present in the N's for the two cross sections as they are cited on the statistical tables which follow.

5. The range described in Table 2 represents a seven-stage opinion scale offered the respondent.

6. 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 (summarized in Table 2) of presently available technology.

7. See, for example, Philip Converse, "The Nature of Belief Systems in Mass Publics" in Ideology and Discontent, Ed. David Apter (New York: Free Press, 1964) and Lester Milbrath, Political Participation (Chicago: Rand McNally, 1965).

8. For a good discussion of regression analysis, see Jan Kmenta, Elements of Econometrics (New York: Macmillan (1971), pp. 9, 197-306, 347-308. While we are not strictly dealing with cardinal level data and are uncertain of the strictly linear causal structure, we believe that they are good approximations in our case. By allowing for interactive effects, we can increase our explained variation by roughly 8%.