## Title

The ambiguous status of science and technology : a study of management attitudes and public policy in Australia



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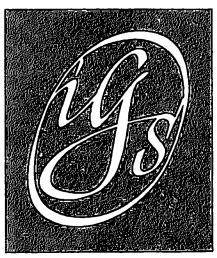

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## *Abstract*

*This paper examines the changing perspectives of Australian public policy makers on science and technology, and reviews the international and Australian literature on public attitudes to science and technology. In recent years there has been an increase in Australian policy debate related to science and technology, and this debate has exhibited ambiguity on the normative status of science and technology. Public attitudes form an important part of the context of this debate, but it has been difficult for policy makers to clearly identify the pattern of attitudes held by the community. This is partly because the relevant issues are very complex and poorly defined, and partly because little pertinent empirical research has has been conducted. In an attempt to redress this latter problem we report the results of our empirical study of the attitudes to science and technology of one particular influential social group in Australia, senior business executives. The results of the study conform with the general themes which have emerged in the international literature. The attitudes to science and technology of Australian business executives (as with the attitudes of the general public, reported in other studies) are quite complex and, in some respects, more sophisticated than popularly believed. Furthermore, the study reveals fundamental ambivalence in the executives' assessments of the social value of technological change. The ambiguity in the policy debate appears to reflect widespread ambiguity in the public's understanding of science and technology, and of technology in particular. This has implications for public policy.*

## Introduction: science and technology in the public eye

Technology and science are now a significant focus of attention in Australia's public policy arena. Technology has always played a role in the Australian economy (whether simple agricultural equipment and gold-mining implements, of earlier days, or contemporary satellite communications systems and new biotechnology manufacturing) but it has recently claimed more public attention. Science also has a substantial history in Australia, but, as the connections between science and technology grow, and federal government fiscal problems increasingly dominate the science and education policy environment, scientists are playing a greater role in public policy debates.[1] This new situation places new demands on policy makers.[2]

The commonwealth and state governments each now have an agency, or group of agencies, dealing with policies and programs in science and technology.[3] In some cases these are tied to traditional portfolios such as industrial development, resources development, agriculture or education, and in other cases new types of agencies have been established to work across traditional portfolio boundaries. Either way, this

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[1]A recent collection of studies of Australian science, from the vantage point of the history of the Australian and New Zealand Association for the Advancement of Science, may be found in R. MacLeod, ed., *The Commonwealth of Science: ANZAAS and the Scientific Enterprise in Australasia, 1888-1988* (Melbourne: Oxford University Press, 1988).

[2]An example of the scholarly interest in Australian science-and-technology policy which emerged at the end of the 1970s may be found in S. Encel and J. Ronayne, eds., *Science, Technology and Public Policy: An International Perspective* (Rushcutters Bay: Pergamon Press, 1979). Publications which followed include: R. Johnston, *Key Issues for Australian Science Policies* (Wollongong: University of Wollongong, 1980); G. Alpine and R. Badger, *Bases for Science and Technology Policy* (Canberra: Policy Division, Department of Science and Technology, 1981); S. Hill and R. Johnston, eds., *Future Tense? Technology in Australia* (St. Lucia: University of Queensland Press, 1983); J. Ronayne, *Science in Government* (Caulfield, Aust.: Edward Arnold, 1984), 142-173. For a recent review see L. Dwyer, "Science and Technology Policy in Australia: Three Studies", *Prometheus* 5, no. 2 (1987): 419-426.

[3]Useful sources of information here are: Organisation for Economic Cooperation and Development, *Reviews of National Science and Technology Policy: Australia* (Paris: Organisation for Economic Cooperation and Development, 1986); J. Ford, *Scitech Technology Directory, 1987-88 Edition* (Canberra: Scitech Publications, 1988); Department of Industry, Technology and Commerce, Policy Development Unit, *Industry and Technology Policy - An Information Paper* (Canberra: Department of Industry, Technology and Commerce, March 1987); Department of Industry, Technology and Commerce, *State Industry Policies*, An Information Paper Prepared for the Economic Planning and Advisory Council, EPAC Discussion Paper 88/04 (Canberra: Economic Planning and Advisory Council, March 1988).

emerging interest in science and technology has an impact on the budgetting process and organizational structure of the public sector. Inevitably, much of the experimentation with new agencies, policies and programs is linked to the political arena and, as such, is subject to public exposure. Public attitudes to technology and science provide a component of the environment in which politicians and public officials operate.

The new attention given to matters scientific and technological is not limited to the public sector. The mass media now abound with references to science and technology.[4] In addition to the popular radio programs of the Science Unit of the Australian Broadcasting Commission, commercial television stations now compete for prime-time viewing audiences by broadcasting futuristic "gee whiz" science and technology programs (e.g., *Beyond 2000*). Newspapers now have regular technology sections (albeit mainly computing news) and terms such as "high-tech" are frequently used as symbols in general reporting. "High-tech" is now a powerful symbol employed by advertizing agencies in promoting almost any product, whether or not it has a significant science-based technological dimension to it.[5]

The business community has also embraced something of the new interest in technology and science. This is illustrated by the emergence of new technology-based firms, the experiments of large corporations in buying or establishing innovative research-and-development subsidiaries, and perhaps most vividly through the speculation over new-technology companies (genuine or otherwise) on stock exchange second boards.

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[4]For an international perspective on the media, science and technology see: L. H. Lapham, ed., *High Technology and Human Freedom* (Washington, D. C.: Communications Press, 1985), 139-158; D. Nelkin, *Selling Science: How the Press Covers Science and Technology* (New York: W. H. Freeman, 1987).

[5]T. Forester, *High-Tech Society* (Oxford: Basil Blackwell, 1987).

In this environment the Australian public sector has taken a greater interest in the problems of evaluating new technology to determine its likely social, economic and environmental impacts.[6] Public opinion has been a significant source of pressure behind this tendency. An early expression of this was the introduction of legislation at various levels of government concerning environmental impact statements or environmental review and management plans.[7] The extension of this approach to the consideration of social impacts was signalled during the late 1970s by the Commonwealth Government's establishment of the Committee of Inquiry into Technological Change in Australia.[8] While there has been much argument over the quality, substance and politics of that inquiry, the important thing to recognize here is that the Government perceived that it was politically necessary to institute such a major and costly exercise.

The Commonwealth Government's investigation of the social impacts of technological change has continued into the mid-1980s.[9] More recently the Senate Standing Committee on Science, Technology and the Environment conducted a major inquiry which has led to calls for formal technology assessment facilities to be set up.[10] This inquiry emerged in the context of a new push during the last several years by the Government to promote new technology as an antidote to the country's economic

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[6]Australian Government interest in technology assessment, which emerged during the 1970s, is represented in a report by the Commonwealth's (now dispersed) Department of Science and the Environment: *Technology Assessment: Proceedings of the 1979 Workshop on Technology Assessment - Its Role in National and Corporate Planning, Sydney, 25-26 July, 1979* (Canberra: Australian Government Publishing Service, 1980).

[7]For an early example see: Australian Conservation Foundation, *The EIS Technique: Papers of a Symposium held at the Australian Academy of Science, Canberra, 29-30 November, 1974* (East Melbourne: Australian Conservation Foundation, 1975). Cf., Commonwealth of Australia, House of Representatives, Standing Committee on Environment and Conservation, *Environmental Protection: Adequacy of Legislative and Administrative Arrangements* (Canberra: Australian Government Publishing Service, 1980).

[8]Committee of Inquiry into Technological Change in Australia (Chairman: R. Myers), *Technological Change in Australia,* Vols. 1-4 (Canberra: Australian Government Publishing Service, 1980).

[9]P. McCann, K. Fullgrabe, and W. Godfrey-Smith, *Social Implications of Technological Change* (Canberra: Australian Government Publishing Service, 1984).

[10]Senate Standing Committee on Science, Technology and the Environment, *Technology Assessment in Australia* (Canberra: Australian Government Publishing Service, 1987).

ills.[11] The majority of the Commonwealth's recent initiatives in this area aim to promote science and technology as stimuli for economic growth and industrial restructuring.[12] Nevertheless, it appears that the Parliament is not in agreement over the likely employment impacts of these initiatives.

While it is frequently acknowledged that new technology may be labour-displacing, the adoption of such technology is normally seen as a strategy to avert even greater job loss which would otherwise arise through Australia lagging behind the technological and industrial prowess of international competitors. Alongside this defensive strategy for the use of science and technology (with an emphasis on protecting existing industry against job loss) there is also a more offensive strategy emerging at both the federal and state levels for the creation of new science-based industries with new types of "high-tech" jobs.[13] Despite the economic hopes now widely placed in science and technology, the demand for investigations, such as the Senate's Inquiry mentioned above, reveals a lingering lack of confidence in the community about whether the needs of certain sectors of the community will automatically be met through the vigorous development of science and technology.[14]

The Australian public sector, inconclusion, is promoting one set of initiatives which reflect a positive evaluation of the contribution of new technology to society, while simultaneously taking another set of initiatives predicated upon a concern that new technology might not be quite so beneficial. It appears that this situation represents a

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[11]See Department of Science and Technology, *National Technology Strategy Discussion Document* (Canberra: Department of Science and Technology, 1984).

[12]R. Joseph, "Recent Trends in Australian Government Policies for Technological Innovation", *Prometheus* 2, no. 1 (1984): 93-111; B. O. Jones, "Preparing for the Future: Science and Technology in Australia", *International Journal of Technology Management* 2, no. 1 (1987): 5-24.

[13]For a review of the recent development of perspectives amongst O.E.C.D.-member policy makers on the relationship between technological change and employment, see R. Brainard and K. Fullgrabe, "Technology and Jobs", *Science, Technology, Industry Review* (O.E.C.D.) no. 1 (Autumn 1986): 9-46.

[14]Two critical discussions of this general topic are: K. W. Willoughby, *Technology for Employment Creation*, Apace Occasional Paper #1 (Perth, Aust.: Apace Western Australia, 1985); C. Gill, *Work, Unemployment and the New Technology* (Cambridge: Polity Press, 1985).

fundamental ambiguity in the public sector understanding of science and technology? Does this ambiguity reflect a more widespread ambivalence in the Australian public towards new technology? In this paper we seek to throw light on this question.

Because public sector initiatives concerning science and technology are affected-by and, arguably, also partly limited-by public opinions about science and technology, it is important for policy makers to have informed pictures of public attitudes in this field.[15] We seek to paint part of such a picture here by reporting on the results of empirical research on the attitudes of one important sector of the Australian public, namely, senior business executives. Before doing so, however, we will briefly review relevant existing literature.

**Attitudes to science and technology: international trends**

The Twentieth Century is frequently characterized as a period of unprecedented and rapid change. Science and technology have been salient in the social change which has occured both internationally and regionally. Public attitudes to science and technology have also shifted over time, both reflecting and affecting the state of technical knowledge.

The prominence of science and technology in contemporary society is to some extent a legacy of the prevailing international environment in the first half of the century. The great exhibitions in the opening decades of the century symbolized the celebration of technological prowess which was growing in both Europe and the New World,[16]

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[15]Some scholars have argued that science and technology initiatives are (and should be) limited not only by public attitudes but also by a range of other social constraints. E.g.: D. A. Bella, "Technological Constraints on Technological Optimism", *Technological Forecasting and Social Change* 14 (1979): 15-26; J. Hubner, "Limiting the System and Reshaping Lifestyles: Solving Unemployment by Social and Technical Innovations", *Technological Forecasting and Social Change* 15 (1979): 37-54; R. Coppock, *Social Constraints on Technological Progress* (Aldershot, Hampshire: Gower, 1984).

[16]See Lewis Mumford's classic two-volume study of the changing symbols of the "technological society": *The Myth of the Machine*, vol. 1, *Technics and Human Development* (New York: Harcourt, Brace

together with the confidence placed on technology as a source of material prosperity and mastery over nature.[17] The massive increase in public expenditure on science after World War II grew from the fertile ground of public confidence in science and technology of earlier years.[18]

The expansion of science and technology budgets in industrialized countries during the post-war period was accompanied by a series of international programs to transfer technology to the "developing" countries in the hope that by such efforts these countries could achieve economic prosperity without undergoing the lengthy process of indigenous technological transformation experienced in Europe and North America.[19]

By the late 1960s and early 1970s, however, public confidence in science and technology was seen by commentators to be diminishing. The reasons for this were varied.[20] The deployment of the atomic bomb at the end of the Second World War, followed by the accumulation of nuclear weapons by the superpowers, spawned disbelief of science and technology as benign and led to the formation of pressure groups advocating new controls being placed upon scientific and technological activities.[21] The persistence, and even deepening of poverty in the "developing" countries, raised doubts about the

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and Jovanovich, 1967); *The Myth of the Machine*, vol. 2, *The Pentagon of Power* (New York: Harcourt, Brace and Jovanovich, 1970).

[17]A historical and philosophical treatment of this perspective may be found in W. Leiss, *The Domination of Nature* (Boston: Beacon Press, 1972).

[18]C. Freeman, "Technological Change and the New Economic Context", in *Future Tense? Technology in Australia*, ed. Hill and R. Johnston (St. Lucia: University of Queensland Press, 1983), 46-67

[19]An example from the early 1960s of the sanguine view of the prospects for technology transfer see A. Goldschmidt, "Technology in Emerging Countries", in *The Technological Order*, Proceedings of the Encyclopaedia Britannica Conference, Santa Barbara, California, 1962, ed. C. Stover (Detroit: Wayne State University Press, 1963), 197-216. For more recent, and more sober appraisals, cf.: J. S. Szyliowicz, ed., *Technology and International Affairs* (New York: Praeger, 1981); O. Hieronymi, ed., *Technology and International Relations* (Basingstoke: MacMillan, 1987).

[20] Critical reviews of the emerging disquiet over the status of science and technology include: B. Gendron, *Technology and the Human Condition* (New York: St. Martin's Press, 1977); A. Mazur, *The Dynamics of Technical Controversy* (Washington, D. C.: Communications Press, 1981); D. Nelkin, ed., *Controversy: Politics of Technical Decisions*, 2d ed. (Beverly Hills: Sage, 1984); S. Yearly, *Science, Technology and Social Change* (London: Unwin Hyman, 1988).

[21]D. Nelkin, *Nuclear Power and its Critics* (Ithaca: Cornell University Press, 1971)

universal applicability of "Western" technology[22] and led to debates over the role of technology in North-South relations.[23] The growth of environmentalism in industrialized countries, together with public abhorrence at the destructive and inhumane use of sophisticated technology by the military, especially in Vietnam, added to the growing lack of confidence in both science and technology and the "system" in which they seemed to be embedded.[24]

The global economic malaise of the 1970s, together with widespread structural unemployment, led to even less confidence in the notion that expenditure on science and technology would automatically lead to social and economic benefits.[25] During that decade public funding for science and technology became constrained in most industrialized countries.[26] At the same time, concerns were emerging over an apparent anti-technology sentiment in Western culture.[27] This was reflected in literature, in art and in a shift in university enrolments away from the natural sciences and engineering towards the social sciences and humanities.[28] Literature dealing with the theme of

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[22]R. Clarke, *Science and Technology in World Development* (Oxford and New York: Oxford University Press; Paris: UNESCO, 1985).

[23]J. Galtung, *The North/South Debate: Technology, Basic Human Needs and the New International Economic Order* (New York: Institute for World Order, 1980).

[24]Empirical research on these phenomena has been published by S. Cotgrove (*Catastrophe or Cornucopia: The Environment, Politics and the Future* (Chichester: John Wiley and Sons, 1982). An early philosophical-cum-sociological study which discussed the same issues, but from a different perspective, is T. Roszak's work, *The Making of a Counter Culture: Reflections on the Technocratic Society and its Youthful Opposition* (London: Faber and Faber, 1968).

[25]The need to formulate new approaches within science and technology policy in response to these developments was addressed by the Organisation for Economic Cooperation and Development in the work of an international study group which it convened during 1969 (see H. Brooks, et al., *Science, Growth and Society: A New Perspective* [Paris: Organisation for Economic Cooperation and Development, 1971]). A subsequent O.E.C.D. study group, working at the close of the 1970s, concluded that fundamental structural changes had occurred in the international economy which called for equally fundamental policy changes (see B. Delapalme, et al., *Technical Change and Economic Policy: Science and Technology in the New Economic and Social Context* [Paris: Organisation for Economic Cooperation and Development, 1980]).

[26]Freeman, "Technological Change".

[27]A. Mazur, "Opposition to Technical Innovations", *Minerva* 13 (1975): 58-81.

[28]Interest in science amongst students in the United States has been falling steadily over the last two decades. In 1988 only 5.8% of college/university freshmen planned to pursue science majors, compared with 11.5% in 1973; pursuit of technology majors (in engineering and computing) has been in steady decline since 1973, but has shown signs of levelling off in 1988 (American Council on Education and UCLA Higher Education Research Institute, cited by P. West, *UC Focus* [Office of the President, University of California] 3, No. 5 [1989], 2).

technology growing out of human control became widespread.[29] Calls increased for the social and environmental assessment of technology[30] and for public participation in technological decision-making.[31]

Alongside both the pro-technology and anti-technology streams of thought during the 1970s a third stream of thought emerged; its adherents called for neither the abandonment nor the simple acceptance of technology, but instead for its transformation. Known variously as the "appropriate technology" movement or the "alternative technology" movement, this stream of thought gained many followers internationally, with over one thousand organizations established by the beginning of the 1980s to conduct or promote work based upon its perspective.[32] The themes of the appopriate technology movement have been taken up by certain technology-policy analysts under the rubric of "technology choice".[33] Others have emphasized "controlling" or "directing" technology.[34]

Most of the critiques of the technological society published prior to the mid-1970s are of a literary or historical style.[35] During the last decade, however, and in response to these

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[29]See L. Winner, *Autonomous Technology: Technics-out-of-control as a Theme in Political Thought* (Cambridge, Mass.: M.I.T. Press, 1977) for a widely-cited review of this literature.

[30]F. Hetman, *Society and the Assessment of Technology; Premises, Concepts, Methodology, Experiments, Areas of Application* (Paris: Organisation for Economic Cooperation and Development, 1973). By the end of the decade the methods of technology assessment were beginning to become formalized into professional techniques (see A. L. Porter, et al., *A Guidebook for Technology Assessment and Impact Analysis* [New York: North Holland, 1980]).

[31]K. Guild Nichols, *Technology on Trial: Public Participation in Decision-making Related to Science and Technology* (Paris: Organisation for Economic Cooperation and Development, 1979).

[32]This stream of thought was popularized by E. F. Schumacher in his book *Small is Beautiful: A Study of Economics as if People Mattered* (London: Blond and Briggs, 1973). Cf.: N. Jéquier and G. Blanc, *The World of Appropriate Technology* (Paris: Organisation for Economic Cooperation and Development, 1983); K. W. Willoughby, *Technology Choice: A Critique of the Appropriate Technology Movement* (Boulder and London: Westview Press [in press]).

[33]E.g.: P. A. David, *Technical Choice, Innovation and Economic Growth* (Cambridge: Cambridge University Press, 1975); M. Goldhaber, *Reinventing Technology: Policies for Democratic Values* (London and New York: Routledge and Kegan Paul, 1986); E. Wenk, *Tradeoffs: Imperatives of Choice in a High-tech World* (Baltimore: Johns Hopkins University Press, 1986).

[34]E.g.: D. Elliot and R. Elliot, *The Control of Technology* (London: Wykeham, 1976); R. Johnston and P. Gummet, eds., *Directing Technology* (London: Croom Helm, 1979).

[35]E.g.: G. F. Jünger, *The Failure of Technology* (Chicago: Regnery, 1956); L. Mumford, *Technics and Civilization* (New York: Harcourt, Brace and Jovanovich, 1963); H. Marcuse, *One Dimensional Man*

critiques, a number of scholars have engaged in empirical, quasi-empirical and analytical studies of public opinion about science and technology.[36] One of the biggest of these studies was a international collaborative project conducted under the auspices of the Technical Change Centre (T.C.C.) in London. The project, entitled "Comparitive National Assessments of Public Attitudes to New Technologies", grew out of the 1982 Versailles "Economic Summit" of the heads-of-government of Canada, France, West Germany, Italy, Japan, the United Kingdom and the United States. The project took place between 1982 and 1986 and involved participation by scholars representing over a dozen countries.[37]

The T.C.C.'s project revealed considerable diversity between countries in the public acceptance of technology. The project also revealed a general international pattern. Public attitudes tended during the 1950s and early 1960s to take the form of a "silent consensus" about the purported benefits of science and technology. A shift away from this position occured during the 1970s, with the public in some countries exhibiting apparent anti-technology sentiments. During the 1980s technology has once again been

(Boston: Beacon Press, 1964); J. Ellul, *The Technological Society*, trans. J. Wilkinson (New York: Alfred A. Knopf, 1964); V. Ferkiss, *Technological Man: The Myth and the Reality* (London: Heinneman, 1969). These studies have continued to appear beyond the mid-1970s. e.g.: E. Schuurman, *Technology and the Future: A Philosophical Challenge* (Toronto: Wedge,1977); E. Braun, *Wayward Technology* (London: Frances Pinter, 1984); B. Frankel, *The Post-Industrial Utopians* (Cambridge and Oxford: Polity Press in association with Basil Blackwell, 1987).

[36]E.g.: R. Maderthaner, et al., *Perception of Technological Risks: The Effect of Confrontation* (Laxenburg, Austria: International Institute for Applied Systems Analysis, 1976); N. Postman, *Conscientious Objections: Stirring Up Trouble About Language, Technology and Education* (New York: Knopf, 1988); A. Kuhlman, "Problems Associated with the Acceptance of New Technologies in Industrialized Societies", *International Journal of Technology Management* 2, no. 2 (1987): 209-217; D. Yankelovitch, "Changing Public Attitudes to Science and the Quality of Life", *Science, Technology and Human Values* 7, no. 39 (1982): 123-129; G. Pion and M. Lipsey, "Public Attitudes Towards Science and Technology", *Public Opinion Quarterly* 45 (1981), 303-316; J. D. Miller, *The American People and Science Policy: The Role of Public Attitudes in the Policy Process* (New York: Pergamon Press, 1983); National Science Board, *Science Indicators*, Biennial Report, National Science Board, Washington, D. C.; A. A. Beveridge and F. Rudell, " An Evaluation of 'Public Attitudes Toward Science and Technology' in *Science Indicators; The 1985 Report*", *Public Opinion Quarterly* 52, no. 3 (1988): 374-385.

[37]The main project report was published as a book edited by R. Williams and S. Mills (*Public Acceptance of New Technologies: An International Review* [London: Croom Helm, 1986])

viewed as a vehicle for social benefit, but with less public consensus than prior to the 1970s.

The T.C.C. study and most of the scholarly papers recently published in the field point to the prevalence of more complex and ambivalent attitudes to science and technology during the current decade than earlier. The public in most countries studied appears now to exhibit neither simple acceptance nor simple rejection of science or technology.

Two seminal empirical surveys appeared in the mid-1970s, one from the United States and one from France, which deserve particular attention.

The first, published by La Porte and Metlay in 1975, examined American attitudes towards science and technology (based primarily on evidence from a survey of just under one thousand Californians).[38] They reported that there no longer appeared to be a broad consensus amongst the public on the automatic benefits of technological development. They found that, whereas science and technology used commonly to be grouped together synonomously, the public had come to make distinct evaluations of the outcomes of scientific and technological work. It was discovered that, while a generally supportive attitude towards science remained in the community, the public's reaction to the impact of technology on society had become one of wariness and skepticism. A distrust of the institutions associated with decision-making in technical policy areas was also found in the public. Evaluations of technology were found not to be independent of the political ideologies of those making the evaluations. Finally, it was also found that the public applied a wide range of values when evaluating technology, with such values sometimes being contradictory.

The work of La Porte and Metlay, in short, revealed a growing uneasiness in the American public about technology, but with a basic confidence remaining in science.

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[38]T. R. La Porte and D. Metlay, "Technology Observed: Attitudes of a Wary Public", *Science* 185 (April 1975): 121-127.

The growing links between science and technology could, La Porte and Metlay nevertheless suggested, have the result of transferring prevailing uneasiness about technology onto science.

The second seminal study, published by Gaudin in 1976, was based on a survey of a representative sample (one thousand people) of the French public, and revealed a similar uneasiness towards technology as that found by La Porte and Metlay in the United States.[39] Gaudin found that the French public had developed an antagonistic attitude towards existing technological innovation; although optimism was also present about the possibility that technology might, in principle, be used creatively to overcome existing technology-related problems.

The majority surveyed in the Gaudin study thought that technological innovation was creating an artificial way of life, threatening the life of the next generation, taking away human freedom, destroying nature, and producing unnecessary waste through poor production methods. While believing that new technology could improve production methods and raise income levels, the public did not on the whole believe that new technology could reduce unemployment or the risks of war, or that it could increase harmony with nature, or help give a poetic sense to life.

Both of the above two studies suggest that policy makers ought not to assume that policies in support of technological innovation or science will automatically receive a simple endorsement by the public. Subsequent research has affirmed this interpretation.[40] Most studies also suggest that the public appears capable, on the whole, of discriminating between different fields of technology (e.g., nuclear-energy technology and health-care facilities) and of simultaneously being supportive of one while being opposed to the other. The public in advanced industrial nations is less

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[39]M. T. Gaudin, "Public Opinion on Innovation in France", *Research Policy* 5 (1976): 106-114.
[40]See items in note 36 above.

likely to hold "blanket" opinions about science or technology (understood as a ubiquitous single entity) than was suggested by much of the critical literature on the technological society of one or two decades ago.

## Attitudes to science and technology in Australia: recent research

A study by Moran of debates about Australian science suggests that changes in public attitudes to science and technology can alter the circumstances under which scientists and technologists operate.[41] Moran identifies shifts in the rhetoric of scientists corresponding to certain changes in the social environment. During the 1940s, in the aftermath of World War II, scientists promoted the notions that science was a key national resource and that scientists ought to have a key role in policy making and society at large. With the outbreak of the Cold War, however, the rhetoric altered with scientists seeking to distance themselves from political controversy associated with the social impacts of science and technology. Consequently, the rhetoric of "excellence in science" began to replace the rhetoric of "relevance" as a justification for government support. During the 1980s, as the strategic relationships between science, technology and the economy have gained in political significance, the rhetoric of "relevance" has once again been adopted by scientists. Moran argues that Australian scientists have a tradition of seeking to protect the autonomy of their work from government intervention, while changing the language used to justify funding for their work as community attitudes towards science and technology alter.

One of the first serious attempts to analyse the attitudes of the Australian public towards science and technology was undertaken by Stubbs in his contribution to the

[41]J. Moran, "Rhetoric and Representation in Australian Science in the 1940s and 1980s", *Prometheus* 1, no. 2 (1983), 271-289. Cf. J. D. Miller, *American People and Science Policy.*

international project of the T.C.C.[42] Stubbs found that Australians (during the early 1980s) were generally favourably disposed towards new technologies, but that opposition towards specific cases of microeconomic technological change did occur when this threatened the sectional interests of specific groups. He concluded that such cases of opposition to technological change tended not to represent general opposition to technological change at the macroeconomic level. He cautioned, nevertheless, that there might be a compound effect of the microeconomic-level opposition to technological change which could impede positive technological change for the society as a whole.

As Stubbs indicated himself, his study was severely hampered by a paucity of reliable data on which to base analysis. His conclusions therefore need to be treated as tentative. The empirical information to which he did have access came largely from indirect sources. Most objective information on Australian attitudes to science and technology had been suffused within the results of broad social surveys designed to investigate subject matter other than attitudes towards science and technology.

The situation has begun to improve, however, with the recent commissioning by Telecom Australia of a survey of Australian attitudes to science and technology,[43] the recent publication of a comprehensive review of the subject by Eckersley (under the auspices of the Commonwealth Government's Commission for the Future),[44] and a symposium on "Public Perceptions of Science" at the ANZAAS Centenary Congress in Sydney on 16 May 1988.

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[42]P. Stubbs, "Public Acceptance of New Technologies in Australia", in *Public Acceptance of New Technologies: An International Perspective*, ed. R. Williams and S. Mills (London: Croom Helm, 1986), 190-222.

[43]Frank Small and Associates, pilot study for Telecom Australia on public attitudes to science and technology (in progress).

[44]R. Eckersley, *Australian Attitudes to Science and Technology and the Future*, Report for the Commission for the Future (Canberra: Australian Government Publishing Service, 1988).

In a recent paper, based on his work for the Commission for the Future and additional research, Eckersley confirms the conclusion of Stubbs that, contrary to prevailing views, Australians are generally well disposed towards science and technology.[45] Drawing upon data from two "omnibus" social surveys he reports that the percentage of Australians saying that technological developments have more benefits than disadvantages has increased in recent years (from 54% in 1983 to 64% in 1987).[46] Eckersley also reports that despite this high level of support shown for technology a similar percentage of the population also expressed concern about the unintended consequences of science and technology, and a sense that science and technology are growing in power and somehow getting out of control. About half of the respondents in one survey agreed that "technology is taking the human element out of life".[47] Attitudes of Australians towards science and technology were also found to vary between social groups, perhaps reflecting the uneven distribution of benefits and costs throughout the community.

In summary, the evidence of the existing literature is that while the Australian public does exhibit positive support for science and technology, this support is problematical and, to some extent, ambivalent. In this respect the attitudes of the Australian public are in keeping with those which predominate internationally in advanced industrial nations.

The recent studies on attitudes of the Australian public to science and technology have produced salient themes for additional research. Given that the attitudes thus far identified appear to vary demographically, it would be useful for future empirical studies to elucidate the variations between different social groups. Our study of one particular social group, business executives, is a first step towards such a goal.

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[45]R. Eckersley, "What Australians Think About Science and Technology", *CSIRO Industrial Research News* 188 (August 1988): 5-7.

[46]*Ibid.*, 5.

[47]Frank Small and Associates, cited by Eckersley, "What Australians Think", 5.

## Attitudes of Australian Business Executives

Corporate business executives form one group whose views are of critical importance to the community. Although public opinion researchers have attempted to monitor public opinions about science and technology, very little is known specifically about the attitudes of top business executives and decision makers. It is reasonable to propose that their decisions concerning, for example, investment in R & D and the adoption of technological innovations, will be somewhat determined by their attitudes to science and technology. The balance of this paper reports on a study of the attitudes of Australian business executives, with the aim of shedding light on the likely implications for public policy.

### *Study Procedure and Sample*

The study involved a cross-sectional survey of a sample of senior level business executives in Western Australia during 1983. On the basis of this exploratory work, a preliminary questionnaire was designed, drawing upon the questionnaires originally used in the work of Gaudin, and La Porte and Metlay, adapted to the Australian context.[48] The initial exploratory phase involved interviews with executives as well as a survey of the literature. This was presented to a test group of executives and revised prior to data collection.

The organizations were selected utilizing the business pages of the Western Australian metropolitan telephone directory. Interviewers telephoned or approached 852 corporations of which 356 agreed to participate. Within these corporations appointments were made with the chief executive and/or other members of the top decision making team. The interviewer then visited the company, explained the nature of the questionnaire to the executive concerned and left it with the executive

[48]Gaudin, *op. cit.*; La Porte and Metlay, *op. cit.*

with an understanding that it would be completed within two weeks when the interviewer would return to pick it up. A total of 211 substantially completed questionnaires were collected and used in the analyses to be described. The response rate of 24% of firms approached and 59% of those who agreed to participate was considered satisfactory given: a lengthy survey instrument; the confidential nature of some of the information sought; and, the high social and managerial level of the respondents.

The executives surveyed came from a wide range of industries. The average age of the executives was 41 years, they had typically been employed by their organizations for 9 years, and they had on the average spent 4-5 years in their present position. Approximately half the firms had sales in excess of $100 million and 42% of the firms were involved in what are popularly thought of as a "high technology" industries, e.g., electronics, communications, medical equipment, machine tools, amongst others. The diversity of organizational size and business activity in the sample justifies the drawing of some generalizations from the study.

*Results and Discussion*

One of the concerns of La Porte and Metlay in their study was with whether the U.S. public was able to distinguish between science and technology. La Porte and Metlay defined science as "the activity of discovering new knowledge and includes the development of prototype inventions" and technology as "the activity which leads to the widespread availability of products based predominantly on scientific knowledge.[49] If these two were considered indistinguishable aspects of a continuous process then public misgivings concerning technology (to which they were much closer) would be translated into a desire for control of both science and technology.

[49]La Porte and Metlay, *op. cit.*, 123.

Table 1 presents data from our study on Australian executives' views on control of science and technology. The results are similar to those found by La Porte and Metlay. The data show that most executives (83%) believed that scientific activities are intrinsically beneficial and that scientists should be given a high degree of autonomy. Strong uneasiness was expressed, however, over the uses to which scientific discoveries may be put. An overwhelming majority (77%) agreed with the statement that "basically all scientific discoveries are good things, it is just how people use them that causes all the trouble."

In their attitudes towards the control of technology the executives displayed more ambivalence. The sample was fairly evenly split (34% to 37%) on the issue that "control of invention will worsen our lives". While 56% agreed that there should be "no regulation of inventions because it interferes with the individuals right to buy", 28% of the executives disagreed with the statement. It is also interesting that 31% believed that regulation of technology is possible, while 40% believed it is not. The results also indirectly confirmed the La Porte and Metlay conclusion that the public is able to distinguish between science and technology.[50]

These findings indicate that the executives tend to believe that science, in and of itself, should not be controlled. It is only in the utilization of science and its implementation as technology that problems are perceived. The sizable proportion who apparently believe that some control of technology is possible and necessary, may have strong implications for public policy. Strong control of science and technology by government may be acceptable to a larger proportion of executives than is commonly thought to be the case.

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[50]La Porte and Metlay, *op. cit.*, 122 - 123.

## TABLE 1

### THE EXTENT OF DESIRE FOR CONTROL OF SCIENCE AND TECHNOLOGY

| Statement | % Strongly Agree 1 | 2 | 3 Neither | 4 | 5 Strongly Disagree | Mean | Std. dev. | Samp. size |
|---|---|---|---|---|---|---|---|---|
| *Science* | | | | | | | | |
| 1. Allow studies: obtain future benefits | 46 | 37 | 11 | 6 | 1 | 1.8 | .9 | 209 |
| 2. Science good, use of science bad | 37 | 40 | 10 | 11 | 1 | 2.0 | 1.0 | 209 |
| *Technology* | | | | | | | | |
| 3. Control invention life worsens | 11 | 23 | 28 | 27 | 10 | 3.0 | 1.2 | 209 |
| 4. No interference with right to buy justifiable | 21 | 35 | 15 | 21 | 7 | 2.6 | 1.2 | 209 |
| 5. Insufficient knowledge for regulation | 19 | 21 | 29 | 24 | 7 | 2.6 | 1.2 | 209 |

NOTE: The full wording of each statement was:

1) Unless scientists are allowed to study things that don't appear important or beneficial now, a lot of beneficial things probably won't ever be invented.

2) Basically all scientific discoveries are good things; it is just how people use them that causes all the trouble.

3) Any attempt to control which inventions are widely produced or made available will make our lives worse.

4) No one should attempt to regulate which inventions are produced because it interferes with the individual's right to decide what he wants to buy.

5) No one should attempt to regulate which inventions are produced because they do not know how to do it.

Another issue of importance has to do with alienation and confidence in science and technology. As we indicated earlier, many writers in advanced industrial nations have expressed disillusionment with techno-industrial advance, and have sought a return back to a more "natural" and less complicated life. Accompanying this "alienation" has been a loss of faith in the ability of scientists and technocrats to solve problems facing the present generation. Data pertaining to these two issues are presented in Table 2.

Strong majorities clearly dismissed the notions of the desirability of a return back to nature (68%) and that technology has made life too complicated (74%), although in both these cases there was some agreement with the statements (17% and 16%). The distribution of the responses to the statement that "people have become too dependent on machines" was bipolar (40% agreed and 46% disagreed). The especially notable finding here is that over half the executives (54%) lacked faith in the capacity of technology to solve the problems caused by its harmful effects. These findings may be summarized as: (1) the majority of the executives did not believe that a return back to nature was desirable; (2) technology is not perceived as having made life too complicated; (3) opinion as to whether people had become too dependent on machines was evenly divided; and, (4) a majority believed that new inventions can not solve the harmful effects of technology.

Following the approach of La Porte and Metlay, data was collected concerning two other issues of consequence. First, an attempt was made to assess the executives' evaluations of specific existing technological developments. They were asked to indicate the extent to which six highly visible technological fields (household appliances, automobiles, automated factories, space program, atomic weapons and nuclear power) have made life better or worse. The results shown in Table 3 indicate a highly positive evaluation of past technological developments. The production of atomic weapons is the only technology which was to a large extent viewed as having made life worse (47%). The

data, therefore, show a distinct positive evaluation of past technological developments with a certain degree of uneasiness about the future directions of that development.

**TABLE 2**

DISENCHANTMENT OF EXECUTIVES WITH TECHNOLOGY

| Statement | % Strongly Agree 1 | 2 | Neither 3 | 4 | Strongly Disagree 5 | Mean | Std. dev. | Samp. size |
|---|---|---|---|---|---|---|---|---|
| 1. To go back to nature desirable | 3 | 14 | 14 | 27 | 41 | 3.9 | 1.2 | 209 |
| 2. Life too complicated | 2 | 12 | 10 | 30 | 44 | 4.0 | 1.2 | 209 |
| 3. Overdependence on machines | 12 | 28 | 13 | 24 | 22 | 3.2 | 1.4 | 209 |
| 4. Technology can solve | 9 | 21 | 16 | 29 | 25 | 3.4 | 1.3 | 209 |

NOTE: The full wording of each alienation-confidence statement was:

i) It would be nice if we would stop building so many machines and go back to nature.

ii) Technology has made life too complicated.

iii) People have become too dependent on machines.

iv) People shouldn't worry about harmfull effects of technology because new inventions will always come along to solve the problems.

Second, the respondents were asked to indicate the level of importance certain social goals should be given in evaluating the impact of technology. They were instructed to choose the most important of 10 given goals and give it a value of six (high importance) and to then choose the least important and to assign it a value of zero (no importance). They were then to assign values to the rest of the goals in relation to these two. The ten goals, and the means and standard deviations of the scores, are shown in Table 4.

**TABLE 3**

TECHNOLOGY - PAST BENEFITS

| Development | % As a result of each development life is ... Very much better 1 | 2 | 3 | 4 | Very much worse 5 | Mean | Std. dev. | Samp. size |
|---|---|---|---|---|---|---|---|---|
| 1. Household Appliances | 77 | 21 | 1 | 0 | 0 | 1.3 | 0.6 | 209 |
| 2. Automobiles | 56 | 38 | 2 | 2 | 1 | 1.6 | 0.8 | 209 |
| 3. Automated Factories | 43 | 41 | 10 | 4 | 2 | 1.8 | 0.9 | 209 |
| 4. Space Program | 38 | 37 | 23 | 1 | 0 | 1.9 | 0.8 | 209 |
| 5. Nuclear Power | 19 | 43 | 26 | 6 | 7 | 2.4 | 1.1 | 210 |
| 6. Atomic Weapons | 6 | 14 | 32 | 19 | 28 | 3.5 | 1.2 | 209 |

The most interesting aspect of these results is the fact that eight of the goals are ranked above the intermediate value of importance (3.0). Only two of the goals ("to increase leisure time" and "to improve Australia's image abroad") were rated, on the average, below the intermediate level of importance. The executives therefore considered a wide range of values to be important in the evaluation of technology. While there could be some inter-value conflict (between, for example, "quality of products and services" and "reduce pollution") the high level of importance of many goals implies that reconciliation and compromises are expected. The high rating of altruistic goals (e.g., "increase employment") and the lower ratings of the more selfish (e.g., "increase corporate profits" and "reduce taxes") suggests that executives are concerned about the public impact of science and technology and would be receptive to the genuine evaluation of technology in the public interest.

**TABLE 4**

IMPORTANT VALUES IN THE IMPLEMENTATION OF TECHNOLOGY

| | Goal | Mean | Standard deviation | Sample size |
|---|---|---|---|---|
| 1. | Increase Standard of Living | 5.0 | 1.2 | 208 |
| 2. | To Increase Employment | 4.5 | 1.5 | 207 |
| 3. | To Improve Quality of Products and Services | 4.5 | 1.4 | 205 |
| 4. | To make Life Enjoyable | 4.3 | 1.7 | 203 |
| 5. | To Improve Quality of Life for Poor | 4.3 | 1.5 | 206 |
| 6. | To Reduce Pollution | 4.0 | 1.6 | 207 |
| 7. | To Increase Corporate Profits | 3.5 | 1.8 | 203 |
| 8. | To Reduce Taxes | 3.4 | 1.8 | 204 |
| 9 | To Increase Leisure Time | 2.8 | 1.8 | 202 |
| 10. | To Improve Australia's Image Abroad | 2.7 | 2.2 | 206 |

A further topic of relevance to science and technology is the attitude of executives to innovation. It is reasonable to expect that executives in companies conducting research and development (R & D) would generally have a more positive attitude to science and technology, and innovation, than those in companies not involved in R & D. To further explore these issues, the questionnaire developed by Gaudin for his study of public opinion on innovation in France, was utilized in as part of our own questionnaire.[51] Analysis of the results from this part of our questionnaire follows.

[51]Gaudin, *op. cit.*

In Table 5 are displayed the results of responses to a question dealing with the issue of products being designed to "satisfy real needs" or "artificially created needs", cross tabulated according to whether or not each executive's corporation was involved in some form of R & D.

**TABLE 5**

DO NEW PRODUCTS SATISFY ARTIFICIAL OR REAL NEEDS OF THE PUBLIC?

| Statement | Firms with no R & D | | Firms with some form of R & D | | Total | |
|---|---|---|---|---|---|---|
| 1. Artificial needs created to created to sell new products | 56 | (41) | 17 | (29) | 73 | (38) |
| 2. New Products respond to real needs of the public | 79 | (59) | 42 | (71) | 121 | (62) |
| Total (1. and 2.) | 135 | (100) | 59 | (100) | 194 | (100) |
| 3. Don't Know | 4 | | 2 | | 6 | |
| Total Reported (1., 2. and 3.) | 139 | | 61 | | 200 | |
| Unreported | - | | - | | 11 | |
| Total (Reported and Unreported) | - | | - | | 211 | |

NOTE: 1. Figures inside brackets are percentages; all other figures are numbers of respondents

2. $\chi^2(1) = 2.8, p < 0.10$

Not surprisingly, the majority (62%) of the executives felt that "new products respond to the needs of the public". This proportion was higher in companies that were involved in R & D in some form or another (71%) than in those who were not (59%). There was, however, a considerable proportion (38% in total, and 41% in "no R & D" companies) who agreed with the statement that "artificial needs are created to sell new products". This implies that some executives believe that their companies are not responding to market forces but are rather seeking to manipulate public desires. To the

extent that this is a reflection of non-compliance amongst themselves and their peers to the marketing prescription for success (i.e., that organizations should seek to satisfy consumers needs at a profit) this is a matter of some concern. If 40% of industry leaders believe that new products do not satisfy the real needs of the public, it is very difficult to place faith in claims by business leaders that leaving the management of industrial-technological change entirely to the business sector would be the best way to ensure that the public was best served. The response to the above question could be an indicator of deep problems in executives' understanding of, and desire to implement the "marketing concept".[52]

**TABLE 6**

PERCEIVED QUALITY OF PRODUCTS MANUFACTURED

| Statement | Firms with no R & D | | Firms with some form of R & D | | Total | |
|---|---|---|---|---|---|---|
| 1. A decrease in quality | 57 | (41) | 28 | (47) | 85 | (43) |
| 2. An improvement in quality | 69 | (50) | 22 | (37) | 91 | (46) |
| 3. An equal quality | 12 | (9) | 10 | (17) | 22 | (11) |
| Total (1. to 3.) | 138 | (100) | 60 | (100) | 198 | (100) |
| 4. Don't know | 3 | | 1 | | 202 | |
| Total reported (1. to 4.) | 141 | | 61 | | 202 | |
| Unreported | - | | - | | 9 | |
| Total | - | | - | | 211 | |

NOTE: 1. Figures inside brackets are percentages; all other figures are numbers of respondents

2. $\chi^2(2) = 4.7, p < 10$

[52]For a discussion of this concept see, for example, P. Kotler, *Marketing Management: Analysis Planning and Control* (6th ed.; Englewood Cliffs, N.J.: Prentice Hall, 1988).

Another question was designed to assess the extent to which the increased quantity of new product development has been accompanied by changes in product quality (improvement, reduction, no change). The results of the analysis (Table 6) are not comforting from the perspective of consumer service. A high proportion (43%) perceived a decrease in the quality of new products. Surprisingly, the proportion of executives in companies which do conduct R & D in some form, and who also perceived a decrease in product quality associated with innovation, was higher (47%). Inferences which may be drawn from these results are that Australian consumers may not be exerting sufficient pressure on the market system, and/or that they are not in fact faced with much real choice between alternative products within a given field.

**TABLE 7**

SOCIAL GROUPS WHICH BENEFIT FROM INNOVATION

| Social group which benefits | Firms with no R & D | | Firms with some form of R & D | | Total | |
|---|---|---|---|---|---|---|
| 1. Workers | 3 | (2) | 1 | (2) | 4 | (2) |
| 2. Management and Capital | 26 | (18) | 17 | (28) | 43 | (21) |
| 3. One as much as the other | 112 | (79) | 42 | (70) | 154 | (77) |
| Total (1. to 3.) | 141 | (100) | 60 | (100) | 201 | (100) |
| 4. Don't know | 0 | | 1 | | 1 | |
| Total Reported (1. to 4.) | 141 | | 61 | | 202 | |
| Unreported | - | | - | | 9 | |
| Total | | | | | 211 | |

NOTE: 1. Figures inside brackets are percentages; all other figures are numbers of respondents

2. $\chi^2(2) = 2.5, p < 0.30$

A further question sought to establish which of the major social groups (workers or management) was perceived as having most to gain from innovation, not only in terms of new products but also in the transformation of manufacturing techniques and existing products. Most of the executives (77%, see Table 7) indicated that innovation benefits "one group as much as another". It is noteworthy that while 21% indicated that this type of innovation benefits "management and capital" only two percent suggested that it benefits workers. This implies that technological innovations which would benefit workers, first and foremost, rather than corporate owners, are less likely to be pursued than others.[53] The adversarial situation in Australian industrial relations contributes to this state of affairs.[54] The poor quality and low level of imagination in both industry and union leadership has also contributed. Although this situation is changing, Australian unions, even when strong, have tended to focus on salary and wage issues, rather than working conditions, job design, and industrial and technological strategy questions.

Another question explored the extent of perceived difficulty in "creating a new enterprise to exploit a new idea in Australia today." Table 8 shows that executives whose companies are involved in some form of R & D perceived significantly less difficulty in creating a new enterprise. The majorities in each category ("no R & D", 77%; "some form of R & D", 53%; and "overall", 70%), however, stated that starting a new enterprise is "difficult" or "very difficult". Responses to a related question indicated that 80% wished to have an opportunity of creating a new enterprise to exploit a new idea. No significant difference was detected between executives in R & D and "no R & D" companies on this point.

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[53]Cf., Gaudin, *op.cit.*
[54]Kotler, *op. cit.*

## TABLE 8

DIFFICULTY OF CREATING A NEW ENTERPRISE TO EXPLOIT A NEW IDEA IN AUSTRALIA TODAY

| Degree of difficulty | Firms with no R & D | | Firms with some form of R & D | | Total | |
|---|---|---|---|---|---|---|
| 1. Very easy | 2 | (2) | 5 | (9) | 7 | (4) |
| 2. Easy | 30 | (22) | 21 | (38) | 51 | (26) |
| 3. Difficult | 77 | (56) | 21 | (38) | 98 | (51) |
| 4. Very difficult | 29 | (21) | 8 | (15) | 36 | (19) |
| Total (1. to 4.) | 138 | (100) | 55 | (100) | 193 | (100) |
| 5. Don't know | 4 | | 6 | | 10 | |
| Total Reported (1. to 5.) | 142 | | 61 | | 203 | |
| Unreported | - | | - | | 8 | |
| Total | - | | - | | 211 | |

NOTE: 1. Figures inside brackets are percentages; all other figures are numbers of respondents

2. $\chi^2(3) = 42.6, p < 0.001$

Another issue has to do with how innovative Australia is perceived in relation to other countries. Table 9 provides a summary of the executives' points of view on this matter. Australia was clearly not perceived, at the time of the study, as being among the highly innovative nations of the world. It was perceived as being on the border line between the advanced industrial nations and the third world nations. Its perceived relative international position seems to fall roughly between those of France and China. This situation suggests that there may be the grounds for support within the Australian business community for increased public initiatives to enhance Australia's international competitiveness in technological innovation. Nevertheless, as indicated in Table 10, there is also evidence of ambivalence about this matter.

**TABLE 9**

COUNTRIES CLASSIFIED ACCORDING TO WHETHER THEY ARE PERCEIVED AS MORE, EQUALLY OR LESS INNOVATIVE THAN AUSTRALIA

| Country | Percentage of respondents | | | |
|---|---|---|---|---|
| | More | Equally | Less | Don't know |
| 1. Japan | 95 | 4 | 0 | 0 |
| 2. Western Germany | 80 | 17 | 2 | 1 |
| 3. United States | 79 | 20 | 1 | 0 |
| 4. U.S.S.R. | 35 | 18 | 34 | 13 |
| 5. Sweden | 34 | 45 | 10 | 11 |
| 6. France | 29 | 40 | 25 | 6 |
| 7. China | 13 | 17 | 60 | 10 |
| 8. Great Britain | 11 | 41 | 47 | 2 |
| 9. Malaysia | 6 | 19 | 67 | 8 |
| 10. New Zealand | 0 | 38 | 58 | 19 |
| 11. India | 0 | 10 | 81 | 19 |
| 12. Iran | 0 | 1 | 84 | 31 |

The respondents were also asked to rate the importance ("zero" = no importance, to "six" = high importance) of six stimulants for industrial innovation. The results, shown in Table 10, indicate that consumers requirements and profit seeking were the two options believed by the executives to be the most important. No statistically significant differences were found between companies that conduct R & D and those that do not.

**TABLE 10**

STIMULANTS FOR INDUSTRIAL INNOVATION

| Stimulant | | Mean | Std Deviation |
|---|---|---|---|
| 1. | Consumers requirements | 5.1 | 1.1 |
| 2. | Profit seeking | 5.0 | 1.1 |
| 3. | Technical imagination | 4.6 | 1.2 |
| 4. | International competition | 4.6 | 1.3 |
| 5. | State action | 3.3 | 1.5 |
| 6. | Union action | 3.1 | 1.9 |

**TABLE 11**

OBSTACLES FACED BY INNOVATORS

| Obstacle | | Number | Percentage |
|---|---|---|---|
| 1. | Financial institutions do not want to take risks | 167 | 80 |
| 2. | Competitors put up obstacle to new products | 72 | 35 |
| 3. | Consumers do not change their habits | 65 | 31 |
| 4. | The state does not help them | 63 | 30 |
| 5. | Don't know | | |

NOTE: The respondents were asked to indicate two major obstacles from the list. The percentages are based on the proportion of the sample who mentioned the particular problem (i.e. the base is 211).

Table 11 shows the aggregate of the respondents perceptions of the obstacles with which innovators are faced. The respondents were asked to indicate from the list which were the two major obstacles. The biggest obstacle found was the reluctance of financial

institutions to take risk; this was followed by competition, consumers and the state. Again, there were no differences due to the presence of R & D in the respondents' firms.

**TABLE 12**

THE MOST PROBABLE CONSEQUENCES OF THE ENERGY CRISIS ON INNOVATION

| Statement | Firms with no R & D | | Firms with some form of R & D | | Total | |
|---|---|---|---|---|---|---|
| 1. Increase in innovation effort | 100 | (70) | 30 | (49) | 130 | (64) |
| 2. Decrease in innovation effort | 2 | (1) | 5 | (8) | 7 | (4) |
| 3. Increase in some sections decrease in others | 35 | (25) | 16 | (26) | 51 | (25) |
| 4. Don't know | 5 | (4) | 10 | (16) | 15 | (7) |
| Total Reported | 142 | (100) | 61 | (100) | 203 | (100) |
| Unreported | - | | - | | 8 | |
| Total | - | | - | | 211 | |

NOTE: 1. Figures inside brackets are percentages; all other figures are numbers of respondents

2. $\chi^2(3) = 18.3, p < 0.001$

A different perspective on perceived stimuli for technological innovation was sought by asking the respondents to indicate what they saw to be the most probable consequence on innovation of the so called "energy crisis" of the previous decade. The most likely consequence was stated to be a "general increase of innovation effort" (Table 12). Companies with no R & D were more positive in this regard. This finding is interesting as it suggests relatively low confidence amongst executives of Australian firms involved in R & D in the capacity of technologists to create solutions to perceived

social and economic problems. The causes of this difference in attitude can only be speculated upon. Clearly, here is an issue requiring more directed research.

The responses to a question asking the executives to indicate how likely they thought it would be for a range of specified effects to result from future technological progress are gathered in Table 13. The respondents indicated that they felt the most likely achievements of technological progress would be the improvement of working conditions and the overcoming of the "energy crisis". It was also considered to some degree likely that technical progress would: "increase per capita real income", "protect nature", "solve malnutrition problems", and "develop new countries". Technical progress, however, was considered less likely to: "bring harmony with nature", "reduce unemployment", "reduce social disparities", "reduce risks of war", and "give a poetic sense of life". There are two possible reasons for the lower credibility of technical solutions in these latter areas. First, it may be that technical solutions are intrinsically not applicable to some of these areas. Second, even where technical solutions might be applicable, the established socio-economic structures and interest groups of the present society could provide resistance against the required changes.

When compared with Table 7 the results in Table 13 also reveal a certain ambivalence in the executives' perceptions of the likely social effects of technological change. While improvement in working conditions cited in Table 13 as the most likely achievement of technological innovation, this conclusion contrasts with the low confidence of executives about the likelihood of workers, in particular, being the prime recipients of the benefits of innovation (see Table 7). These contrasting perspectives suggest that although the executives may express clear opinions in repsonse to particular questions, there are unresolved tensions within their attitudes which have not as yet been thoroughly thought out.

**TABLE 13**

MOST LIKELY EFFECTS OF FUTURE TECHNICAL PROGRESS

| Effect | | Mean | Std Deviation |
|---|---|---|---|
| 1. | Improve working conditions | 7.6 | 1.4 |
| 2. | Overcome the energy crisis | 7.4 | 1.5 |
| 3. | Increase per capita real income | 6.4 | 1.8 |
| 4. | Protect nature | 6.0 | 2.1 |
| 5. | Solve malnutrition problems | 5.5 | 2.1 |
| 6. | Develop new countries | 5.2 | 2.2 |
| 7. | Bring harmony with nature | 4.8 | 2.1 |
| 8. | Reduce social disparities | 4.4 | 2.1 |
| 9. | Reduce social disparities | 4.4 | 2.0 |
| 10. | Reduce risks of war | 4.3 | 2.3 |
| 11. | Give a poetic sense of life | 3.4 | 2.2 |

Note: The figures summarize scores on a scale from 1 to 9, with 1 indicating that the respective effect is "not at all likely" and 9 indicating that it "certainly is" likely.

Table 14 shows the responses to a question dealing with "major objectives for innovation". The feeling that it is vital to "exploit new energy resources" and "reduce waste" was strongly exhibited by the respondents. These two, and the need to "protect nature", were the most frequently cited objectives for innovation. This is probably a reflection of relatively vigorous debate which took place on the problems resource depletion and pollution during the decade prior to our survey. There were no statistically significant variations due to the respondents' firms being active in R & D. These results suggest that the objectives for innovation which the executives articulate tend to be a reflection of widely perceived current social problems. When the results in Table 5 and Table 6 are taken into account, however, it appears that there is some

discrepancy between what the executives believe *should* happen and what they believe probably *will* happen.

**TABLE 14**

MAJOR OBECTIVES FOR INNOVATION

| Objective | | Firms with no R & D | | Firms with some form of R & D | | Total | |
|---|---|---|---|---|---|---|---|
| 1. | Exploit new energy sources | 119 | (84) | 49 | (80) | 168 | (83) |
| 2. | Reduce was of all sorts | 117 | (82) | 38 | (62) | 155 | (76) |
| 3. | Protect nature | 65 | (46) | 32 | (52) | 97 | (48) |
| 4. | Improve working conditions | 28 | (20) | 22 | (36) | 50 | (25) |
| 5. | Improve quality and duration of leisure time | 30 | (21) | 18 | (34) | 48 | (24) |
| 6. | Fertilize uncultivated land | 33 | (23) | 9 | (15) | 42 | (21) |
| 7. | Make human life longer | 18 | (13) | 9 | (15) | 28 | (14) |
| 8. | Solve the transport problem in cities | 14 | (10) | 5 | (8) | 19 | (9) |
| 10. | Make housework less unpleasant | 0 | (0) | 1 | (2) | 1 | (0) |
| Total | | 142 | | 61 | | 203 | |

NOTE:
1. Figures inside brackets are percentages; all other figures are numbers of respondents
2. Respondents were to indicate only 3 major objectives
3. Percentages are based on number of respondents ie. column totals. They refer to number of times mentioned.

It is interesting to note that, notwithstanding popular portrayals in Australia of the business community being uncaring towards the environment, environmental concern ranks above other concerns of the business leaders surveyed in our study.

**TABLE 15**

ATTITUDES TO MODERN INDUSTRIAL LIFE

| Statement | Responses | | | | | |
|---|---|---|---|---|---|---|
| | Yes | | No | | Don't Know | |
| | # | % | # | % | # | % |
| 1. Technological progress creates such an artificial way of life it threatens next generation | 26 | 12 | 168 | 80 | 15 | 7 |
| 2. Modern life turns men into robots | 20 | 10 | 184 | 88 | 5 | 2 |
| 3. One must allow mankind to live in harmony with nature even if it makes it necessary to consume less | 155 | 75 | 33 | 16 | 20 | 10 |

| 4. Which of the two objectives would you put first? | # | % |
|---|---|---|
| • Make life in the country possible for everyone | 60 | 29 |
| • Improve the framework of life in the cities | 133 | 65 |
| Don't know | 12 | 6 |

One other observation from Table 14 is that the respondents showed virtually no interest at all in the application of technology to solve problems of household work. This may be an expression of gender based differences in perceptions of the importance of domestic work as against formal employment outside the home (with business

executives being predominantly male, and "home makers" being predominantly female).[55]

Finally, Table 15 displays the results of a question about the executives' attitudes to modern industrial life. A large proportion of the executives did not agree with the first two statements in the Table, which indirectly indicates some degree of satisfaction with modern industrial life, and a low preference for "opting out" or "returning to the land". There was, however, strong agreement with the statement that "[humankind] must live in harmony with nature even if it makes it necessary to consume less". The need to improve the framework of life in the cities was placed ahead of a life in the country as an objective by the majority. To some extent these results reflect the urban bias of the survey sample, and of the Australian population as a whole. The most notable impression conveyed by Table 15, however, is that the executives have a relatively complex range of attitudes towards technological progress and modern industrial life. They exhibit neither simple approval nor simple censure of modern industrial life with its dominant types of technology. Rather, they find themselves evaluating technological society differently depending upon the aspect of technlogical progress in question and the area of impact in mind.

## Summary and Conclusions

We argued early in the paper that there is a fundamental ambiguity in the understanding of science and technology embodied in Australian public policy debate. One set of initiatives appears to be based upon an optimistic evaluation of technological

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[55]For indications of other research being conducted around these issues see the following three essays published in*The Social Shaping of Technology*, edited by D. MacKenzie and J. Wajcman (Milton Keynes and Philadelphia: Open University Press, 1985): R. Schwartz Cowan, "The Industrial Revolution in the Home" (181 - 201), and "How the Refrigerator Got Its Hum" (202 - 218); M. Doorly, "A Woman's Place: Dolores Hayden on the 'Grand Domestic Revolution' " (219 - 222). Cf., R. Schwartz Cowan, *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave* (New York: Basic Books, 1983).

change, while another set of initiatives appears to be based upon a pessimistic evaluation of technological change.

Most recent published research, as revealed in our survey of the pertinent literature, has indicated that public attitudes to science and technology, both in Australia and overseas, are not straightforward. The ambivalence in international public opinion about science and technology makes the ambiguity of Australian public policy in the area less surprising than might otherwise be expected. Our study of the attitudes of Australian business executives, furthermore, suggests that the ambiguity in Australian public policy related to science and technology is underpinned by the fundamentally ambivalent status of technology in the Australian community (as reflected in the attitudes of the business executives). Further work is needed to see to what extent the pattern of attitudes found amongst business executives holds throughout the whole community; but the evidence found in other studies does suggest that it does indeed apply across a broad cross section of the population.

Some implications for public policy may be tentatively raised. First, governments ought not to expect simple reactions from the public to their policies in the science and technology arena; ambivalence is the more likely public response. The general community exhibits mixed attitudes towards science and technology. Future policies and programs concerning technology and industry, therefore, need to be framed to take this public ambivalence into account, probably by concentrating attention on the variety of impacts likely from a variety of fields of technology, rather than pointing just to the ubiquitous benefits of "technology" in general. Secondly, the attitudes of business leaders tend to parallel those of the community at large. This means that public policy ought not to be framed as if a "trade-off" is necessarily required between pleasing business leaders, on one hand, and pleasing the wider community, on the other hand. Policies aimed at ensuring that the needs of people and the problems of the

environment are properly taken into account in technology policy will not necessarily displease the business community, so long as the capacity of Australian business to be innovative and competitive is not adversely affected. Designing policies which manage to serve both the commercial and normative concerns of the Australian community presents a major challenge for policy makers. Third, the ambivalent attitudes of the Australian community towards science and technology points to the need for public education programs in which sophisticated attempts are made to comprehend science and technology in a social context, rather than as exogenous phenomena which belong only to the domain of technical experts.