Putting scientists in their place: Participatory research in environmental and occupational health

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PUTTING SCIENTISTS IN THEIR PLACE:

Participatory Research in Environmental and Occupational Health

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PUTTING THE SCIENTISTS IN THEIR PLACE: PARTICIPATORY RESEARCH IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH.

By Juliet Merrifield

SUMMARY:

Many community and workplace activists have come into head-on collision with the scientific establishment in recent years over threats to people's health from toxic chemicals in the environment and workplaces. These conflicts have cast doubts on some of the most deeply embedded values of science itself, including the central concept of objectivity. This article reviews some of the issues of control over the production and use of scientific knowledge which have emerged from struggles over the past decade in the southeastern United States. Alternative approaches have been developed which range from systematizing and validating people's own knowledge to attempts to develop a 'new' science which is responsive to people's needs and accountable to their oversight.

SECTION 1. SCIENCE AND SCIENTISTS

> Out of the libraries strike the slaughterers
> Mothers gaze numbly at the skies
> For the inventions of the scholars.
>
> Berthold Brecht.

Around the world, the years since the early 1970's have seen a remarkable growth in activism on community and workplace health issues. In the United States, the Black Lung movement of disabled coal miners in the early seventies led to precedent-setting legislation on coal-mine health and safety, which was the precursor of a new wave of legislation to regulate workplace and environmental health hazards. Unions have become involved in health and safety issues, and coalitions of workers and professionals have formed to work for cleaner and healthier workplaces. More and more communities across the country have organized around environmental health hazards of toxic wastes, air and water pollution.

The reasons for this spurt of activism have yet to be fully analyzed. We might point to the period of stable economic growth and relative prosperity which enabled unions to look beyond purely economic issues in the workplace. The environmental movement of the seventies, while having little to do with people's health and more to do with saving trees and wildlife, did begin to develop a public consciousness in this area. The federal legislation which was developed, in part as an attempt to contain and deflect union and community organizing, opened up avenues for public participation which had not been there before.

But perhaps most important of all, the second half of the 1970's and first half of the eighties was a period in which the cancer scare grew. People who had been exposed to new chemical hazards during the period of greatest growth of the petro-chemical industry, in the early fifties, began to develop symptoms of cancer and other long-latency diseases. Mass media were filled with reports of research into cancer's causes, which heightened public awareness of environmental and occupational health hazards.

Science itself changed, and continues to do so, through this period of public awareness and involvement in toxic chemical threats to health. Epidemiologists, immunologists, neurologists and others are being pushed to the frontiers of their fields, as they try to understand and document subtle changes in body chemistry and function following exposures to toxic substances. Science does not have answers to many of the questions that the public is asking.

Activism around environmental and occupational health problems has brought many people into confrontation with the scientific establishment and its values for the first time. Their view of science, or at least applied science and technology, has changed from a neutral and benevolent source of knowledge to <u>solve</u> problems, to a part of the <u>cause</u> of the problem. Development of applied science and technology is seen as contributing to many of today's health problems. Because science cannot provide answers to the many questions about how to correct or even prevent such problems, it seems to many to have failed us.

The mythology of science holds that it is politically neutral, value-free, 'above' politics. In practice our science has come to be seen by many as inextricably intertwined with the power relationships of late twentieth century capitalism. That is at the root of conflicts around environmental and occupational health.

To understand such phenomena, we need a full study of the political economy of science in twentieth century America, beyond the scope of this article. However, our experiences of the 1970's and 1980's gives us clues as to what such a study would have to look at. We need to examine the production of scientific knowledge and how it is shaped by external forces; how the social controls on scientists influence the subjects and approaches of their research, and whose ends are being served by science as it is currently practiced.

<u>The production of scientific knowledge:</u>

The production of scientific knowledge has been strikingly transformed in the last hundred years. The science of the eighteenth and nineteenth centuries was primarily small-scale, individual and independent work. Only in the late nineteenth century did it become apparent that science was essential to the development of industry. German industry, for example, drew ahead on the strength of German development of chemistry - initially for textile dyes, later for munitions and fertilizer. [1]

It is curious that the nowadays common myth that science is divorced from action, that scientists have no responsibility for the uses to which their research is put, developed only as science was becoming ever more intertwined with industry.[2] Seventeenth century, even eighteenth century science had no such dichotomy between knowledge and its applications. If the myth has persisted that science is pure and altruistic, above the world of commerce, World War Two should have put an end to it. It was no coincidence that, as Ravetz puts it, 'it was the most aristocratic, philosophical and pure branch of science that was converted into a new technology of destruction'.[3]

World War Two not only saw the development of the atomic bomb but also gave the biggest push to the chemical industry ever, surpassing even that of the First World War. The explosive growth in petrochemicals which followed the war can be traced back to the new plants built and the new products developed during the war, most of them financed by government. For example, the defoliant 2,4,5-T, used in the Vietnam War as Agent Orange, was developed during World War Two.

Parallel with the increasing interdependence of science and industry has been the industrialization of science itself. By the beginning of the twentieth century, science and scientists had become situated primarily in universities, secondarily in industrial laboratories and government research centers. As the century progressed, scientific research required more and more specialized and expensive equipment, larger teams of workers, and an industrial-type organization of its own.

More and more we can see every branch of science as producing information as a commodity, to be sold in the marketplace. Science itself has become capital-intensive, requiring an

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1. For accounts of the industrialization of science, see Jerome R. Ravetz, _Scientific Knowledge and its Social Problems_, Oxford: Clarendon Press, 1971, especially Chapter 2; David Noble, 'Corporate roots of American science', in Rita Arditti, Pat Brennan and Steve Çavrak, eds. _Science and Liberation_, South End Press, 1980; and J.D. Bernal, _The Social Function of Science_, London: Routledge and Kegan Paul, 1939.

2. J.D. Bernal, _op cit_, p. 28.

3 Jerome R. Ravetz, _Scientific Knowledge and its Social Problems_, Oxford, Clarendon Press: 1971, p. 220.

industrial-type organization to handle the large-scale and constantly changing production of knowledge.

The age of 'Big Science' means that ever larger and more expensive equipment is needed to carry out scientific experiments, research projects become larger and require more staffing, and knowledge becomes more and more fragmented and less and less assimilable to those without specialized training. Scientists today must become entrepreneurs and managers, seeking funding, gaining access to equipment, assembling and keeping functional a team of workers.

But scientists are entrepreneurs in a limited market, and operate within many constraints. Therein lies the system of social and political controls on scientific research which has brought science to its position as the handmaiden of powerholders. There are only two primary sources of research funds for scientists in the U.S. today: the federal government and large corporations. What they will fund is limited. Sixty-eight per cent or $43.3 billion of federal research and development (R & D) spending today goes to military research, compared with $1.9 billion (4%) to general science.[4]

Just as the two World Wars were peak periods of growth for the chemical industry, so now even in peacetime, the military continues to be a dominant force in private industry. If we look at MIT graduates who go to work for the private sector, around 30% go to firms working primarily for government contracts-military contractors.

The apparent pluralism of research establishments and, masks a new level of control of science and scientists. Bell estimates that although there are some 2,500 institutions of higher learning in the U.S., 93 per cent of all university-based research is carried out by 100 universities.[5] Thirty-eight per cent of that research is carried out by only ten universities.

The industrialization of science has had significant effects on how scientists work and what they choose to study. Working within an industrialized science means that scientists have lost much of the independence and autonomy that are part of science's mythology. In their place they have found a struggle to survive and advance their careers, and a subtle or not-so-subtle steering

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[4] Quoted in Natasha Aristov, Chester Regan and Elliott Smith, 'Careers in Science', Science for the People, Vol 18, # 5&6, Nov/Dec 1986.

[5]. Daniel Bell, The coming of Post-Industrial Society, London: Heinemann, 1974, p. 244-6.

of their research projects toward meeting the needs of some sectors of society rather than others. Science is not the value-free and independent search for knowledge that the myth portrays.

Subjects for study:

The biases of scientists are perhaps most closely revealed in the subjects that are deemed worthy of their attention, and those that are ignored. In a sense there is little 'new' work being done: most of it is within a tradition or an existing framework. Kuhn called this framework of understanding about the world a 'paradigm', and distinguished between 'normal science', which solves puzzles within a paradigm, and 'revolutionary science', which switches paradigms and alters the very puzzles which scientists set themselves.[6] Hilary Rose and Steven Rose take the argument a step further when they argue that a paradigm is never value-free, never neutral, although a particular piece of puzzle-solving research within the paradigm may not be obviously value-laden.[7]

John Vandermeer gives an example when he discusses his own agricultural research.[8] He has been concerned with a variety of questions associated with plant populations, and while his own research was 'basic science', not 'applied science', his choice of issues for research was strongly influenced by applied researchers whose main concern was with increasing productivity. Vandermeer's initial research concluded that productivity could most easily be increased by intercropping, the practice of planting more than one type of crop in a particular plot of ground.

But that line of enquiry was quickly stifled by the response from other researchers that intercropping could not work because 'modern harvesting techniques,' i.e. mechanization, could not deal with intercrops. And so a line of enquiry in basic research was considerably delayed by an aspect of the paradigm, the world-view that defines modern agriculture by the current practices of agri-business.

There is a common distinction made between scientists - who are only human and may have biases or make mistakes - and scientific

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6. T. Kuhn The Structure of Scientific Revolutions, Chicago University Press, 1962.

7. Hilary Rose and Steven Rose, 'The myth of the neutrality of science', in Rita Arditti et al, eds, Science and Liberation, op cit., p. 28.

8. John Vandermeer, 'Agricultural research and social conflict', Science for the People, Vol 13 # 1, Jan/Feb 1981.

knowledge. L.K. Nash, for example, describes scientific knowledge as 'ethically as neutral as iron', capable of being turned into swords or ploughshares.[9] But since the state of scientific knowledge at any one time can only be the accumulation of what individual scientists have chosen to study, it is easy to see how biassed it may become. What if the technologies developed will only turn the iron into swords, and no research is even directed at the production of plowshares?

Controls on scientists:

This leads us to a discussion of the mechanisms of control over scientists themselves, what they study, how they do it, and for whom. The mechanisms range from informal peer group pressure to the power to withhold grants and even dismiss scientists from their jobs.

The image of the scientist whose research is shaped by a pure thirst for knowledge is misleading at best. Most scientists are part of research teams in large establishments. Their research is usually planned by others and stems from others' work. They are normally dependent on grants and contracts to get funds to do their work - even large universities do not have enough funds for their scientists to do what they want.

Because of the structure within which they must work, scientists may be 'persuaded' to do some kinds of research and not others. The means of persuasion may vary from subtle to overt. We will see below one of the most overt: the story of the Oak Ridge National Laboratories scientist who lost his job after attempting a study of toxic pollutants around Oak Ridge which was not appreciated by his employers. While the threat of job loss may lie behind many of the control mechanisms, most do not need to take matters so far.

Money is a primary mechanism of control, but we must not overlook the system of internal controls on scientists which are also effective in influencing them to serve the needs of the powerful rather than the powerless. In order to engage in scientific research today, scientists need not only funds but also access to facilities and equipment, access to the media of scientific communications, and the rewards of recognition. All of these are tightly controlled by an elite group of scientists at the 'top' of their fields.

Access to facilities and especially large and expensive equipment like radio telescopes or linear accelerators, may have quite rigorous selection procedures, controlled by a few senior

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9. L.K. Nash, The Nature of the Natural Sciences, Boston: Little, Brown 1963.

scientists. Maverick or eccentric scientists whose research does not fit the prevailing mold, like Barbara McClintock, may find difficulty in gaining access (see below).

Likewise, access to the scientific media is tightly controlled by the editors of the scientific journals and the 'peer review' boards they use. Scientists need to communicate their work to other scientists to advance scientific research generally by enabling people to build on the work of others. But they do so also to advance their careers - especially to gain tenure at universities, and to gain research grants to continue their work. Although there may appear to be a large number of scientific publications, within any given field the number of journals which carry prestige (and the means for career advancement for contributors) is quite small. And while in theory publication is on the basis of merit alone, there are stories which suggest other factors are also at work. Blume's sociological research leads him to believe that social and cultural factors routinely enter into the evaluation process in science.[10]

We should not overstate the pressures to which scientists are susceptible. They do have some autonomy, self-direction and control over their own work - and the concomitant responsibility for it. But one of the deepest sources of the power of science in our society stands revealed as a sustaining myth: that of science's independence and insulation from society's politics. The system of financial and social controls that operates in today's scientific establishment predisposes it to a bias toward the powerful at the expense of the powerless.

Objectivity:

While funding, control of access and the reward system do serve as powerful social controls, we must look even further, for they reinforce factors within the very nature of what we call science. The notion of objectivity is at the core of Western science, and has been heightened under twentieth century capitalism. As Gorz suggests, 'capitalism has to an unprecedented extent sharpened the division between practice and theory, manual and intellectual labor.[11]

Objectivity carries with it many meanings, some of which are tied to scientific practice, and others to the ideology of science. It may connote reasoned analysis rather than emotional reaction. It

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10. Stuart S. Blume, Toward a Political Sociology of Science. New York: The Free Press, 1974. p. 78.

11. Andre Gorz, 'On the class character of science and scientists', in Hilary Rose and Steven Rose, The Political Economy of Science, London: Macmillan, 1976, p.63.

may imply rigorous requirements of proof, or training of scientific workers. But when objectivity becomes part of the ideology of twentieth century Western science, it may go beyond these notions.

The effort to bring rational analysis to bear on natural phenomena may allow scientists - and politicians - to dismiss as 'subjective' any complaint or viewpoint that is held with emotion or passion. The requirement for rigorous proof may imply that problems are not accepted as being real unless they can be tested in a laboratory or counted on a computer. The ability of the human nose to detect certain chemical odors at concentrations lower than those detectable by testing machines is well known. But the possibility that human health may be susceptible to changes or damage at concentrations which are not detectable, or not proven by deaths of laboratory animals, is less well accepted. The requirement for rigorous training of scientists may allow the opinions, ideas, even the knowledge, held by ordinary people to be held of little worth.

The notion of objectivity gets even further perverted when scientists may get involved in political battles only if their services are paid for. Only then may they be said to be 'objective witnesses'; unpaid services are suspected of being contaminated by subjective opinions.

There are scientists who seek to modify the dominant notion of 'objectivity', but they are seldom celebrated by their peers. Barbara McClintock is one such scientist. In Evelyn Fox Keller's words, McClintock' work transcends the limits imposed by the conventional objective/subjective distinctions, and the fragmentation of knowledge.[12] She argues that what we label scientific research is 'lots of fun. You get lots of correlates but you don't get the truth.'[13] While her colleagues in cytogenetics have been trapped by the view of genes as masters of the cell, Dr. McClintock's view of cellular organization, like her view of science, begins and ends with a concern for the interaction of its parts.

> ... in her mid-forties, her research in the cytogenetics of maize brought her to concepts so new and so radical that her colleagues had difficulty 'hearing' them ... It seemed [to them] as if few basic questions were left to be answered ... little place seemed left for the complexities of Mcclintock's cytogenetics. [14]

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12. Evelyn Fox Keller, 'Feminism, Science and Democracy',

13. Ibid. p. 203.

14. Ibid. p. x.

For over thirty years, McClintock's work was ignored, and regarded as eccentric at best, or mad at worst, by her fellow scientists. She has been a rare exception to the rule.

In the context of this brief overview of the political economy of twentieth century Western science, we can turn now to some examples of how community and worker activists have experienced problems in dealing with the scientific establishment and scientific knowledge about environmental and occupational health problems. The areas of dispute range from the validity of people's own knowledge versus that of scientists, or the way that subjects are selected for study with little regard to issues of pressing concern to the communities at risk, to problems with gaining access to scientific knowledge and the way that science is used to buttress political power, and keep people quiescent.

SECTION II. CONFRONTING ESTABLISHED SCIENCE

During our work at the Highlander Center over the past decade, we have seen many examples of communities and workers trying to deal with toxic chemical problems, and the problems that established science has caused them. A few are described here. These are not special or unusual cases. The kinds of problems they represent will be familiar to most people who have themselves been involved in such issues.

1. <u>Experiential knowledge is dismissed as subjective and irrelevant</u>.

Science usually dismisses knowledge derived from experience as biassed and subjective. It may be a subject matter for study, in such 'soft' scientific subjects as anthropology. In the 'hard' sciences it is normally regarded as irrelevant. But people living with a problem may know more about it than scientists who are far away and have not studied the issue. Community residents may be the first to know that something is wrong, but the last to have their story accepted by scientists and officials. An example is that of Bumpass Cove, a small rural community in upper east Tennessee.

Bumpass Cove:

An old mining valley, where the last remaining mine shut down in 1961, Bumpass Cove is in a fairly remote, mountainous area of the state. Springs or wells, provide drinking water to the residents. The creek flows into the Nolichucky River, from which many people used to fish. Downstream that river supplies drinking water to the small towns of Jonesborough and Greenville. Bumpass Cove residents have either been unemployed, living off the land, since the mines closed down, or have travelled long distances to work in factories.

Residents were relieved when in 1972 a company called Bumpass Cove Environmental Control and Mineral Co. announced plans to resume mining and to backfill the mined areas with a household garbage landfill. The mining never happened, but the landfill meant a few jobs for valley residents - working in the company office, or driving the trucks which brought the garbage to the site. And household garbage seemed harmless enough to everyone.

In fact, a feasibility study conducted for the State of Tennessee Department of Public Health before the landfill opened showed how unsuitable the area was for waste disposal. The water table was only 50-100 feet below the surface, and there were numerous open shafts, pits and boreholes which connected the surface directly to the water table. The study recommended that no hazardous waste be stored there. But the report, which did not become public knowledge for years, did not stop the landfill operators.

Soon after the landfill began operations, people in the valley began to notice strange things happening. Trucks would come into the landfill at night, without lights. One time a barrel rolled off a truck onto the side of the creek, and all the vegetation around it was killed off. An incinerator started to emit noxious smoke and fumes. As it turned out, the incinerator was unlicensed, but the neighbors did not know that. Some of the people who lived beside the only road up the Cove began to suffer new illnesses. One woman's daughter began to suffer from serious asthma attacks, especially when she was playing outside in the yard beside the road where the trucks came through.

Most people ignored what was happening: there were jobs at stake, and they could not believe that the government would allow any serious threats to their health. But one man, Hobart Storey. who had spent his life roaming and hunting the hills around the Cove, began to notice changes among the wildlife. He would find animals dead for no apparent reason, birds disappearing. He began to write letters to the Tennessee Department of Public Health, asking what was going on with the landfill, and requesting that they investigate. His handwritten letters were filed, but were not acted upon.

Hobart Storey was ignored not only by the officials, but also by his fellow residents. The more he talked about the problems he saw, the more people dismissed him as a 'crazy old man'. Surely the Department of Public Health would not allow dangerous materials to be placed in their community? But slowly the evidence began to gather. One man died of a raging fever after hunting in the hills and drinking from a spring there. Doctors would not go public, but privately said they thought the death was from poisoning. Hobart and another community resident used a home movie camera to document the trucks bringing barrels into the landfill, the barrels left split open on the hillside. But still most people in the community could not believe in the seriousness of the problems the landfill was causing.

It took a crisis to precipitate action. One Saturday night in Spring 1979 there was a flood which washed barrels out of the landfill into the creek and downstream into the Nolichucky River. Next morning when people attended church in the Cove, the fumes were so strong that some passed out. The local Red Cross ordered the evacuation of the community, and people were finally mobilized.

Monday morning saw most of the community out on the road blocking the way of the landfill trucks. When the trucks later tried to bypass the blockade via a dirt road, that road was strewn with nails. The county government cooperated by putting a weight limit on a bridge which effectively excluded the landfill trucks. No trucks reached the landfill until the company, three months later, finally closed the landfill.

It was much later that scientists from the state health department admitted what Hobart Storey had known all along: that hazardous chemicals had been placed in the landfill, although it was licensed only for domestic garbage, and that they had already begun leaching out of the landfill into groundwater and the creek. How a group of citizens from Bumpass Cove educated themselves about the chemicals that were in the landfill and their effects on human health, and challenged the state health department inspectors on their own ground, is described later in this article.

The lessons of cases like Bumpass Cove, and the more famous Love Canal, are that people who must live with toxic chemicals may recognize their effects long before scientists ever get around to studying them, and that they do so through observing changes in phenomena well known to them - it may be their children's health, as in Love Canal, or it may be wildlife and natural phenomena as in Bumpass Cove. They may not know these phenomena in the same way that scientists do, or use the same concepts and language to describe them. But they do know them. Scientists must learn to acknowledge this.

The Bumpass Cove example also shows that the prevailing myth of science as the domain only of those trained for it, may discourage many people, persuading them that what they know is not valid, that only the experts 'really' know. And the notion that it is politically neutral may persuade people that scientists would not allow bad things to happen to them. Our deference to the experts may continue to allow science to be used to buttress political power, and to disempower ordinary people.

2. Problems are selected for scientific study with little regard to the interests of powerless people.

Oak Ridge mercury:

How can a community full of scientists with Ph.Ds, with research projects on many forms of pollution, toxic wastes and health hazards, nevertheless allow in its own midst the highest level of pollution by mercury, a hazardous substance, known in the United States -- and then refuse to study it? It happened in Oak Ridge, Tennessee, home of World War Two's Manhattan Project and birthplace of the Bomb, and it speaks volumes about the selection of subjects for scientific study.[15]

Subjects are selected for study by scientists with a good deal of influence from government and industry, and with little comparable pressure to include issues of importance for powerless people. The government and the industrial contractor which runs Oak Ridge Operations (the bomb manufacturing and uranium enrichment plants and research laboratories) for the government had considerable interest in not researching the problem. The community most at risk was the still-segregated black community of Scarbro, which could have little influence on the selection of scientific studies in its home town. Scientists who did become concerned about the level of pollution around them were strongly discouraged from pursuing their ideas, even to the extent of losing their jobs.

Not for years after the 1950's mercury contamination had taken place, in 1983, and then only through the efforts of a crusading local newspaper, the Appalachian Observer, did the extent to which the production of nuclear weapons had affected the environment of Oak Ridge began to be made public. The Department of Energy then revealed that in the years up to 1977 they had lost an estimated 2.4 million pounds of mercury, used in extracting lithium, a vital ingredient in atomic bomb manufacture. An unknown quantity had been allowed to leak into the air, water and land around the plant-site.

Mercury has been known since days of the 'mad hatters' in the eighteenth century as a very hazardous substance, causing damage to the nervous system. In 1953, soon after Oak Ridge began using mercury in massive quantities, the people of Minimata, Japan, began suffering the first symptoms of a chronic nervous system disease. Later named Minimata Disease, it was found to be caused by methyl mercury contamination of the fish they ate. Mercury is

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15. Sources for this section include Tom Schlesinger et al Our Own Worst Enemy, Highlander Center 1985, and reports from the Appalachian Journal and Knoxville News-Sentinel from 1983 to 1986.

converted into this methylated form by the action of bacteria, once it is released into the environment.

In the 1950's, Oak Ridge scientists were sufficiently aware of the potential problems with mercury to test workers' urine samples for contamination. But they did not tell the workers they were exposed to hazardous materials, they did not significantly change production processes in order to limit workers' exposure, and they did not take serious steps to avoid environmental contamination. A Cold War mentality was at work: atomic bomb production was going on at a feverish pitch, and nothing must be allowed to stand in its way.

That mentality continued among Oak Ridge scientists for many years. In 1977, when a scientist from the Oak Ridge National Laboratories made a preliminary study of mercury releases into the environment and mercury contamination of Poplar Creek and the Clinch River, the report was quickly shelved. The head of the Department of Energy's Environmental Protection Branch, Jerry Wing, said 'since the situation is quite sensitive from a public information standpoint, it is requested your report remain "Business Confidential".'

The scientist who prepared the study, Dr. Jerry Elwood, a research ecologist, took it no further himself. Asked by the press in 1983 why he thought his recommendations for further research on soils, sediment, vegetation, fish and insects, had not been carried out, he said he had an opinion but declined to elaborate. All of his 1977 fish samples had mercury levels above the limit recommended by the Food and Drug Administration at that time. No action was taken to warn fishermen of the dangers of eating fish from Poplar Creek. Dr Elwood waited until 1983 to make his opinion public: 'Well, my own opinion is that the public should have been informed of the mercury level so that they could make their own decisions.'

Nothing much happened between 1977 and 1982, except that Oak Ridge officials lied to the State of Tennessee about the quantities of mercury that had been spilled over the years, admitting to a total of 100,000 pounds instead of 2.4 million pounds. In 1982 a junior scientist at the National Laboratories decided to try to get funding for a joint research project with his brother who worked for the U.S. Geological Service by getting some preliminary data on heavy metal contamination on the Oak Ridge reservation. In their free time, the brothers Steven and Larry Gough walked along the banks of Poplar Creek gathering vegetation samples which Larry Gough took back to his USGS lab in Denver, Colorado, for analysis.

When Oak Ridge officials heard in April 1982 of the extraordinarily high levels of mercury beginning to be found in the plants, all hell broke loose for Steven Gough, the research biologist at ORNL. USGS was ordered to return the samples, without a cover letter so that there would be no record in the files of the incident. Steven Gough was reprimanded for insubordination, and a couple of months later was removed from his job.

When the story hit the news a year or so later, amid massive publicity about Oak Ridge environmental damage, his superior stated that Steven Gough had been reprimanded because he had taken on a study for which he was not qualified, and they did not want ORNL's scientific reputation damaged by sub-standard work. But those same ORNL scientists who were said to be 'acclaimed nationally and internationally for their work on environmental aspects of mercury pollution"[16] had never carried out a study of Oak Ridge's own environmental pollution with mercury - or indeed with any of the rest of the toxic materials which have found their way into the Oak Ridge air, land and water.

DoE's scientists seemed to be anxious only to downplay the significance of the high levels of mercury in fish from East Fork Poplar Creek. They suggested that Oak Ridge is a town of scientists and engineers, too affluent and too busy to fish for food. They ignored the fact that it was the poor black community of Scarbro that was 'on the front line' of Poplar Creek's pollution, and that people from that community do indeed depend on fish and turtles from the creek as a source of food.

The Oak Ridge example has many aspects that are common to other cases of scientists ignoring problems that are a political nuisance. Scientists are often encouraged to become international experts on exotic subjects, but to leave strictly alone issues in their own backyards, and especially problems that may be vitally important for low-income and powerless people. In another example, agricultural research on tomatoes has focussed on production of fruits that can be transported across the country, or fruits suitable for mechanical harvesting. There has been no effort to find the perfect tomato for hand-pickers - the farmworkers.

Funding opportunities and career incentives may be among the constraints directing research initiatives, It is true that agricultural corporations are generous with grants and contracts to those willing to do research on their interests.[17] But it is also true that the dominant scientific paradigm today allows that

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[16] Science Vol 21, 8 July 1983, p. 130.

[17]. See, for example, John Vandermeer 'Agricultural Research and Social Conflict', Science for the People, Vol. 13 # 1, Jan/Feb 1981: 5-30.

what's good for business is good, period. And that in itself does much to channel the direction of scientific research.

3. Increasing specialization of scientific knowledge fragments information affecting human health.

The Holston River and Cherokee Lake:

Back in 1978, trained as a researcher, anthropologist and political scientist, but new to community struggles, I was asked to help a group of community residents document an environmental health problem. They lived in rural Scott County, Virginia, downwind from a large chemical manufacturing complex in Kingsport, Tennessee. Several of them worked with handicapped children, and had long felt that the number of babies born with birth defects in the community was exceptionally high: They suspected air pollution from the chemical plant, or occupational exposures of the plants' approximately 15,000 workers, many of whom live in rural areas around the plant. But they had little evidence for their suspicions. A group of us got together under the auspices of the 'Kingsport Study Group' to try to gather what information we could about pollution in the area and its connections with human health.

At that time I, like most people, believed that someone, somewhere had the answers to the questions we were asking. I had only to find the right scientists, whether in universities, research institutions or government, and we would get the answers. But I was soon disillusioned. The State of Virginia's scientists were able to draw no conclusions from the birth defects records of Scott County - the numbers were too small for statistical manipulations. Almost no-one was studying the complex of chemicals being emitted into the air from Kingsport's industries.I found that the scientists who were studying pollution of the Holston River downstream from the Tennessee Eastman chemical plant were interested primarily in temperature and bio-oxygen demand -- aspects of pollution that affected fish and other aquatic life. They knew nothing about human health, and had little interest in chemicals in the river.

Scientists at the Tennessee Valley Authority were studying one chemical in the river - mercury, left in sediment along a 160 mile length of the Holston River from a disused chlor-alkali plant in Saltville, Virginia. But again, they looked at fish, not people. And it is significant that they studied only mercury from the closed-down plant, not the -- politically sensitive-- chemicals which are found in the waste streams from still-active Kingsport industry. Furthermore, even when mercury levels found in fish approached the 'unsafe' levels determined by EPA, they did not feel it was their 'place' to publicize the information they had or warn people who fished in the lake. They left that for the state of Tennessee to decide. And the state did nothing.

There were, of course, scientists whose primary concern was human health. Indeed there was a Department of Public Health in the State Government which had broad responsibility for safeguarding human health. But, at that time, their primary concern was with proper sanitation and drinking water, immunization programs and the like. Pollution was largely out of their purview.

Then, and since, the organic chemicals and metals which are discharged into the Holston River by Kingsport's chemical companies were seldom monitored by federal or state government agencies, mostly by the chemical companies themselves. It is very expensive to test water samples, especially for an unknown mix of chemicals. And the Reagan administration since 1980 has further decimated the Environmental Protection Agency's funds, making 'self-monitoring' by the companies themselves an even more attractive option for the agency.

In the case of the Holston River and Cherokee Lake, no-one at that time was putting together a broad range of information from detailed specialist studies and assessing their overall impact on the health of people living near the river and lake, boating on it and eating fish from it. This a common deficiency we still live with. The fragmentation of scientific research has taken place in a world in which ever more complex combinations of chemicals surround our daily lives. Even detailed studies of single chemicals in laboratory tests are less and less useful in assessing the real problems people experience.

The fragmentation of scientific research has also done little to overcome the problems of 'proof'. Epidemiology, for example, lags far behind what people know in demonstrating harm from exposure to chemicals. Medical science, too, is outwitted by the classic symptoms of exposure to many chemicals like solvents - they may mimic other disorders, like flu, or may be interpreted as malingering, pyschosomatic disorders, hysteria. Science is a long way behind in the game of 'catch-up' with the health effects caused by industrialization over the last forty years.

4. <u>Difficulty of non-scientists in obtaining information.</u>

The arcane and highly specialized language used in communication of scientific research makes it hard for anyone untrained to get information they may need about particular problems. The availability of scientific journals is also restricted to university and other specialized or large libraries. For rural communities in Appalachia and the South, where the nearest public library may be in a small country town a 30 mile drive away, such information is almost unobtainable. But there is more to the difficulty in getting scientific information than simply the restricted availability of journals and the jargon. Most scientists have little interest or incentive in communicating with the general public. They may even have a real reluctance to do so.

Even fairly sympathetic scientists may have difficulty in giving information to citizens concerned about particular issues. They may believe that the citizens will not be able properly to understand and evaluate the information. They may be afraid that it will be used in a partisan cause and so threaten their own scientific reputation for objectivity. They may be instructed by their superiors to avoid public comment. Such instances are common to citizens struggling around environmental and occupational health matters.

One example concerned plans to build a synthetic fuels manufacturing unit in a rural area close to Oak Ridge, Tennessee. Members of a citizens' group, Save Our Cumberland Mountains, which had been active in the coalfield areas of east Tennessee for over a decade at the time, became concerned about the effects such a plant would have upon the community, and sought information. Oak Ridge at that time had a team of scientists who for some years had been researching the environmental impacts of various technologies for manufacturing liquid fuels from coal. It was an obvious source of information. But while sympathetic young members of the research team were prepared to meet with the citizens' group staff in private, and discuss the environmental problems likely to accompany the building of such a plant, they were not prepared to attend a public meeting called by the group and make public the results of their research.

Scientists' reluctance to become embroiled publicly in such issues stems in part from their internalized norms. According to their own self-image, scientists, like science itself, are supposed to remain politically neutral. The emphasis on objectivity in their research methods spills over into removing from them the right -- or the responsibility -- to hold opinions, to have values, and to exercise their rights as citizens.

Part of their reluctance stems from more external modes of social control in the profession. Scientists who become too closely associated with 'causes', or with citizen groups tend to become regarded as 'mavericks', eccentrics, and controversial figures. Such people may have difficulty in getting and holding positions, unless they already have tenure. They may have problems getting the research grants which are vital to their work. They may find the mainstream journals reluctant to publish their work, conferences reluctant to accept their papers. And at the most extreme, if they are young and vulnerable, they may find their jobs at risk.

5. <u>'Fake science' is used to buttress political power.</u>

We may call it 'fake science' when the high status accorded to experts, and the notion of science as objective, disinterested and pure, are used to assure ordinary people of their own ignorance, in contrast to the power-holders' ability to_capture expertise for their own side.

In our study on the Holston River and Cherokee Lake, we talked to boat dock operators who made a living from people fishing the lake, and whose livelihoods suffered directly from the pollution which killed fish. We asked them about the series of public hearings the State of Tennessee had held on the condition of the lake. One man told us: 'I didn't say a word during the meeting ... Eastman had fifteen lawyers, what's a man with a high school education going to say to a bunch of college professors?' [18]

Fake science has many uses for the powerful. It may be used to:

** delay and defuse: 'doing a study on it' may have nothing to do with the merits of the problem; it may be simply a means of avoiding action while keeping people quiet. The studies usually take so long and have such inconclusive results that people have given up the struggle long before they are completed.

** impress and bemuse: as in 'blinding them with science'. The mere marshalling of numbers of highly qualified experts may impress people with their own inadequacy.

** gloss and confuse political decisions as based on scientific procedures. Perhaps the best example of the last use of fake science is in the federal government's standard-setting procedures.

Workers who experience problems with exposure to particular chemicals in the workplace are usually assured by management that the levels of the chemical in the workplace are quite safe because they are at or below the Threshold Limit Value (TLV) which has been set by the government. This limit value is expressed in terms of parts per million, or milligrams per cubic meter of air. It sounds good, sounds like there must be some scientific reason to set it, that the level will protect workers.

But in fact standard-setting is a bargaining procedure between representatives of corporations, unions and government. Scientific studies may be used as chips in the bargaining, but the end result may not have much to do with protecting workers' health. At best, standards assume a young, otherwise healthy workforce, which is not unduly sensitive. Workers who are no

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[18] Quoted in Kingsport Study Group. 'Smells Like Money', Southern Exposure, Vol VI, No. 2, p. .

longer young, who have other illnesses, may be pregnant, may have been sensitized by prior exposures, may not be 'safe' when working under the TLV. But scientific disclaimers which the American College of Governmental Industrial Hygienists attaches to its TLV recommendations are not made known to workers generally. The standards are used to keep workers quiet and remove their grounds for complaint. Those who persist in reacting to chemicals at lower levels are blamed as victims, and may lose their jobs, or be moved to other positions with lower pay.

At worst, the standards may ignore long-term health hazards. Many scientists, for example, would argue that there can be no 'threshold' for a cancer-causing chemical: no level below which exposure has no effect. But standards commonly allow limited exposure even to known cancer-causing agents like benzene and vinyl chloride.

And then there are examples of standards which have been relaxed after vigorous lobbying from some affected industries. The standard for mercury in fish had been set at 0.5 ppm until 1977, when the tuna fishing lobby stepped in: suddenly the 'safe' level for mercury in fish doubled, to 1 ppm.[19] Let no-one be comforted by the government's view of what is safe.

6. Accountability and Responsibility

Objectivity has a price tag, in more ways than one. While it may be acceptable for scientists to be the paid consultants of industry and government, it is seldom considered acceptable for scientists to become the unpaid consultants of communities or unions. They are considered to lose their objectivity if their labor is not paid for, and their evidence is tainted by the suspicion that their sympathy to the cause may have rendered them subjective and biassed.

The problem is most commonly encountered in legal proceedings and government hearings. One case from our region involved Lewis Lowe, who sued the land company upstream from his small-holding for damages caused by their strip-mining for coal, and subsequent siltation of the creek. The repeated flooding and deposition of toxic sediments affected his ability to grow food and be self-sufficient. It was a difficult technical case, to prove downstream damage from strip mining, and a public interest group, the East Tennessee Research Corporation, played a lead role in marshalling expert research and testimony. Those experts who had donated their time to the case were accused by the land company lawyers of having lost their objectivity and credibility, and one

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19. See 'The "Lost" Mercury at Oak Ridge', Science, 8 July 1983, Vol. 221, p. 131.

expert witness refused to donate his time on the grounds that his professional reputation would be affected.

At the least, such arguments create economic problems for disenfranchised people. Despite the donated expert time, the public interest group estimated its costs to be around $50,000 (and they would have been far higher if they had had to pay all the experts). The case was won, but damages of only $3,000 were awarded. This was a poor person, who did not have much property to start with, and who was growing food. Property damages can never be high if you are poor to start with. But the case was a precedent-setting one: the first case to prove downstream damage from strip-mining.

These experiences, and the problems they reveal in the way scientific research is conducted and used, may seem a bleak picture indeed. But those who have been involved in such struggles know that there is another side. The barriers erected by the scientific establishment have led activists to seek alternative ways of meeting their goals. These alternatives, or the search for them, gives us hope that there are ways to overcome the barriers, and even to begin a process of shaping a 'new' science that is accountable and responsible to the needs of ordinary people. We will turn now to some examples of the alternative approaches that have been developed in our region in recent years.

SECTION THREE. CREATING ALTERNATIVES: PARTICIPATORY RESEARCH.

Perhaps the strongest examples of alternatives to mainstream science have been in systematizing people's own knowledge and broadening their access to information produced by scientists. In many places also, attempts have been made to develop cooperative relationships between scientists and citizens, with a view to research that meets people's needs. Both kinds of activities have often been difficult. Lessons from these experiences may help us develop further the beginnings of a 'new science'.

1. Systematizing and giving validity to people's knowledge

At the most basic level, people have knowledge of their own bodies, their own health. We have a number of examples of projects to systematize and analyze this knowledge. Both workers and communities have carried out their own health surveys to document problems they suspect (and sometimes to uncover problems they had not suspected), and to give the validity of numbers to what they know. 'Worker epidemiology' and the so-called 'housewife epidemiology' have been important tools in organizing in many cases. They have their problems, of course, but they also have real strengths.

Yellow Creek, Kentucky:

The Yellow Creek flows from the pristine Fern Lake, past the town of Middlesboro, and on downstream for some 14 miles before joining the Cumberland River. From Middlesboro downstream, the creek is heavily polluted, the primary source of contamination being the Middlesboro Tanning Company. The tannery has been operating for many years, but until the mid-sixties used vegetable dyes which were biodegradable. They colored the stream, and sometimes used up so much oxygen in decomposing that the fish died. But they did not have as major an impact on the creek - and people's health - as the chrome tanning process which the tannery introduced in 1965. This process involved the use not only of chromium, which in its hexavalent form is very toxic, but also a couple of hundred other chemicals and minerals. Now the pollution of the stream began to be of a different order.

Along the stream people began to notice changes in animal, plant and fish life. Domestic and farm animals died after drinking creek water, and people became concerned about their own health. Individually, residents along the creek tried to raise questions and express their concerns to local and state officials, but had little impact. In 1980, a small group of residents got together and decided to form a group to try to clean up the creek. From small beginnings the Yellow Creek Concerned Citizens (YCCC) grew rapidly.

One of the initial problems they faced was that the tannery was in the city of Middlesboro, and sent its wastes to the city's sewage treatment plant - which was quite unable to deal with such industrial wastes. But the concerned citizens for the most part lived outside the city boundaries, in the county, and their protests had little significance for the mayor or city council of Middlesboro. The Yellow Creek Concerned Citizens made repeated efforts to get the Mayor and City Council to listen to their concerns and answer their questions, finally, out of frustration, holding a sit in at the council offices.

When they approached state and federal officials for answers and action, they found they needed ammunition. They needed to be able to show, with numbers, that there were health risks associated with the creek, and that it was not simply a question of color, of the water looking bad. It was out of this need for ammunition, some means of assessing the present and potential damage from the creek's pollution, that the group decided to conduct its own health survey.

A Health Survey Committee of YCCC was formed and began to develop a questionnaire and plan the survey, with help from students at Vanderbilt University, the Student Environmental Health Project of the Center for Health Services. They combined elements from earlier community and worker health survey questionnaires with their own particular concerns. The group's members themselves conducted the interviews, achieving a 99.5% success rate in almost 300 households along the creek, involving almost 1,000 people.

The process of developing and carrying out the survey was exciting for the group, and had some important effects. The Yellow Creek health survey did several things for the organization. First, it gave them a reason and an incentive to call at every household along the fourteen mile length of the creek, and sit down and discuss with them the problems they were experiencing. It expanded and broadened both their understanding of the problems, and the membership base of the group. Without the survey they might not have found the time and energy to do this. Secondly, it broadened and strengthened the leadership within the group. The prime activists in the health survey were women who became better-informed and more vocal and confident through their work with the survey. And finally the process of doing the survey enabled the group to draw on and mobilize new outside resources.

The survey also gave them some information which they had not had before, and which they could use with state officials and the EPA, to persuade them of the seriousness of the situation at Yellow Creek. Now it was no longer a case of mere color, but of people's health. The survey found a statistically significant association between reported illnesses and exposure to creek water. Those who lived in areas prone to frequent flooding from the creek, and those who drank well water, reported higher levels of kidney problems and gastro-intestinal problems than those who had alternative water supplies. The survey also found a statistically significant increase in the rate of miscarriages after 1970, five years after the chrome tanning process began.

The survey had its problems, both with the process and the end results. While the community was much involved in developing and administering the questionnaire, it had little involvement in the stage of data analysis - the questionnaires were taken away to Vanderbilt University for coding and computer analysis. That stage took a long time, because it depended on student time and labor, and access to university resources. And residents lost much of their sense of excitement and ownership of the project.

The survey, in common with others of its kind, also had problems with the end product. It was a hybrid between the rigorous proof requirements of epidemiology and the systematization of people's own knowledge. It went some way toward validating people's knowledge, but it did not really 'prove' all that the community felt to be true. By not being a full-scale epidemiological study, the numbers. although statistically significant, did not really prove anything.

Dick Couto who directed the Center for Health Services at the time it cooperated with YCCC on the health survey, distinguishes between a 'health risk assessment', which is what the YCCC health survey was, and an epidemiological study.[20] Epidemiologists, he says, attempt to find statistically significant rates of illness, or relations with other factors. It is intrinsically a conservative approach, that prefers to err on the side of missing true correlations rather than to err by making false ones. It is limited to studying existing illnesses. And it is subject to mistakes and biases. Communities at risk, like the Yellow Creek residents, need to know what might happen, what is happening now as well as what has happened. Epidemiology can meet only the last need of communities, and that often imperfectly.

Couto argues that health risk assessments, on the other hand, may meet community needs. They can assess if the degree of risk is such that a reasonable person would avoid it, and that is what is needed in political battles over risk. 'Given the limited resources of a community at risk, members of that community are better off conducting assessments of the health risks - changes in the environment, indications of toxic pollution and reported conditions of illness - and demanding that official agencies conduct the more rigorous epidemiological studies.'[21]

Local union health survey at General Tire plant:
Sometimes the more rigorous scientific studies are used to delay and defuse controversy. A United Furniture Workers of America local in Ionia, Michigan carried out its own workers' health survey and successfully resisted management's attempt to bring in the experts for a 'real' study.[22] Workers noticed skin problems after introduction of a new process at the plant, but when they called in the government inspectors they were told that chemicals in the workplace air were below permissible limits. The problems persisted, but the company argued that it was only a few loud-mouthed troublemakers who were complaining. To counter this claim, shop stewards conducted a survey of the workforce, documenting symptoms experienced and time lost from work.

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20. Richard A. Couto, 'Failing Health and New Prescriptions: Community-based Approaches to Environmental Risks', paper presented at the annual meeting of the Southern Anthropological Association, April 1984, and forthcoming in Carole E. Hill (ed) Contemporary Health Policy Issues and Alternatives: An Applied Social Perspective, Athens: University of Georgia Press.

21. Couto, op.cit. p.21,22.

22. Personal communication, Jamie Cohen, former Director of Health and Safety, United Furniture Workers of America.

When the survey substantiated their claims, stewards felt in a stronger position to go to management and argue for the introduction of a new ventilation system for the plant. The company wanted to bring in a university-based researcher to conduct another survey on scientific lines, but the local said no, they did not want another survey - they knew what the problems were, and they wanted action. After a two-year struggle in all, the union's demands were met: they successfully negotiated new engineering designs for ventilating each of the mold presses in the plant.

2. Broadening access to information

An important part of our work with the research program at Highlander has been to teach people how to gain access to information about problems that affect them. In the environmental health area this really began with the Bumpass Cove community. Prior to that, our staff had done research on chemicals and their health effects for people, and given them the results, but had not systematically taught them to how to gain access themselves to the information they needed. Without that step, little empowerment took place. People might have the information they needed for a particular fight, but they were no better equipped to confront the next one. And they had not changed any of their perceptions about themselves vis-a-vis the scientific experts. It was only when the citizens themselves knew how to get information they needed that they felt able to challenge the experts on their own grounds, and felt that what they themselves knew could be validated. The importance of that became apparent to us with the Bumpass Cove experience.

Bumpass Cove:
Soon after the community organized and stopped the landfill from operating, a small group of residents came to a Highlander workshop. This brought together people from communities across Tennessee who were experiencing hazardous waste problems. The excitement with which they found that they were not alone, that other communities shared their problems and frustrations, and had knowledge from their experiences to share, is common to many Highlander workshops.

Later, a couple from Bumpass Cove travelled to Nashville, to the offices of the State Department of Public Health, to try to obtain all the documentation they could about the chemicals which had been buried in the landfill. They found the Department's files in 'a terrible mess', but after a couple of days work obtained quite a stack of xerox copies of correspondence between the landfill operators and officials, and a number of internal memos.

The problem they faced then was that much of the material was couched in technical and scientific terminology, and they had to assess its significance. They came to Highlander with another woman from the Cove to use our library facilities. They wanted to begin to compile a list of chemicals which might have been placed in the landfill during its operation.

Together we went through the mass of correspondence, memos and test reports, making a 3x5 card each time we found a mention of a chemical having been dumped, or found in tests, or where there was a request to dump the material from the operators with no indication that permission had been refused by the health department. Our supposition that it was quite likely that these materials had in fact been dumped at Bumpass Cove was later borne out by Health Department comments.

After compiling our list of chemicals, we needed to find out what the potential health effects were. And for this information we resorted to chemical directories, medical dictionaries and Websters. The chemical directories gave us information on potential health effects, results of animal testing done, and any standards for workplace exposure to the chemical. The medical dictionary helped us figure out what the symptoms really meant (we found 'apnea', for example, to be loss of consciousness). And the Websters helped us translate the words of the medical dictionary into language that we could understand.

Now, you have to remember that none of us were trained health scientists, and some of the people who were doing this research had not graduated from high school. They would have been - indeed were - regarded as scientifically illiterate by the 'experts' employed by the state health department. But they had the incentive to struggle with the difficult material. It was <u>their</u> health at stake, and their children's. And with that incentive they were able to overcome the barriers placed in the way of their understanding by obscure language, remote sources, and lack of scientific training.

What came out of the exercise at Highlander was a list of chemicals suspected to have been dumped at the Bumpass Cove landfill, together with their potential health effects. But its impact was much more than a list. For the first time people began to feel that they had some control over the information, some beginnings of a feeling of power vis-a-vis the experts. That feeling was strengthened not long afterwards, by a confrontation with the health department inspector.

The health department had agreed to sample water in several drinking wells in the Cove which were close to the landfill. An inspector then visited the citizens' organization to report on the findings at one well in particular, which was only 200 yds from the landfill. In a standard technique, he reeled off a list off chemicals with long names which had been found in the samples from the well, then hastened to reassure the citizens that these chemicals were harmless. They pulled out their copy of a chemical directory which we had sent home with them, looked up the names of the chemicals, and challenged the inspector. 'This book says this chemical may cause liver damage, that one affects the central nervous system.' The inspector left speedily, and the citizens, while disturbed by the nature of the information they had found, felt empowered to have been able to challenge an 'expert' on his own ground.

This small experience contributed to the citizens' growing feeling that they knew what the scientists did not, and that they had a right to speak out on what they knew.

Highlander continued to do this kind of research training with citizens' groups, both in the field of environmental and occupational health and in other issue areas. We have found it an effective tool whenever there is a strong personal incentive to get the information. And people have devised their own creative ways of gaining access to information they need, in a process we call 'guerrilla research'. Tactics may range from raiding corporate garbage cans (useful sources for company records) to removing labels from chemical containers so that their chemical names may be looked up in libraries. Approaches to getting information from companies may be as subtle as leaving a chemical reference book casually on view to supervisors in one's lunchbox to launching statewide campaigns for the 'right to know' about chemicals being produced or used in one's state.

3. <u>Education to overcome "fake science".</u>

From our experience with Bumpass Cove, and with similar experience from other areas in which the research program was working, we came to recognize the power in our society that goes with control over knowledge and information. It led us to begin to devise educational programs that could help people understand and challenge the uses of 'fake science', science used to keep people ignorant and powerless, and to grow more confident about the validity of their own knowledge.

One example of an educational program which attempted to do just that, was a curriculum for workers on occupational health which was developed for Highlander by David Clement, a British labor educator who had worked with a similar program in Britain compiled by the Trades Union Congress (TUC). The curriculum is designed primarily to train shop stewards and other activists on occupational health problems and how to confront them in their workplaces. It demystifies such issues as TLVs, and how to test for chemical exposures. It uses small group problem-solving techniques to analyze problems ranging from what the Occupational Safety and Health Act itself says about protecting workers' health to how to deal with company officials. And it consistently looks at how organizing and education of the membership can help confront and resolve shopfloor problems.

Highlander staff were excited about the ideas behind the curriculum, feeling that it approached a merger between our goals of research and of education for social change. We published the curriculum and offered some workshops to train union staff and labor educators in using the curriculum. These had mixed results. Some were excited by what they saw, and felt there could be a real change in their approaches to labor education. Others felt that the workers could never deal with the level of technicality at which they were being asked to operate in the curriculum. They were used to a top-down educational system as well as a science production system which denies valid knowledge and intellectual capacity to those who have not been officially trained.

Our own experience with using the curriculum, as with other similar attempts to educate and teach research skills on technical issues, leads us to believe that ordinary people are more than capable of mastering technical skills when they really want to. And programs to teach such skills can be empowering, and have effects far beyond the utility of the information gained, when they change people's conceptions of themselves as actors, of science in society, and of what changes are possible. It is especially important to stress action - group action not individual advancement - as a part of the learning process. 'Scientific literacy", like literacy itself, may be a tool for social change when it is approached in an empowering way.

4. Cooperative relationships between scientists and people.

Science shops in the Netherlands were probably pioneers of cooperative relationships between scientists and people.[23] These have been developed further in such European efforts as the Utopia project, which brought together teams of workers and researchers in several Scandinavian countries to develop new technology in a way that did not deskill workers.[24]

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23. See, for example, Peter Groenewegen and Paul Swuste, 'Worker-Scientist Cooperation: a case study from the Netherlands', Science for the People, Vol. 16, # 6, Nov/Dec 1984: 7-29.

24. See The Utopia Project: on Training, Technology and Products Viewed from the Quality of Work Perspective, report produced by the Utopia Project Team at Arbetslivcentrum, Stockholm, Sweden; Datalogisk Afdeling, Aarhus Universitet, Denmark; Numerisk Analys och Datalogi, Tekniska Hogskolan, Stockholm, Sweden; Nordiska Grafiska Unionen.

In the field of environmental and occupational health there have been a number of scientists who have joined with citizen or worker groups to address their concerns. The experience of the Love Canal residents and their health survey carried out with the help of Dr. Beverly Paigen has been well documented.[25] COSH groups (committees on occupational safety and health) have commonly allied health and legal professionals with union activists. In the more conservative political climate of the South, away from the major centers of scientific research, it has often been harder to find scientists willing to ally themselves with workers or citizens. But there have been some examples.

In 1985, the North Carolina Committee on Occupational Safety and Health (NCOSH) with the Communications Workers of America (CWA), developed a study to document the effects of job stress on communications workers.[26] Many of the union and company officials did not believe that there were work-related health problems for telephone operators - it has always been seen as a clean, safe job. But the mainly female workforce knew there were problems, especially relating to stress from the use of new technology-video display terminals - and close monitoring of work by supervisors. The survey was designed by a team from NCOSH and the statewide women's organization with the CWA, with the help of an epidemiologist who was primarily interested in the incidence of cardiac problems related to stress.

The CWA women involved in the project designed the study, carried it out, and wrote the report. They felt a real sense of ownership in the study. The interviewing was carried out by means of a self-administered mail questionnaire, followed up by CWA members over the telephone. Care was taken that the control of the research process should remain with the workers' research team. The survey did demonstrate many of the problems that they had expected to find, and some - notably relating angina and VDT use - that had not been expected. In fact, the study documented the first known long-term chronic effect of VDTs. The real issue for most workers was not having control over their own work. A combination of low control and high-paced work demand create the most stress.

The women's research team increased their leadership skills as a side benefit of the research project. It also helped build the credibility and reputation of the newly-formed statewide women's

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25. See Adeline Levine, Love Canal: Science, Politics and People, Lexington, Mass: Lexington Books, 1982; and Lois Marie Gibbs, My Story, as told to Murray Levine, Albany: State University of New York Press, 1982.

26. Personal communication from Tobi Lippen, North Carolina Committee on Occupational Safety and Health.

organization within the CWA in North Carolina and nationally. This was the group's first project, and it was a successful one that gained a lot of publicity. Women within the union and outside were calling to ask about the study. It persuaded the union leadership to take the women's organization more seriously.

There were some problems over ownership of the data, and control over the publication process. The scientist involved was reluctant to pass control over to the union or COSH group. And the workers team felt they had to make some compromises because of being involved in a 'scientific' study. But on the whole it does represent a step toward the goal of defining new relationships between scientists and people, and the beginnings of a new concept of science.

There are some crucial questions that must be asked about any relationship between scientists and people:

** who determines the need for the research?
** who controls the process of research and makes decisions along the way which affect its outcome?
** who controls the dissemination of results?
** where does accountability lie?

We may not yet have any perfect example of participatory research on environmental and occupational health, but we do have examples where both citizens and scientists have worked for a new approach and which go as far toward citizen control and accountability as we can go, given the context in which we all work.
Understanding what may be possible to develop may be helped by developing further our understanding of the intersection of different forms of knowledge with different modes of enquiry. This gives us the quadrants illustrated in the diagram below:

ELITE MODES OF ENQUIRY
stress:
- objectivity
- separation of researcher
- special skills
- arcane knowledge
- specialized language
- officially non-political

KINDS OF KNOWLEDGE

PEOPLE'S KNOWLEDGE
- based on experience
- involves those affected
- appropriate to needs
- passed on orally
- part of people's culture

SCIENTIFIC KNOWLEDGE
- based on theory
- rigorous rules of proof
- uses experiments
- not tied to uses
- passed on through publication
- often requires high technology

PARTICIPATORY MODES OF ENQUIRY
stress:
- experience
- accountability
- control
- meeting needs
- tied to action
- overtly political

<u>Forms of knowledge</u> may range from what we are calling 'people's knowledge' at one extreme to 'scientific knowledge' at the other. People's knowledge is based on experience, is appropriate to needs, involves those affected, is usually passed on through oral traditions, and is a part of the total culture of a people. Scientific knowledge, at the other extreme, is based on theoretical assumptions and experimentation, is not tied to its application and use, has rigorous rules of proof other than 'it works', often requires high technology, is passed on almost entirely in written form, and is part of the culture only of its participants.

Of course these represent poles, and in practice much knowledge falls somewhere between the two extremes. This is especially true in modern industrial societies. If we look at the Trobriand Islanders, or any other people made famous by anthropological research, it may be quite clear what their 'popular knowledge' is, and how it relates to their needs. It may include knowledge of natural phenomena like possible locations of particular plants used for food, or weather patterns, crop predators or hydrodynamics involved in the launching and sailing of canoes and outriggers. It may include a variety of herbal remedies for illness and disease. It may include many beliefs that western scientists have long discounted as superstition, but are slowly coming to recognize have a sound foundation in natural phenomena. Because of their relative isolation from industrial society, such cultures have been comparatively easy to describe.

Anthropologists have been much less interested in describing popular culture in advanced industrial societies. The respect accorded to the Trobriand Islanders' ability to function well within a potentially hostile environment has not been granted to twentieth century working class Americans' ability to function within their own potentially hostile environment. Indeed, it is much more difficult to describe popular knowledge within such a society.

We can suppose that popular knowledge in twentieth century America must be quite differentiated and variable. The knowledge that sustains Midwestern farmers in their environment is not what sustains up-town New York youth. Much popular knowledge, whether rural or urban, is still derived from traditions, although the traditions may be more recent than many documented by anthropologists. Much popular knowledge is derived from personal experience. Anyone who talks with production workers must be impressed with their knowledge of the production line, its hazards, and what might be done to avoid the hazards - as well as to make the line less de-humanizing.

But we cannot ignore the fact that popular knowledge in America today also includes a kind of pseudo-science that is derived largely from the mass media. Aspirin ads and cold remedies, the latest fad diet, earnest articles on child-rearing and nutrition - all may compete for attention with the remedies of parents and grandparents and what we remember from school. Together they form what we might call 'common sense'.

Anthropologist Robin Horton describes common sense as the knowledge that we need in our everyday lives. Science - or mystical thinking - is what we turn to when common sense does not have an explanation for some phenomenon. He argues that despite all the new scientific theories of the past few hundred years, common sense has had remarkable staying power. 'Common sense is handier and more economical than theoretical thinking. It is only when one needs to transcend that limited causal vision of common sense that one resorts to theory'.[27]

The problems we are experiencing in environmental and occupational health struggles stem in part from the fact that scientific knowledge is lagging behind common sense in documenting health hazards. People who are exposed to toxic chemicals know they are affected even when the 'scientific' instruments for measuring these effects are inadequate. As long as political power demands scientific proof of harm before action is taken, common sense knowledge on its own will be inadequate.

Modes of enquiry may range from the most elite to the most participatory. Elite modes of enquiry stress objectivity, the separation of the researcher from the researched, arcane knowledge, specialized skills and language, and is officially politically 'neutral'. Participatory modes of enquiry stress the value of experiential knowledge, meeting needs, accountability and control, are overtly political and tied to action.

When we intersect modes of enquiry with forms of knowledge, we see that most of today's scientific research is concentrated in the quadrant of elite enquiry and scientific knowledge. Popular knowledge may be the subject of research in the soft sciences, like anthropology, but has no role in the harder sciences. The quadrants of most interest to us are the ones involving participatory forms of enquiry - ranging from those focussed on popular knowledge to those focussed on scientific research.

Participatory research has been done in the realm of popular knowledge - systematizing and analyzing people's knowledge of health or pollution. It has been harder to use participatory approaches to scientific knowledge, although various attempts at developing cooperative relationships between scientists and communities fall within this sphere. What we need to do now is break the link between scientific knowledge and elite forms of enquiry, and devise new approaches that combine essential elements of scientific research - the rigorous rules of proof, for example - with a process that is accountable to people. Only through such changes will we see a science that begins to meet the needs of ordinary people rather than the power-holders, and only in such a way can we hope to see a constructive and humane science.

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27. Robin Horton 'African traditional thought and western science', Africa, Vol. XXXVII, 1969, p. 67.

INFORMATION SHEET:
RESOURCES FOR PARTICIPATORY RESEARCH
(available in North America)

Information Centers include:

Participatory Research Group
229 College Street, Suite 309
Toronto, Ontario
Canada M5T 1R4
416-977-8118

Highlander Research and Education Center
Route 3, Box 370
New Market, Tn. 37820
615-933-3443

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Mcquire, Pat, Participatory Research and Feminist Scholarship (approximate title, available Center for International Education, Hils House South, University of Massachusetts, Amherst, Mass, 01003)

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Reason, Peter and Rowan, John, Human Inquiry: A Sourcebook of New Paradigm Research (John Wiley and Sons, 1981,.

Whyte, William Foote, Learning From the Field, especially Chapter 10 (Sage Publications, 1984).

"With Peoples' Wisdom," videotape with Rajesh Tandon on origins of PR. 25 minutes (Available from Highlander, above)

Working Papers on Participatory Education and Research, Highlander Research Center (see above).