The One-Hundred Year War Against Air Pollution

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Background

Air pollution in the form of smoke pollution is an ancient urban problem. As early as 1301, Edward I banned the burning of soft coal in London, but by 1684 London was again suffering from smoke pollution. As the problem worsened during the Industrial Revolution, numerous technological fixes were made including the earliest known anti-pollution device patented by James Watt in 1785 (The American Architect and Building News 1882). Later, Parliament commissioned several studies of urban smoke pollution in the 19th century. This interest in the growing problem culminated in the Public Health Act of 1875 in which smoke pollution was defined as a nuisance and responsibility for its elimination was assigned to local English governments (Townsend 1907, Nicholson 1899). City and regional governments paralleled this national effort. Before 1900, Manchester (1844), Liverpool (1854), Leeds, London, Glasgow, Edinburgh, Sheffield and others adopted legal measures aimed at limiting or eliminating smoke pollution. On the continent, there were parallel efforts in Paris and other French industrial centers, in Germany and in Austria, which resulted in similar regulatory systems (Kershaw 1912). Generally, successful regulation of smoke pollution resulted from active local smoke-abatement groups made up of "…public-spirited men gathering information on the subject and drawing the attention of… the governing bodies…." to the problem (The Builder 1899). These groups were aided, advised and coordinated by professional engineers and

public health officials. These professionals comprised a "technological elite" and seemed to be the controlling leadership of the movement. This technological elite transcended national borders and was identifiable in each European industrial nation. There was close international cooperation, exemplified by the frequent international meetings and exhibitions held before World War One (Engineering 1905, Kershaw 1906, Stradling and Torsheim 1999).

The engineers, who made up the bulk of the technological elite, were interested in eliminating smoke pollution primarily in the search for greater efficiency. To them coal smoke meant unburned fuel and therefore "…smoke, inefficiency and waste" (Kershaw 1915). Health and aesthetics were usually lesser motivations. A research study describing the constituents of smoke pollution mentioned "… soot, which alone darkens and defiles" (Shaw 1902). Most of the emphasis was, however, scientific and not moral. As early as 1896, careful investigations were made if the quantity and composition of pollutants arising from coal and gas fires. Numerous other studies followed. This information was widely shared and even promulgated internationally through diplomatic channels (Cohen and Russell 1896, Kershaw 1912).

Progressives and Clean Air

American engineers and public health officials shared their foreign colleague's attitudes toward smoke pollution. Conservation appealed strongly to American engineers and efficiency became something of a national craze (Layton 1971). Coal smoke pollution represented an inefficient use of a valuable natural resource. Engineering professional organizations were very active in providing advice and leadership to the smoke-abatement movement. The ASME (American Society of Mechanical Engineers) was particularly active in setting standards for measurement of smoke, devising experimental means of producing smokeless coal fires and in educating firemen and the general public to more efficient fire building techniques (Layton

1971). The American Chemical Society was involved through its Committee in Occupational Diseases in Chemical Industry and American Institute of Chemical Engineers through its Committee on Atmospheric Pollution (Obermeyer 1933, Miles 1976). As Samuel P. Hayes has pointed out, these engineers approached conservation "… from the vantage point of applied science rather than of democratic protest….” and were not "…Malthusian prophets of despair and gloom," emphasizing possibilities rather than limitations (Hays). They were practical men more interested in achievable improvements than in perfectionism. Their advice was generally respected and accepted, for as John C. Burnham has pointed out, "…deference to experts and technicians was an important theme in Progressive thinking" (Buenker, Burnham and Curnden 1977). This is not to say that the urban reformers always agreed with technologists. There were sometimes fundamental differences in tactics as well as in aims.

By the turn of the century active interest in smoke-abatement was characteristic of most American industrial cities (The Engineering Magazine 1902). R. Dale Grinder has pointed out that in the early years it was largely a woman's movement in most cities. These were elite, upper and middle-class women with the education, leisure, and influence the reform movement needed. They were "the vanguard of the smoke abatement crusade" leaving the more conservative engineers and civic clubs to follow. The women wanted immediate results, which were often not achievable in reality (Grinder 1980, Merchant 1985). Women, as well as children, were usually depicted as the primary victims of air pollution, although working men were the ones most dangerously exposed to smoke. By selecting these innocent victims the reformers avoided conflict with the prevailing ethos of industrial capitalism; material progress and the status of labor (Gugliotta 2000). The first reaction of the reformers was "let’s pass a law," which they did. As early as 1907, it was pointed out that "…there is probably not a large city in the United Stated

that does not have some kind of smoke ordinance in force (Townsend 1912). Yet the smoke problem grew steadily more serious in most cities.

To the engineers the solution was obvious. The remedy for smoke lay in "well tried devices" in the hands of "competent engineers" (King 1905). In the future the smoke-abatement movement must be led by a "vigorous minority" who were technically trained engineers. In each city an engineering service must be created to advise, to educate, and to demonstrate proper smokeless fire techniques (Hood 1938). Such services could best be provided by the engineers of the U.S. Bureau of Mines, which came to have a leading role in smoke abatement.

The Bureau of Mines Effort

The work of the U.S. Bureau of Mines in smoke -abatement started in 1904, when it began a program of fuel testing for the U.S. Navy at the order of President Theodore Roosevelt who personally observed the effects of an inferior coal on ship performance during maneuvers. The program was expanded to determine how government purchased fuels might be used with maximum efficiency. This led to the study of furnace construction and management in hundreds of Federal buildings. The work of the Bureau of Mines attracted widespread interest; particularly from those civic groups interested in smoke abatement. Soon the Bureau of Mines was leading and coordinating local smoke-abatement groups. It provided technical advice, devised model ordinances, and propagandized for the cause (Flagg 1912, Randall 1912).

Through the years, Bureau of Mines' engineers watched many local smoke abatement movements start, have a brief existence, and then die a natural death due to disinterest and involvement in local politics. The Bureau devised a plan to overcome the earlier failures of smoke -abatement campaigns based on the leadership of engineers and the mobilization of

support from civic groups (Hood 1938). Salt Lake City provided the opportunity to test the Bureau's program.

Surrounded on three sides by the mountain ranges that reach from 3,000 to 6,000 feet above the city, Salt Lake City is a natural basin in which there is little regular movement of ambient air (The Salt Lake Tribune 1920). Locally mined bituminous coal was cheap but contained volatile materials, which produced heavy smoke. Occasionally the smoke problem was prolonged enough and severe enough to provoke political action. Six distinct smoke abatement campaigns have been identified before 1919 with the earliest coming in 1890. These usually accomplished little in the conservative political atmosphere of Salt Lake City where politics were dominated by the anti-Mormon American Party (Thiessen 1913, Gudmundsen 1930). A non-partisan commission form of city government was established which emphasized thrift and efficiency. As Progressives, the reformers were also willing to accept an enlarged government regulatory role (Ryan 1913). The smoke problem was also increasing and more of the citizenry were demanding action (Outlook 1915). The pressure resulted in a smoke ordinance put into effect by the new government in 1915. Residences were not covered by the ordinance, nor were existing systems, and the ordinance had few enforcement powers as "…hasty prosecution of offenders does not meet with favor in court" (Snow 1915)

Needless to say, the law was not particularly effective and Salt Lake City's smoke problems remained. The quick population growth of the First World War, the expansion of war spawned industries and vast increase in railroad (coal fired) traffic soon caused smoke levels to seem unbearable. The nearby Murray and Midvale smelters booming with wartime business were blamed for much of the increased pollution (Chemical and Metallurgical Engineering 1921).

The Salt Lake City Commission voted unanimously on 26 February 1919, to undertake a major effort to eliminate the smoke problem. A cooperative agreement was signed between Salt Lake City, and the University of Utah and the U.S. Bureau of Mines (The Salt Lake Tribune 1919). The direct participation of the Bureau in the Salt Lake City smoke crusade was a pioneering effort to get around local politics (Monnett 1920).

The Bureau of Mines investigation undertook, for the first time anywhere, an exhaustive examination of all of the factors contributing to smoke pollution. Salt Lake City was planned to be the model study for all cities with smoke problems.

Every imaginable facet of the smoke pollution was examined during the period 1919 to 1921. The consumption of fuel was determined through door-to-door surveys. Its composition was determined through detailed chemical analysis. Trained observers measured the smoke densities of various types and classes of smoke producers, systematically, for a period of months. The quantity of solids in the air and deposited as soot was measured methodically and then analyzed microscopically and chemically (Monnett, Perrott, and Clark 1926, The Salt Lake Tribune 1921). An airplane was used to collect air samples at varying altitudes over the city (Monnett). Other experiments aimed at workable processes to make relatively smokeless coke from Utah bituminous coal for the Salt Lake City market (Monnett 1920, Perrott and Clark 1922). Attempts were also made to develop more efficient home furnaces through studies conducted at the University of Utah Experiment Station (Monnett 1923).

The results of the project were immediate in their impact upon Salt Lake City. Smoke production (measured in minutes of output of heavy smoke) fell 46.5% overall, and 65% among large producers through a non-compulsive program of education, demonstration and boiler room

supervision in the downtown area and railyards. It fell 16% from residences although there was no program for them; only publicity about the overall effort (Monnett, Perrott, and Clark 1926).

The question of air pollution from the big smelters at Garfield, Murray and Midvale was also finally laid to rest. A Federal Court appointed Professor R.E. Swain of Stanford to investigate. His 500-page report exonerated the Murray smelter, found that the Midvale smelter had done some local crops harm and that neither had any effect on Salt Lake City. Similar conclusions had been reached by the Bureau of Mine's study, which pointed out that it was actually more likely that Salt Lake City was polluting the smelters than the other way around (Monnett, Perrott, and Clark 1926).

The campaign's results were stunningly effective. The smoke produced in 1925 was 66% of that of 1924, 42% of that of 1923, 27% of that of 1922 and only 4% of that of 1919 (itself a relatively low year). This came despite an enormous increase in coal usage (Hood 1926). Salt Lake City became a model for the world.

But as the smoke problem lessened so did public interest and enthusiasm. The era of Progressive reform had passed. Growth and boosterism won out over clean air and in 1925 the Smoke Department was eliminated. Almost immediately smoke pollution increased by over 700% and some funds were hastily restored (Monnett, Perrott, and Clark 1926).

After 1926, enforcement once more was allowed to slacken. This was somewhat offset by the increasing use of natural gas and petroleum, introducing new, less obvious pollutants. However, most residents of Salt Lake City still cooked and heated with coal in 1935 (Business Week 1935). Once more the smoke problems mounted up until they were considered unbearable and in 1941 a strong anti-smoke ordinance was passed which succeeded in reducing smoke emissions by 50% during the next winter (Latimer 1942). The enforcement of this law grew lax

during World War II and was replaced by a stronger ordinance in 1946 (Thomas 1947). And so on.

Interim

By the late 1930's most cities and states had pollution abatement laws and bureaucratic structures to enforce them (Barkley 1939). But like Salt Lake City, there was little interest in pollution or public will to extend or enforce sometimes inconvenient and expensive regulations. Even the reform minded New Deal government was more interested in restarting the American industrial machine than it was in cleaning up its emissions. The reformers concluded that the public was simply not willing to pay money to eliminate air pollution (Hood 1938, Ives, Public Health Bulletin 1936). Nevertheless, the regulation and enforcement bureaucracies already in existence succeeded in steadily reducing smoke levels in most industrial centers in the 1930's and 1940's (McCabe 1954). Concurrently coal was being widely replaced by lesser polluting oil and natural gas.

In many ways the early post war years are a transitional period. There was a new emerging emphasis on health issues and basic scientific studies of the processes involved in air pollution. This new or middle phase, sandwiched between "Smoke Abatement" and the modern "Environmental" movement, was where most of the action was from 1945 until the 1960's. Significantly, the Air Pollution and Smoke Control Association changed its name in 1952 to the Air Pollution Control Association. Its original name when it was founded in 1907 had been the Smoke Prevention Association. The changing titles accurately reflected the shifting emphasis in the air pollution community (McCabe 1954). This, in turn reflected a fundamental shift in public opinion. Attention had been gradually shifting from its primary emphasis, urban coal smoke pollution, to other forms of pollution and their health effects. Fluorine poisoning of crops and

livestock had been a recurring problem since the turn of the century but was becoming more frequent and was receiving more publicity. The public became more aroused by the events occurring around Vancouver, and Spokane, Washington, Polk County, Florida, Troutdale, Oregon, eastern Tennessee, and other recent events, than they ever had over the much more severe fluorine poisoning, early in the century, near Butte, Montana. The same was true of sulfur dioxide emissions from smelters at Butte, Trail, British Columbia, San Francisco Bay, Salt Lake City and other places as well as pollution from paper mills scattered over the country (Sawyer 1951).

What caused the change in public attitude were several ecological disasters which occurred close together in time and which received widespread publicity. In Donora, Pennsylvania an atmospheric inversion trapped pollutants and killed 20 people (Schenls 1949). In London, in 1952, some 4,000 died in the most famous of all smog disasters. The explosion if a shipload of ammonium nitrate in Texas City, Texas in 1947, was also widely regarded as a related environmental disaster. New York City suffered several smog episodes in 1948, 1963, and 1966 when 168 people died. But it was the West Coast and in particular, Los Angeles, which focused the world's attention on the "smog" problem.

The problem had grown, along with population and industry, in the Los Angeles, basin injuring rich agricultural interests, causing major health problems, and becoming a serious public nuisance. It grew much worse during WWII when population and industry expanded rapidly. Newspapers took the lead, crusading against the growing evil and spread the word to the rest of the country where other cities facing similar, if lesser, problems, paid close attention. Actually, Los Angeles had started regulating air pollutants, including those from petroleum, as early as 1904 and had some of the strictest laws in the world by 1947. Some $20 million had been spent

by local industry but the problem was growing steadily worse. It was obvious that the old smoke abatement remedies were not working, so in 1947, pressured by the Chamber of Commerce and other groups, the city brought in researchers from the Stanford Research Institute. They found that the smog was “a complex mixture of gases, solid particles, and liquid droplets” that reacted photolytically in a bewildering pattern. The source was the 10,500 tons per day of gasoline being burned in the Los Angeles basin (Sawyer 1951). Like most western cities, petroleum and natural gas played a more important role than in eastern cities creating a new set of environmental problems. The rest of the nation, as events in New York showed, would soon face the same problems as automobile travel increased.

But understanding the causes of smog had to come before any amelioration was possible. By 1953, 98 laboratories were reported working on various aspects of the problem (McCabe 1954). The American Chemical Society, the Manufacturing Chemists’ Association, the American Medical Association and many other scientific groups, including governments sponsored technical conferences devoted to the problem. The public and the media blamed oil and gas refineries for the smog, but the research quickly revealed that the primary source was the public's beloved Detroit chariots (Stern and Greenburg 1951).

It was soon found that the pollution damage in the Los Angeles area was not caused by the traditional culprits, such as sulfur dioxide. Instead, Arie Jan Haagen-Smit at Cal Tech showed that the smog was the product of airborne hydrocarbons photochemically reacting with nitrogen oxides. There are hundreds of reactions possible, they are remarkably complex and are not fully characterized to this day. Researchers found that gasoline engines were the primary source of both the hydrocarbons and the nitrous oxide and that ozone was the principal resulting troublemaker in the smog (Stephens 1987). Further research was an obvious need and in 1955

the Federal Government began to support and to shape a large-scale scientific assault on the causes of air pollution (Public Law 84-159). In 1956, the Public Health service established the National Air Sampling Network. What they found was frightening and helped to set the stage for action in the 1960's and 1970's. "The atmosphere of the modern industrial community is a carcinogenous sea…." in which humans live (Rosen 1958).

A New Environmentalism

The late 1960's proved to be the decisive period for air pollution amelioration efforts. The changes were radical and took place with amazing rapidity. Essentially, the general public itself become aware of and involved in the air pollution question and in the process changed the nature of the anti-pollution movement fundamentally and irrevocably.

Public opinion shifted dramatically during the 1960's. Polls showed that air pollution was a minor problem (number 9 of 10 listed national problems) in 1965 but had become the most important problems in the public mind by 1970 (The New York Times 1969).

The new attention on environmentalism was triggered by many events: the publication of Rachael Carson's influential Silent Spring, Senator Edward Muskie's 1964 Committee hearings on air pollution around the U.S. and several well publicized ecological disasters. In 1966, some 80 people died in a four-day smog event in the New York City area. In 1969 an oil well in the Santa Barbara Channel blew out polluting seacoast areas near Los Angeles and in June 1969, the badly polluted Cuyahoga River, in Ohio, caught fire. There, events, shown live in America's living rooms on the new ubiquitous electronic medium, television, had a profound dramatic impact and an immediacy about them that imparted great momentum to a new type of American environmentalism. It also mobilized new demographic groups into the crusade for purer air.

American attitudes toward pollution had been gradually changing through the years. As the material well-being of Americans had grown in the post war period they had become less preoccupied with making a living and more concerned with non-economic or quality of life issues. No longer valid was the basic assumption of the Progressives that resources existed to be exploited, albeit in an efficient and sustainable way. There was a growing disconnection in the public mind between the insatiable desire for improving high-tech living standards and a romantic vision of a simple, primitive, pollution-free life. Improved medical care also meant that people lived longer and "slow, cumulative" health problems often associated with environmental conditions predominated (Hayes 1985).

The new environmentalism was a grass-roots mass movement that was quite unlike the predecessors. The old technological elite that had dominated early efforts was displaced and repudiated by an emotional mass movement, often with radical fringe leadership that had strong, anti-technology, anti-materialistic and even anti-rational elements and a generally low level of technological education or expertise. There were serious doubts among scientists as to whether the fundamental scientific basis of pollution was understood sufficiently to support amelioration programs (Wandesforde-Smith 1971). It mattered not to many of the new environmentalists who had long-range goals of reordering and restructuring society that went far beyond clean air. Air pollution was no longer a technical problem to be solved but represented a form of moral turpitude requiring the purification of society (Arnold 1987).

The old technological and managerial elite who had been displaced and repudiated were puzzled by the new movement. They continued to hold essentially the same attitudes that they always had; they were against theoretical solutions unrelated to real world experience, they feared "emotional politics" and hoped to overcome them with a "rational appeal to facts," and

they favored efficient utilization of whatever resources were involved (Russell 1985). A rationalist, pragmatic view collided with a romantic, millenialistic one.

Technically qualified people were not in control of the new movement. Instead, the new leaders were technologically naïve and inbred with anti- technology bias (Tribus 1971). The result was that many environmental actions, particularly in the early years, were unsoundly conceived and implemented. To this day, the movement, and its bureaucratic embodiments such as EPA enjoy a reputation for poor science and poorer scientists among other engineers and scientists.

Legislation followed closely the wave of public interest. The 1963 Clean Air Act established national policy and set uniform standards for air quality. This was amended by the Air Quality Act of 1967, which set enforcement mandates for the earlier laws and established the National Air Pollution Control Administration that was tasked to enforce air quality standards and administer air pollution research programs. In 1969, the landmark National Environmentalist Protection Act (NEPA) was passed, whose purpose was "restoring and maintaining environmental quality." It created the Council on Environmental Quality and required the now famous Environmental Impact Statement (EIS), for all important actions affecting the national environment. The EIS quickly became the favored bureaucratic and legal tool in the environmentalist's kit. The Environmental Quality Act of 1970 created a bureaucracy to enforce environmental laws while the Clean Air Act of 1970 closed the loopholes left by the 1967 act. No state had filed plans by 1970 and the new (Nixon) law required state plans to be submitted by 1975, allowed class action suits and was aimed at reducing auto emissions by 95% by 1975. The Arab Oil Embargo of 1973 slowed the process of cleaning the air of designated pollutants as the nation scrambled to develop replacement energy suppliers. Expanded use of high sulfur fuels

was temporarily accepted, for example. A Federal Appeals Court, in 1973, also ruled that the EPA had not considered the economic effects of its regulations on the auto industry and granted further delays. Nevertheless the movement progressed and in 1977 the Clean Air Act Amendments established "noncompliance penalties" which were equal to cleanup costs and strengthened the EPA's regulatory powers (Grossman 1994).

Reaction and Results

In 1981, Ronald Reagan and his harshly anti-environmentalist Secretary of the Interior, James Watt came to power determined to undo the large environmental regulatory programs that the business community opposed so strenuously. But Watt and his successor failed to make any substantive changes. The reason was simple, the public remained committed to stringent environmental laws even if they were costly to industry and government (The New York Times 1981). The public's interest in environmentalism had waned in the 1970's probably as part of the general reaction to the excesses of the "The Great Society " programs of the 1960's, because of the energy crisis and because of some well-advertised blunders by environmental regulators. However, when fundamental environment programs were threatened by the Reagan Administration in the 1980's the public rallied strongly behind the effort for a cleaner environment (Dunlap 1985). The public has maintained the commentment at an amazing level for a remarkably long time by American political standards. So much so that in the Presidential election of 2000, a major issue, however chimerical, was which candidate was more devoted to a clean environment.

Outside of the public's satisfaction, what have been the real results? To this observer, the environmental community still exhibits strong anti-technology biases and a relatively low level of scientific expertise, though the latter has improved in recent years. The bureaucratic and

regulatory structure created to clean the atmosphere and maintain it has remained essentially unchanged since the 1970's. It is a permanent part of American life and the various industries have successfully, if reluctantly accommodated themselves to its strictures (Karell 2000, Closser 2000). It is costly, cumbersome, exerts a negative pressure on the economy, and is manifested in a maze of unresponsive bureaucratic structures. But it is well worth it to most of the public, and no politician dares to directly attack the core values or the legal basis of environmental regulation.

The Federal Courts have generally upheld the various EPA and Clean Air Act regulations. In an important case in 2000, the Courts upheld the power of the EPA to regulate interstate air pollution ensuring that the efforts will continue (The Albuquerque Journal 2000, Wall Street Journal 2000, The Washington Post National Weekly Edition 2000). The Courts have repeatedly reaffirmed the right of the EPA to make environmental regulations based upon Congress' delegation of power to the agency. The doctrine was first upheld in U.S. vs Grimaud in 1911. And the Courts have accepted an ever-widening range of EPA responsibilities for air pollution. The 1990 Clean Air Act Amendment established 188 Hazardous Air Pollutants that require special permits by industries emitting them and which must use Maximum Available Control Technology (MACT) to reduce their level (Jones 2000, Garner 2000).

Better scientific understanding of the nature of air pollution has been another goal of the reformers throughout the 20th century. In the last three decades, the research effort has accelerated, there is more money available for research, and more interest in the field, yet basic understanding still remains elusive. The processes are multitudinous and remarkably complex. The fundamental chemical processes are mostly unknown, even today. This makes regulatory efforts more difficult (Seinfeld 1989, Charlson and Wigley 1994).

The most important result has been a substantial reduction in air pollution in American cities, despite enormous increases in population and industrial production. This has resulted primarily from the reduction of harmful emissions (Easterbrook 1993, Lents and Kelly 1993). While air pollution reform efforts since the 1970's have not lived up to environmentalist's expectations, the improvements have been real and important (Welles 1997, Parenteau 1990).

At the same time the costs have been many times higher that the environmentalists' original estimates (U.S. Council on Environmental Quality 1972). The costs of paperwork for EIS's alone amounts to over one percent of the Federal budget for Government agencies (Welles 1997). Permits required under the Clean Air Act Amendment of 1990 cost private industry $1.3 to $2 billion a year. Metal mining and smelting has almost completely been ended in the United States because of regulatory costs. Air control equipment is very expensive and the high costs associated with compliance with Federal regulations have driven numerous small or inefficient operators out of business resulting in a rapid concentration of industry and growth of monoply (Reitze 1969, Hughlett 1999).

Typically, regulatory agencies have ignored the economic impact of their actions and operated in "…the belief that any measure which will remove the deficiency is necessarily desirable…" whatever the other (usually economic) effects (Coase 1960). In the Fall of 2000, the Supreme Court agreed that Government regulators are required to consider costs when establishing standards for air pollution. Lower courts have also generally favored industry's position. The application of cost/benefit analysis to air pollution is a frightening prospect to most environmentalists who see it as tipping the scales against further tightening of standards (Savage 2000). There are other problems. The bureaucratic rigidity and lack of realism of the

EPA are legendary and has tarnished its reputation, never good, particularly with industry (Schneider 1993).

Future Track

It has already been seen that when an economic slump develops, environmental concerns quickly become minor issues compared to full employment (Reinhold 1993). In the current economic slump and in the post 9\11 world the public's commitment to environmentalism seems to be weaker. While the industrial nations, particularly the United States, have been successfully cleaning up their air supplies, the less developed nations have massively expanded the amount of pollution that they emit into the same atmosphere. The Third World is increasingly the source of most air pollution yet no regulatory or governmental structures exist that might control it nor is there any reasonable prospect of one developing (The Tuscaloosa News 1994). The Kyoto Accords, which the United States refused to sign, would have enshrined this imbalance in a permanent treaty. It was rejected by the majority of Americans in the face of hysterical pressures by international, Liberal and environmental groups and the strong effort of the Democratic President, Clinton. It has left the United States isolated. Environmentalists and foreigners seem willing to achieve marginal improvements in air pollution emissions at major cost to the American economy. Most of the American public is not. Is the United States then doomed in the future to breathe ever fouler air, produced by the poorer nations, while its own economy, hampered by rigid environmental rules, stagnates?

Conclusion

The twentieth century began with the smoke abatement movement, which was centered in the emerging technological and managerial elites. They provided expert, balanced and confident leadership which largely succeeded in achieving their legal and bureaucratic goals. In

the middle decades of the century active air pollution reformation efforts were centered on the research effort and the movement's leadership rested with this group. The success that they had came through their influence on the normal political processes and came primarily in the form of even more research. After the 1960's the movement was based upon the general public's concerns and found expression in large government regulatory bureaucracies. No longer dominated by technocrats, the movement's leadership and membership was much less technically sophisticated, but achieved some important fundamental changes in American society, and succeeded in cleaning up the air. In all, the movement has been successful for a century. Not only has it succeeded in improving air quality overall, it did it while population and living standards were rapidly increasing. Future improvements seem likely to be linked to economic issues.

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