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Small Towns Can't Stop Growing

by John Fraser Hart and Tanya Bendiksen

In This Issue

Some people seem to think that small towns are losing their population and slowly fading away, but they are wrong. In 1980 Minnesota had 734 free-standing incorporated places (we counted contiguous incorporated places as single places) that ranged in size from the Twin Cities, with 1,782,870 people, down to Funkley, with only 18. Between 1970 and 1980 the population increased in two-thirds of these places, and only the smallest group, those with less than 350 people, had nearly as many losers as gainers (Table 1). For many places, however, the change, whether gain or loss, was rather less than earthshaking. Morris, for example, soared from 5,366 people in 1970 to 5,367 in 1980, while Canby was plummeting from 2,147 to 2,143, and Hanley Falls stood stock still with 265 persons in both census years. So many places changed so slightly, in fact, that we classified a place as "stable" if it gained or lost less than 5 percent of its population during the decade; a change of less than half of 1 percent a year is not particularly impressive.

We have shown only the places that gained or lost more than 5 percent on the map of population change in incorporated places in Minnesota between 1970 and

Table 1. NUMBER OF INCORPORATED PLACES IN MINNESOTA, 1980, BY SIZE AND PERCENTAGE CHANGE IN POPULATION, 1970-1980

	Percentage change in population, 1970-1980			
Size of place in 1980	Gain of 5 percent or more	Gain or loss of less than 5 percent	Loss of 5 percent or more	Total
2,500 or more	66	32	7	105
1,000—2,499	72	37	10	119
500—999	80	55	14	149
350—499	41	23	7	71
18—349	117	67	106	290
Total	376	214	144	734

1980 (Figure 1). Most parts of the state had a mixture of places that gained and places that lost. The numbers are about evenly balanced north of a line from Moorhead to Duluth, and southwest of a line from Moorhead through Mankato to Albert Lea, but the eastern and central sections of the state had a clear preponderance of places that gained. Some people believe that the only small towns that grow are those that are dormitory suburbs for larger cities, and certainly the concentration of places that gained within a forty-mile radius of the Twin Cities would support such a view, but commuting cannot explain the growth of most of the other places that grew.

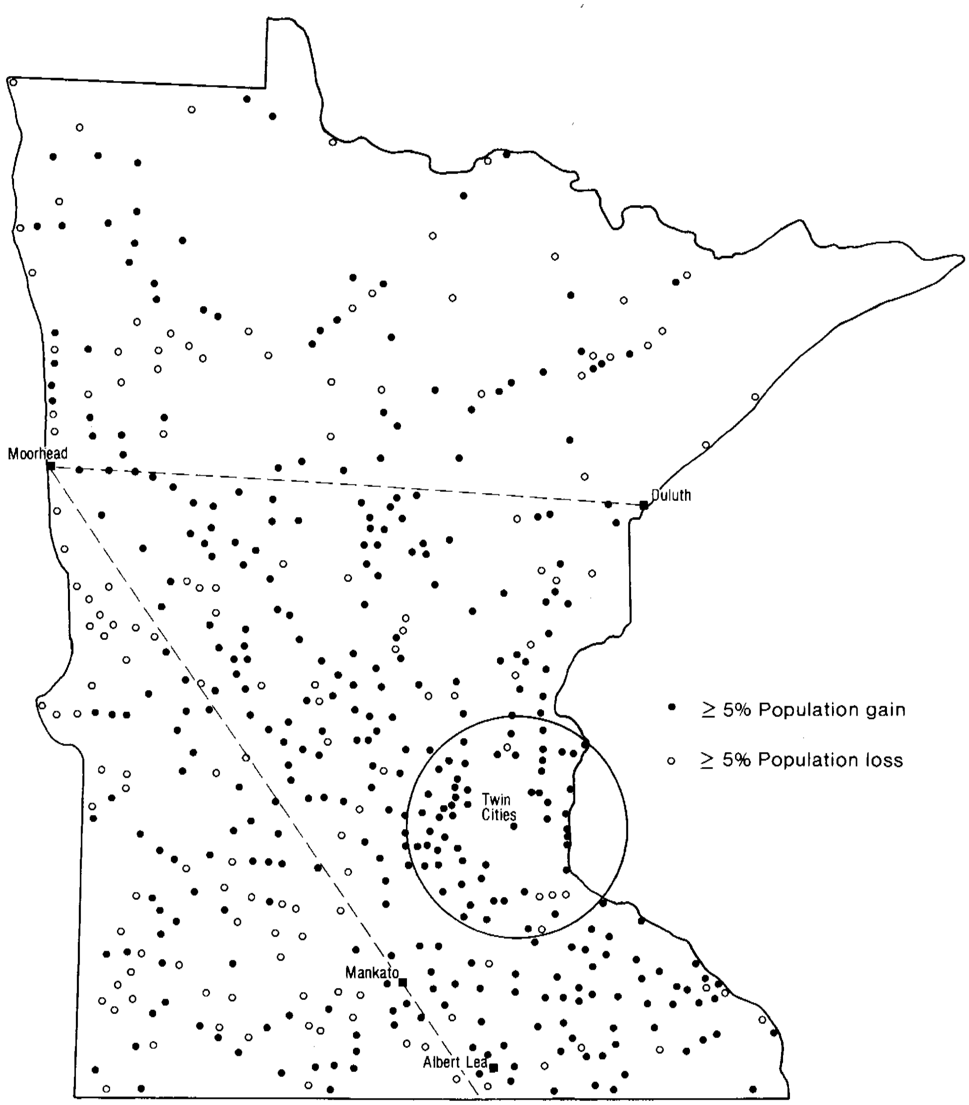
Commuting does not "explain" the growth of small towns nearly as well as the simple fact that they exist. Once a place attains a population of somewhere around 350 people it cannot seem to stop growing. Most of the larger places in Minnesota gained population during the 1970s (Table 1), and most of the larger places are in the eastern and central sections of the state (Figure 2). Except for the Iron Ranges, which are a law unto themselves, northern Minnesota has less than its share of the state's cities (the Census Bureau does not officially classify a place as a city until it has at least 2,500 people). The southwest has its fair share of the state's cities, but it also has more than its share of the smallest places, those with less than 350 people.

The size of places in Minnesota in 1980 reflects the way the state was originally occupied and settled a century or so earlier. The principal thrust of settlement was northwestward along the Red River Trail from the Twin Cities toward Moorhead, but then westward from Moorhead across the Dakotas rather than northward toward Canada. The forests of the north were exploited later by lumber barons whose operations required railroads and temporary lumber camps, but few towns or cities. The prairies of the southwest were penetrated by railroads whose prosperity depended on the grain trade. The railroad companies platted towns dominated by grain elevators at regular intervals along their lines.

The railroad towns of the prairies were too many, too small, and too late. Their spacing was appropriate for horse-drawn wagons loaded with grain, but they were too close to their competitors when automobiles and trucks replaced horses. If they had been founded earlier they still might have been able to attain the critical size that seems to ensure continued growth, which is somewhere around 350 persons, but they simply did not have enough time. Those places that did manage to pass the critical threshold of 350 people are distinguished by a solid block of contiguous buildings, usually two-story structures of brick or masonry, on at least one side of their main street. In smaller places even the principal business block is "gap-toothed," with vacant lots separating the individual buildings that stand along it.

We used decade of incorporation as a surrogate for the date of town founding, because the decade in which a town was incorporated is closely related to the size of its population in 1980 (Table 2). Two-thirds of the places with more than 1,000 people in 1980 had been incorporated by 1890, but two-thirds of the places with less than 500 people in 1980 were incorporated after 1900. It appears that the basic urban network of Minnesota had been established by the turn of the century, or shortly thereafter, and it has hardly changed since. The smaller and later places have merely filled in some of the gaps in the network.

Figure 1. POPULATION CHANGE IN INCORPORATED PLACES IN MINNESOTA BETWEEN 1970 AND 1980.



During the twentieth century this entire network has grown like an expanding balloon, but a very lumpy balloon. Each place has retained its relative position in the network, and it has grown as the entire network has grown. Most places of 350 people or more in 1980 have been gaining population ever since they were first incorporated, but their growth has been spasmodic and irregular. Their population has fluttered up and down, up at one census, down at the next, with random short-term fluctuations, but over the long term they have been growing slowly. They have been growing so slowly, in fact, that some wags have claimed they are merely stagnating upward, but even upward stagnation is growth rather than decline or loss.

We grouped places by the size of their population in 1980, and we plotted the average population of all places in each size group from 1900 until 1980 to show how the state's network of small towns has grown (Figure 3). Most places grew from 1900 until 1920, but then they sagged after World War I when the widespread availability of automobiles enabled rural people to bypass their local market centers for the greater range of goods and services that were offered by larger places. The slow, lingering, painful demise of Main Street began in the 1920s, and the smallest places, those that had less than 350 people in 1980, have never recovered from the setback they suffered in this decade. Places of more than 350 people in 1980 began to grow once again in the 1930s, perhaps because of the "return to the land" during the depression years, and they have been growing ever since, although the growth curves of some size groups dropped a bit in the 1960s because the populations of some towns on the Iron Ranges declined so drastically.

Table 2. NUMBER OF INCORPORATED PLACES IN MINNESOTA, 1980, BY SIZE AND DECADE OF INCORPORATION

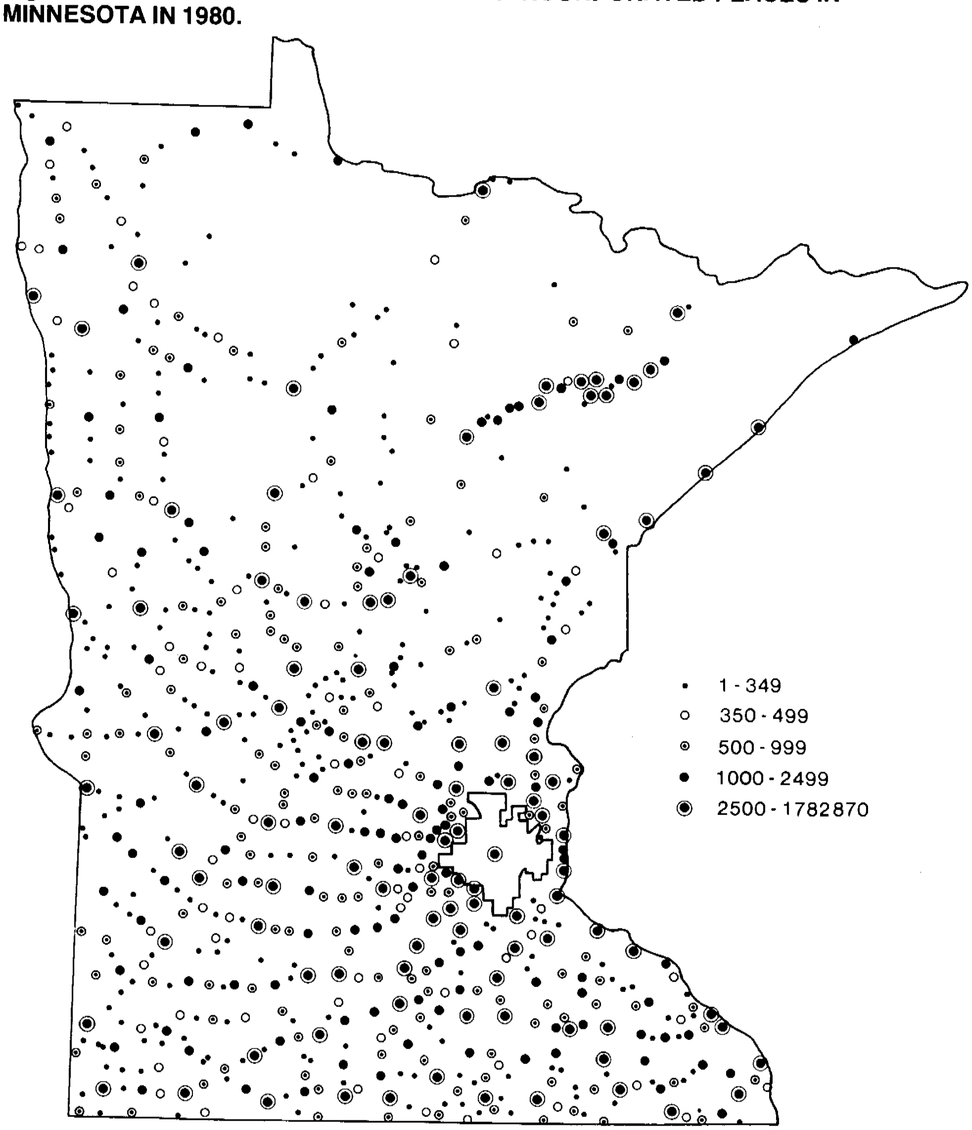
Size of place in 1980	Decade of incorporation: Before 1880	1880s	1890s	1900s	1910 or later	Total
2,500 or more	63	11	16	5	10	105
1,000—2,499	40	40	16	14	9	119
500—999	24	35	47	23	20	149
350—499	9	9	20	22	11	71
18—349	6	8	66	95	115	290
Total	142	103	165	159	165	734

Some people still want to reject these numbers, however, because they would rather believe the evidence of their own eyes. They have seen Main Street, and it is dead. Weeds are popping up through the cracks in the sidewalks, many stores have been abandoned and their fronts are boarded up, most of those that remain open clearly are hurting for business, and it seems well-nigh impossible to get professional people to live and practice in small towns. Main Street was the creature of the horse and buggy, and it has been mortally wounded by the automobile. The retail and service functions once performed on Main Street have been shifting up the urban hierarchy to larger and larger places, and especially to the malls and shopping strips that festoon them.

Even though small towns have lost their traditional retail and service functions to larger places, they have continued to gain population because their basic reason for being has changed. Since World War II they have been quietly transformed from central places serving the surrounding agricultural communities into small cogs in the national system of manufacturing centers. Forget Main Street. It will still continue to hobble along, but the prosperity of the contemporary small town depends on its factories, not on its stores. Employment in manufacturing has been trickling down the urban hierarchy at the same time that employment in retail and service activities has been shifting upward.

At the end of World War II manufacturing in Minnesota was concentrated in the Twin Cities. In 1950 the state had 187,000 people employed in manufacturing, and 57 percent of them were in Hennepin and Ramsey counties alone. By 1980 the number of people in the state who were employed in manufacturing had increased to

Figure 2. POPULATION OF FREE-STANDING INCORPORATED PLACES IN MINNESOTA IN 1980.

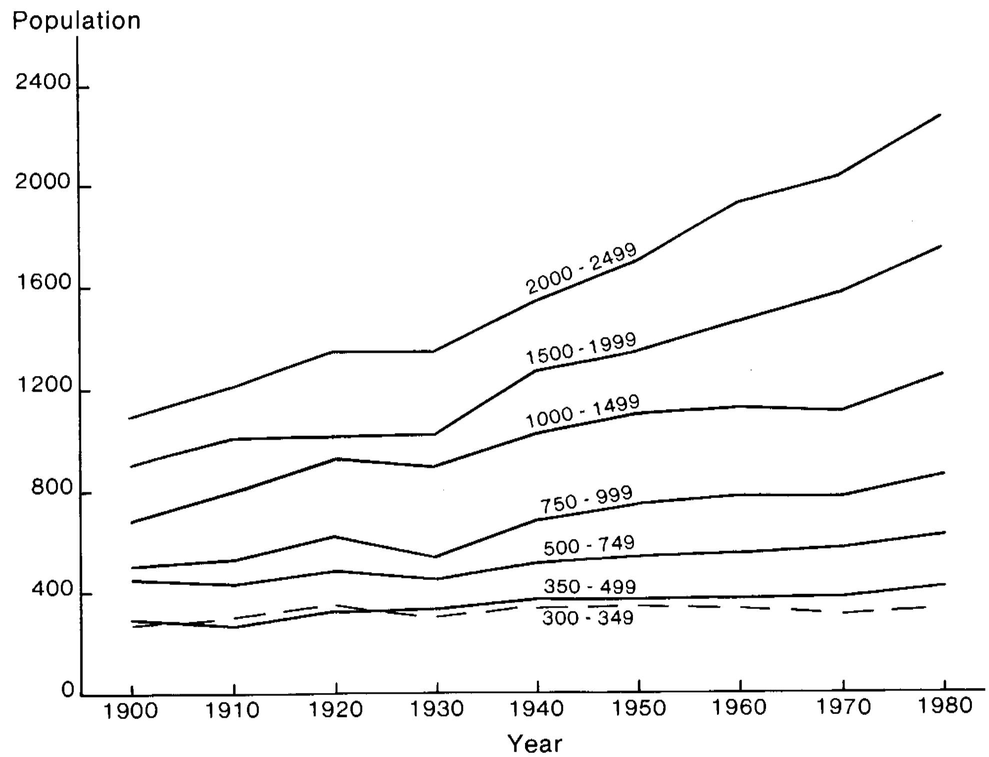


381,000, but only 41 percent were in the two Twin Cities counties, and manufacturing employment in the rest of the state had jumped from 80,000 in 1950 to 226,000 in 1980. The greatest increase in manufacturing employment was in a ring of overspill counties around the Twin Cities and in a strip between Mankato and Rochester, but between 1950 and 1980 employment in manufacturing more than doubled in all of the counties of central and eastern Minnesota except those where manufacturing was already a major employer in 1950 (Figure 4). Employment in manufacturing also increased in the larger places in the southwestern part of the state, but in 1980 the number of manufacturing workers in many counties of the southwest was still less than one per square mile.

The new manufacturing plants in small towns produce a remarkably diverse range of products. One might expect food processing to be a major manufacturing activity in rural areas, and indeed it is, but many of the new factories have few ties to the local rural area other than the workers they employ. Workers commute considerable distances to the new plants, and some small towns that have no new factories have become dormitories for others that do.

Some of the new small town factories are home-grown, developed by local entrepreneurs, and some are branch plants of larger companies; we have no information on their relative importance. We do know, however, that some manufacturing firms have left the Twin Cities for smaller places, or at least opened branch plants in such places, in search of cheaper labor and cheaper space. In the Twin Cities they have to compete for a shrinking pool of increasingly expensive labor, but in smaller places they can have their pick of the labor force,

Figure 3. AVERAGE POPULATION OF INCORPORATED PLACES, IN 1980 SIZE GROUPS, IN MINNESOTA FROM 1900 UNTIl 1980.



with its highly developed work ethic, and they can pay lower wages than they would have to pay in the Cities. Most small places also have cheap floor space in empty stores, schoolhouses, and other buildings that are no longer needed for the purposes they were originally build to serve.

The recycling of old buildings, many on side or back streets, can disguise the growing importance of manufacturing in small towns, and those who look for shiny new factories will be disappointed. Some firms have built new plants, to be sure, but many prefer the cheap floor space available in older buildings. The planned industrial park at the edge of town has not fared as well as its developers had hoped, but its weed-choked lots do not indicate that the town has failed to attract new industry.

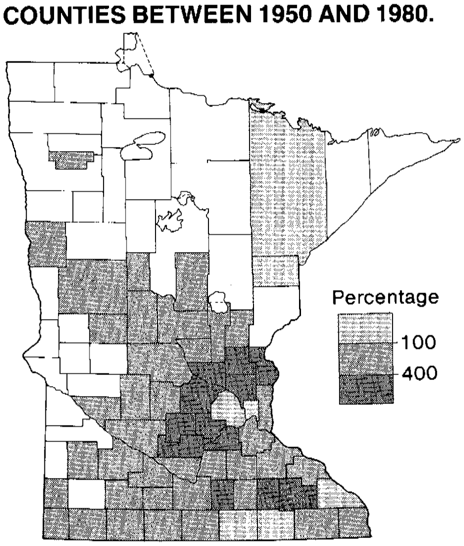
The spread of manufacturing to small towns may be partly related to the major restructuring of American industry since World War II. Manufacturing firms in the United States have shifted away from the mass production of long runs of standardized products in large factories to smaller, more specialized, more flexible operations that are fast on their feet and can switch product lines quickly. The firm has identified specific tasks that it can subcontract to smaller firms that rely on low-skill, low-wage, and often temporary or part-time labor.

Low-skill, low-wage jobs have recruited large numbers of women into the manufacturing labor force. In 1950 not a single county in Minnesota had a manufacturing labor force that ran as high as 30 percent female, but by 1980 women accounted for more than 30 percent of the manufacturing labor force in most of the counties of southern Minnesota (Figure 5). Low-skill, low-wage jobs are hardly an acceptable formula for sustained prosperity, but perhaps one can take some slight solace in the thought that at least they give the small town a brief breathing space as it contemplates a future that will be influenced by its changed role in society.

The future of small towns depends on the ability of their leaders to adjust to new ideas. Too often both the minds and the ranks of small town leaders are closed, and they must become more open to women, to young people, even to newcomers. They must understand that their town has changed from a rural service center to a minor manufacturing center. Attempts to pump new life into Main Street probably are doomed. Small towns need new industry, but industry needs small towns just as much, and it will be attracted to those that are most receptive.

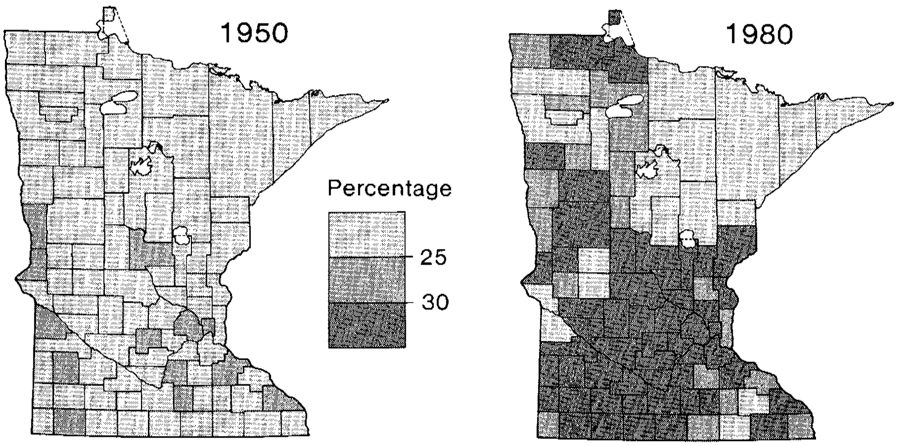
A small town is what its people make it. It has grown over the years because of the dedication and commitment of its individual citizens, their belief in the town and their willingness to invest their time, money, and energy in helping to make it prosper. The decision to incorporate, which is so closely related to the present size of the town, was a major act of civic commitment. The construction of a solid block of buildings on Main Street, the hallmark of the towns that

Figure 4. PERCENTAGE INCREASE IN NUMBER OF PERSONS EMPLOYED IN MANUFACTURING IN MINNESOTA COUNTIES BETWEEN 1950 AND 1980.



Unshaded counties had less than one person per square mile employed in manufacturing in 1980.

Figure 5. **FEMALES AS A PERCENTAGE OF ALL PERSONS EMPLOYED IN MANUFACTURING IN MINNESOTA COUNTIES IN 1950 AND IN 1980.**



have grown, was a major commitment by individual citizen investors. The next major commitment of the small town must be to do whatever is necessary to attract new industry and to encourage local industrial entrepreneurs.

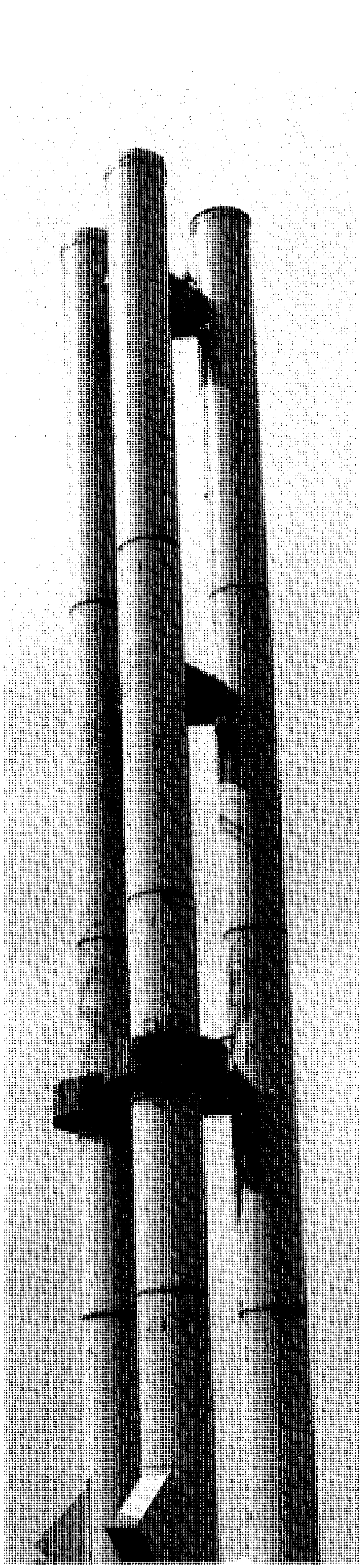
John Fraser Hart is a professor of geography at the University of Minnesota. Tanya Bendiksen, who begins graduate work in geography this year, did the computer work for this study.

Working Papers on Rural Economic Development

Five working papers have recently been published by the State and Regional Research Center, one of CURA's special programs. The Northwest Area Foundation funded the work reported in these papers through a project titled "Policies and Strategies for Rural Economic Development." The three-year project is assessing a range of approaches to helping distressed nonmetropolitan areas. The principal investigators are Margaret Dewar (Urban Planning Program, University of Michigan, on leave from the Humphrey Institute), Glenn Nelson, and Thomas Stinson (both of the Department of Agricultural and Applied Economics). The papers now available are:

- **The Minnesota Economy: A Regional Perspective for 1967-83**, Brenda Burk and Glenn Nelson.
- **Taxes, Jobs, and Market Growth Rates**, Thomas F. Stinson, Margaret E. Dewar, and Kip Sullivan.
- **Credit Rationing in Non-Metropolitan Markets for Small Business Loans**, Julia Mason Friedman.
- **Regional Labor Markets: Econometric Analysis**, Michael Grosse and Glenn Nelson.
- **Tax Incentives and Public Loans and Subsidies: What Difference Do They Make in Nonmetropolitan Economic Development**? Margaret E. Dewar.

The State and Regional Research Center was begun in 1985 as a way of facilitating research on regional economic development issues. The center sponsors the Minnesota Development Policy Workshop, which meets weekly during the school year and serves as a forum for the discussion of research proposals, research in progress, and findings from completed projects. These five working papers begin a series of papers that will be published by the center as research from a number of grants is completed. The papers are available free-of-charge by writing: Publications, State and Regional Research Center, 130 Classroom Office Building, University of Minnesota, St. Paul, MN 55108.



Assessing the Health Risks of Incinerating Garbage

by Jeffrey B. Stevens

In 1980 the Minnesota Legislature passed the Minnesota Waste Management Act initiating a vigorous effort by many municipalities and counties throughout the state to find alternatives to landfilling for disposing of their solid wastes. The major impetus for seeking alternatives was the environmental contamination, especially to aquifers, caused by landfilling garbage and the health risks this created. One alternative that many counties have chosen, or are in the process of choosing, is incineration. To date, thirteen municipal solid waste (MSW) incinerators are in operation or have been permitted in the state of Minnesota. They are located in Alexandria, Duluth, Elk River, Fergus Falls, Fosston, Mankato, Minneapolis, Perham, Red Wing (two), Rochester, Savage, and Winona.

But what are the risks associated with MSW incineration? Is MSW incineration risk free? If not, what types of risks are there to the public and to the environment from burning our garbage? The answers to these questions became the focus of this research project.

Assessing Health Risks

It was soon apparent how impossible it is to determine the actual health risks for the public from any particular incinerator. This reality stems from the current lack of all the scientific data required to predict the movement of chemical emissions in the environment; the myriad of human behavior patterns within the population group around any particular incinerator; and our present lack of knowledge about how, and under what conditions, chemicals cause injury to the human body. These three areas form the databases required in assessing the real risks of any garbage incinerator (Figure 1).

Chemical-specific knowledge of the fate of emissions into the atmosphere, where they go in the environment, is required to accurately quantify contamination levels around an incinerator. Human behavior patterns dictate the frequency and magnitude of human contact with the contaminated environment. The pharmacokinetics of chemicals in the human body, how chemicals interact with our bodies, governs the conditions that will cause chemicals to produce their toxic effects. The complexity in each database is so enormous that it simply prohibits the prediction of real health risks for any given project.

Consequently, regulatory agencies such as the United States Environmental Protection Agency (EPA) and the Minnesota Pollution Control Agency (PCA) have come to rely upon hybrid databases composed of scientific data and estimates or assumptions when they evaluate specific incinerator proposals. The EPA health risk assessment guidelines suggest standard approaches and "representative" data that can be used to model the environmental fate of chemicals and to calculate human exposure doses to various emission substances in lieu of the above requirement for actual chemical and site-specific data. In addition, EPA criteria documents contain the necessary toxicological data to translate calculated exposure doses into health risks. By using these standard assumptions in databases, a health risk assessor can estimate the potential health effects for a given incinerator project. But, the assessment of risk obtained in this way only approximates the actual risks that may be present.

Thus, risk assessments should not be viewed as "predictions of the future." They are intended for use on a comparative basis only. They do not answer the question "How hazardous is this particular MSW incinerator to people in the surrounding area?" They do, however, allow one to look at several important comparative questions:

- What substances emitted from MSW incinerators are likely to be most hazardous to public health?
- Which routes of exposure are most important for each chemical emitted from an MSW incinerator?
- What engineering and environmental factors are most important in determining, and therefore controlling, the magnitude of the health risks for the public?
- How do currently operating incinerators compare with those being proposed for the future? How do currently operating facilities compare with the state guidelines for acceptable risk?

Only the first two questions were addressed in this project.

Figure 1. COMPONENTS OF HEALTH RISK ASSESSMENT

Incinerator Emissions

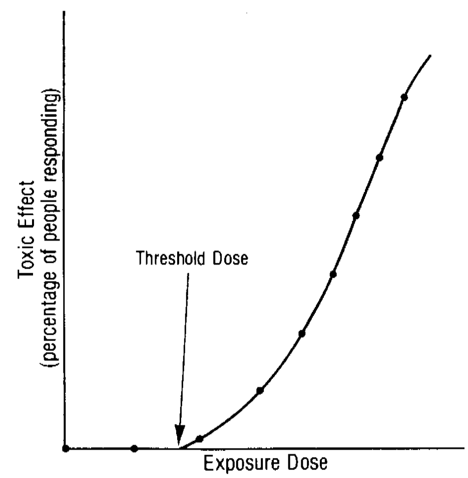
The first steps of this investigation were to quantify the major emission substances from MSW incinerators and to characterize their toxic properties. A variety of chemicals are emitted (Table 1): gaseous compounds such as sulfur dioxide, oxides of nitrogen, carbon monoxide, and hydrogen chloride; volatile organic substances like the chlorobenzenes; toxic metals such as lead, arsenic, nickel, cadmium, chromium, and mercury; and organochlorine compounds like the dioxins, to name just a few.

All of these compounds have been shown to be toxic to animals and/or humans. Lead, for example, causes kidney damage and anemia, and learning disabilities in children. Arsenic, cadmium, and chromium are all regulated today because they cause lung cancer. Dioxins and PCBs are known to cause cancer in animals and suspected of causing cancer in humans. The acid gases are all strong irritants (to the eyes, the respiratory system, and the skin). The volatile organics are toxic to the nervous system. Thus, it is evident that a variety of chemical toxicities can be associated with exposure to incinerator emissions.

Toxic Effects

But, does simply knowing that a chemical substance is toxic automatically imply a health hazard? The answer to this question goes to the heart of the risk assessment process. Most chemical substances are believed to follow a dose-response curve (Figure 2). In fact, millions of dollars each year are spent by the federal government

Figure 2. DOSE - RESPONSE CURVE



Faculty Interactive Research Grants

The study reported here was supported by an Interactive Research Grant from CURA and the Office of the Vice President for Academic Affairs, University of Minnesota. Jeff Stevens comments on his experience with the grant.

"The Interactive Research Grant allowed me to work with the Minnesota Pollution Control Agency (MPCA) during the summer of 1987. This practical experience has given me a much better perspective of how our public health "doctrines" work in the real world. This practical experience has been translated directly into several of my courses in the School of Public Health.

I have reoriented the contents of these classes and added the use of guest lecturers. No less than four members of the MPCA staff provided lectures in these courses this past academic year. In fact, one of these staff members, Dr. Velma Charles-Shannon, is now an adjunct assistant professor in the school. The benefits to our students are obvious. The students not only receive the technical details about environmental pollution from our faculty, but now they have the opportunity to listen to the practical implications of our environmental policies.

The interaction has also, in my opinion, been beneficial to the state as well. Currently, two of the faculty members in the Division of Environmental and Occupational Health (myself and Dr. D. Swackhamer) serve on technical advisory committees for the MPCA.

While I was at the MPCA I also had the opportunity to research in depth the area of health risk assessment. This would have been impractical but for this sojourn, and it yielded some valuable research opportunities that I am now pursuing. I currently have a contract with the Minnesota Department of Health to evaluate the bioavailability of soil-bound lead. This project will yield an important piece of information to the state since the MPCA is scheduled to establish a soil-lead standard within the next few years. I have also been developing state-of-the-art chemical exposure models for use by federal, state and local agencies, as well as by environmental consultants. The students that were supported by this award have played critical roles in this endeavor. The publication of papers describing these models is not only beneficial to my academic career, but also to the MPCA as it proceeds to rulemaking on incinerators.

Other benefits from this project include an ongoing professional relationship between our division at the University and the MPCA, the placement of several of our former students in the MPCA and Minnesota Health Department as employees, my participation at a retreat held for the MCPA Citizens Board on Health Risk Assessment, and support for students that worked on the project.

The student support was particularly useful. The project gave one of the students the training to pursue a career in the risk assessment field. She currently is employed by a private consulting firm in Washington, D.C. The other two students who worked on the project are finishing their Ph.D. degrees in environmental health and also hope to develop careers in this area."

Interactive Research Grants have been created to encourage University faculty to carry out research projects that involve significant issues of public policy for the state and that include interaction with community groups, agencies, or organizations in Minnesota. These grants are available to regular faculty members at the University of Minnesota and are awarded annually on a competitive basis. An announcement of the competition for next year's grants will be mailed to all faculty late this fall.

(through the National Toxicology Program) to test chemicals for toxicity and to determine their dose-response parameters. As the figure clearly shows, toxic effects do not appear in the exposed population until a threshold dose is exceeded. What this phenomenon implies is that with most chemicals low levels of exposure are not harmful. A good example of this principle is ingestion of alcohol. A sip of an alcoholic beverage will not intoxicate a person, but drinking more (say four ounces) certainly will. It also follows that some individuals are more sensitive to the effects of alcohol than are others.

The point that is being made here is that chemical toxicity and chemical hazard (or risk) are not one and the same. Scientists define chemical toxicity as an inherent property of a chemical. It is a property of the chemical that does not change and therefore can be determined in a laboratory. Chemical "x" is an eye irritant; chemical "y" is a carcinogen, and so on.

The hazard (or risk) that a chemical possesses is defined as the likelihood that the chemical will be toxic in a given exposure situation. Thus the chemical hazard is a function of both the toxicity and the exposure. To return to the earlier example, scientists know the toxic properties of alcohol; they have been defined in carefully designed laboratory experiments. The health risk of alcohol, therefore, depends on how much a person drinks. If a person takes only a sip, we know that the risk of alcohol poisoning is extremely low, perhaps zero. If a person drinks four ounces of alcohol, the risk of poisoning is quite high.

These same relationships apply to many of the environmental pollutants emitted from an MSW incinerator. Some of these chemicals have been shown to be toxic to animals and humans, and in most cases scientists have determined what levels of exposure do cause harm. The risk to the public from these emissions depends on the rates of emissions, the level of exposure, and the toxicity of each chemical.

Table 1. CHEMICAL EMISSIONS FROM MUNICIPAL SOLID WASTE INCINERATORS[1]

Pollutant	Emission Rate Range
Particulate matter	5.49—1,530.0 gr/dscf[2]
Sulfur dioxide	0.04—401.0 ppmdv[3]
Oxides of nitrogen	39.0 —309.0 ppmdv
Carbon monoxide	3.24—1,350.0 ppmdv
Hydrogen chloride	7.50—1,270.0 ppmdv
Hydrogen fluoride	0.62—15.6 ppmdv
Arsenic	0.45—233.0 ug/Nm3[4]
Cadmium	6.22—942.0 ug/Nm3
Chromium	3.57—6,660.0 ug/Nm3
Lead	25.1 —15,500.0 ug/Nm3
Mercury	8.69—2,210.0 ug/Nm3
Nickel	1.92—3,590.0 ug/Nm3
PCDD (a dioxin)	1.13—10,700.0 ng/Nm3[5]
2,3,7,8-TCDD (a dioxin)	0.02—62.5 ng/Nm3
PCDF (a benzofuran)	0.42—14,800.0 ng/Nm3
2,3,7,8-TCDF (a benzofuran)	0.17—448.0 ng/Nm3
Polychlorinated biphenyl (PCB)	8.31—833.0 ng/Nm3[6]
Total chlorobenzenes	160.0 —1,400.0 ng/Nm3[6]
Total chlorophenols	299.0 —3,330.0 ng/Nm3[6]

[1] Data taken from Midwest Research Institute "Municipal Solid Waste Combustion Study, Emission Database for Municipal Waste Combusters" EPA/530-SW-87-021, and personal communication with Dr. G. Pratt and A. Jackson, Division of Air Quality, Minnesota Pollution Control Agency.
[2] Grains per dry standard cubic foot.
[3] Parts per million on a dry volume per volume basis.
[4] Micrograms per normal cubic meter.
[5] Nanograms per normal cubic meter.
[6] The lower end of the range is an average for facilities with dry scrubbers; the upper end of the range is an average for all facilities.

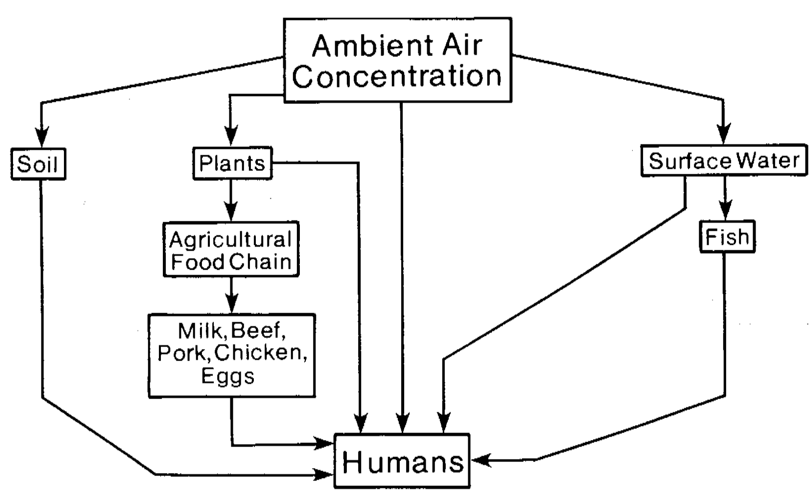
Contamination of the Environment

The types of chemicals emitted from an MSW incinerator, as well as their emission rates, have been provided in Table 1. These chemical emissions are both gaseous and bound to small particulate matter. Most modern incinerators are required to have pollution control equipment installed that efficiently removes any larger particles. Thus, in effect, only chemical emissions bound to small particulate matter and gases exit the stack. In either case once these emissions enter the environment they dissipate in the air around the facility. Eventually they deposit onto surfaces within the impact zone of the facility. They will land on water, soil, and vegetation, thus contaminating a variety of environmental media (Figure 3).

People living near incinerators can therefore be exposed to facility emissions not only from breathing contaminated air but also through a variety of other routes: eating or touching the soil; eating fruits, vegetables, and meats that have been contaminated; drinking or touching the water; or eating contaminated fish (Figure 3). A major portion of this project was spent developing mathematical models to quantify first, the various chemical fluxes in the environment around an incinerator, and second, the resulting accumulation of these chemicals within the various parts of the environment. This type of study is known as *environmental fate modeling*.

The degree of chemical accumulation in surface soils is related to the rate of chemical deposits from the air, the half-life of the chemical in the soil (the time it takes to degrade the chemical), the physical mixing of the soil through animal or human activities, and the physical processes that remove the chemical from the soil (surface runoff and leaching). Equations were developed to model chemical accumulations in soil. As mentioned earlier, much of the data in such equations varies from site-to-site and even within a site (from season to season). A review of the literature and discussions with

Figure 3. PATHS OF CHEMICAL EMISSIONS INTO THE ENVIRONMENT



various experts (such as soil scientists) were used in order to estimate representative data for the equations. The equations and the "estimated" data were then used to determine which emission substances are likely to accumulate in the soil and result in significant exposure for people.

Chemical accumulations in plants (garden produce and agricultural crops) were also examined in this study because many individuals keep home gardens in their backyards and because agricultural crops are used as food for local farm animals. Plants absorb environmental pollutants in three ways: from contaminated soil through their roots, from material deposited on their surfaces, and from airborne materials through their stomata. Equations were developed to quantified plant contamination from each of these routes. As with the soil models, however, much of the data are highly variable and site-specific. So, as with the soil models, representative data were collected from the scientific literature and used in the equations. This approach allowed us to determine which emission substances are likely to contaminate plant matter and thereby enter humans when common garden vegetables are eaten.

Once estimates were made of chemical levels in agricultural crops (such as hay, alfalfa, and corn silage) the chemical doses transferred to typical farm livestock were also modeled. These mathematical models are designed to translate how the daily animal doses of each chemical eventually contaminate human food. The end result is a quantification of each chemical emission in foods like milk, beef, pork, chicken, and eggs. Many of the data were found in the scientific literature and therefore, fewer estimates and assumptions had to be incorporated into this model.

Modeling chemical fates in surface waters and the aquatic food web is important because much of Minnesota's drinking water comes from surface water and because Minnesota is a popular sportfishing state. Chemicals that fall on water will dissipate into sediments and into the water column itself (dissolved and bound to suspended matter). Fish absorb the chemicals from either or both of these environmental reservoirs. Chemical partitioning between the dissolved phase (suspended solids) and the particulate phase (sediment) in surface waters has been examined quite extensively by the EPA as well as others. Many types of modeling equations are therefore present in the literature. For this project a subset of these equations was chosen in consultation with the Minnesota Pollution Control Agency staff.

The transmission of chemicals to biota in surface waters has also been studied extensively by many investigators and the EPA, and in general the data used by the state of Minnesota for setting ambient water quality criteria were used in the aquatic food chain section of this assessment model for health risk from incinerator emissions.

Human Exposure

Once the distribution and fate of each chemical in the environment has been described—so that chemical levels in air, soil, plants, surface waters, agricultural products, and fish are quantified—human exposure doses can be estimated. The general equation used to quantify exposure is:

$$\text{Human Exposure Dose} = \frac{\text{Chemical Concentration in the Environmental Medium} \times \text{Contact Frequency and/or Amount of Human Contact with the Environmental Medium}}{\text{Body Weight}}$$

As mentioned earlier, many of the assumptions about human physiology and anatomy used in creating human exposure models have been standardized by the EPA and these standard values are consistently used in risk assessments today. For example, average body weight estimates for humans are: 70 kg (154 lb) adult for both sexes, 42 kg (92 lb) adolescent, 14 kg (31 lb) toddler, and 8 kg (18 lb) infant. The volume of air inhaled while resting and the area of skin surfaces have also been standardized.

Human behavioral assumptions, however, can vary significantly from site to site. For example, Minnesotans' rate of vegetable eating was found to differ both qualitatively (what vegetables are eaten) and quantitatively (how much is eaten) from national averages. Minnesotans in general eat more vegetables daily than most Americans. Also, Minnesotans eat more fresh fish than the national average. There are a large number of individuals in Minnesota, most likely sportfishers, who eat up to twenty times the national average of fish. Thus, one major conclusion of this project was that as much site-specific data as possible should be incorporated into any assessment of an MSW incinerator so that reasonably sound estimates of exposure doses can be calculated. Only then can proper risk comparisons be made between facilities or proposed sites for a facility. If an incinerator is located near a lake or river where fishing is popular, then sportfisher rates of fish eating should be modeled in the heath risk assessment. Similarly, if an incinerator is not near any rural farms, then consumption of agricultural products doesn't need to be evaluated in the project.

The final step in assessing the dangers of human exposure to the chemical emissions from incinerators is the summation of the chemical doses from each of the routes of exposure which are relevant. This provides an overall exposure dose for each chemical being studied. We have discovered that there is considerable variability in which routes of exposure are most significant for different groups of chemicals, say dioxins and volatile organic compounds, but that there is also consistency among chemicals within a particular chemical group (Table 2). For example, exposure to lead through breathing contaminated air is a significant pathway. Even more significant is eating it in fish, if there are surface waters near the incinerator. Also significant, but to a lesser degree, are exposures to lead from eating contaminated garden vegetables and agricultural products like milk, beef, pork, eggs, and chicken. And in relation to this, lead doses from incidental eating of contaminated soil and from skin contact with soil are negligible.

The modeling data also substantiate the belief that chemicals that are relatively water-insoluble and resistant to degradation in the environment (PCBs, dioxins, and DDT) present the greatest problems when they contaminate the environment. Conversely, the only significant route of exposure for the highly volatile chemicals is through breathing them.

By relating the total exposure doses calculated for these chemical compounds to the federal and state standards for "safe" exposure levels, we get some idea about which emission chemicals are of most concern. In practice, cancer risk is usually calculated for each emission, and the risks are summed to give an overall risk rate for emissions from incinerations. Overall cancer risk, then, is one outcome from these assessments that can be used to compare facilities or to compare possible sites for a proposed facility. Risks not related to cancer are usually evaluated independently of each other. For example, lead doses are evaluated with respect to the neurological development of children, while cadmium doses are evaluated with respect to kidney damage. Many noncancer effects must be examined for specific chemicals when assessing a facility.

The overall cancer risk and the various noncancer risks are independent of each other because they involve different chemicals. An incinerator may impart a low cancer risk to people in the surrounding area yet present serious noncancer health risks, or vice versa. It is also possible for an incinerator to impart both (or neither) significant cancer risks and noncancer risks.

When dose comparisons are made under worst-case exposure conditions, it becomes readily apparent that the organochlorine carcinogens (dioxins and benzofurans) are the emission substances most dangerous to public health. Lead, arsenic, cadmium, and mercury, are also dangerous. The volatile organic solvents modeled to date and the toxic metals chromium and nickel are of comparatively minor concern. It should be stressed, however, that modeling of exposure doses for only these select chemicals has been completed to date. Many more remain to be evaluated. It is also important to recognize that the risks of MSW incineration do not stop with the air emissions from a facility. The residual ash from these facilities contains many highly toxic chemicals. Improper disposal of the ash could also lead to significant health risks. Very little work has been conducted to date on the health risks from incinerator ash.

Table 2. RELATIVE DANGER TO MAXIMALLY EXPOSED ADULTS FROM MSW INCINERATOR AIR EMISSIONS

	Routes of Exposure					
Chemical Class	Breathing Air	Eating Soil	Eating milk, beef, pork, chicken, eggs	Eating Vegetables	Eating Fish	Skin Contact with Soil
Organochlorine Compounds						
Dioxins/ Benzofurans	±	+	+ + +	+ +	+ + + +	±
Polychlorinated Biphenyls	±	+	+ + +	+ +	+ + + +	±
DDT	±	+	+ + +	+ +	+ + +	±
Metals						
Lead	+ +	±	+	+	+ + +	±
Cadmium	+	±	±	+	+ + +	±
Arsenic	+	+	±	+	+ +	+
Chromium	+	+	±	+ +	+	+
Nickel	+	+	+	+ + +	+ +	±
Mercury	+	+	+ +	+	+ + + +	+
Volatile Organic Compounds						
Benzene	+ + + +	+	+	+	+	+
Hexachloro-benzene	+ + + +	+	+	+	+	+
Carbon Tetrachloride	+ + + +	+	+	+	+	+

A worst case scenario for each route of exposure was assumed in these calculations. The significance of each route, i.e., the relative magnitude of the dose calculated, is designated by the number of + signs; + + + + indicates the major route of exposure by several orders of magnitude over the rest of the routes. ± indicates that this route is of little significance to the overall exposure dose.

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Involving Parents in Head Start

by Robert K. Leik and Mary Anne Chalkley

The Head Start program, which began in the 1960s, has become a successful national attempt to overcome some of the educational disadvantages faced by children of poverty. Although research findings are mixed regarding purely intellectual or academic gains (gains in IQ, for instance) there is strong and consistent evidence of long-term gains for children who have gone through such a program. These gains include less need for remedial school work, less getting into trouble, higher rates of completing high school, and higher rates of employment after school.

Comparisons across various preschool curricula indicate that the curriculum per se makes little difference; being in such a program is what matters. Funding limitations mean that too few children who could benefit are able to participate, but those who do, seem to have better life chances as a result. The evidence suggests that something about attitudes and beliefs gets molded in a way that has lasting effects. Since the family is the primary milieu of the very young child, it is important to ask whether involving parents as well as children could enhance those benefits which have already been demonstrated.

Since its beginning, Head Start program goals have included involving parents in the program. Just what involvement means, however, and whether it has any favorable impacts, has been less clear. For most programs, parental involvement has meant helping the Head Start staff with routine tasks such as serving food or riding buses with the children. The Head Start Family Impact Project was planned specifically to test the notion that joint parent-child interaction in the context of Head Start would be the most beneficial form of parental involvement. The initial data suggest some validity for this notion. There seem to be important benefits from parent involvement with Head Start that were not previously envisioned.

Design of the Project

The Head Start Family Impact Project began in the late Summer of 1986 in cooperation with Parents in Community Action (PICA), the Hennepin County Head Start program. Because over 80 percent of PICA families are single parents who are female, only that type of family was sampled. All told, eighty-one Head Start mothers and their children participated in two sets of assessments. In addition, twenty-one mothers and their children who were on the PICA waiting list also participated in the assessments as control families. Of these 102 families, 42 were white, 40 were black, and 20 were American Indians. The assessments occurred early in the Head Start year (October 1986) and again at the end of the Head Start year (April 1987).

The assessments measured variables in the parent and the family as well as in the child. Mothers answered questions that supplied most of the data. Personal psychological variables were examined in the mother, such as her self esteem and sense of control in her life. The mother's evaluation of her own child's behavior and capabilities was assessed through questions about the child's competence and social acceptance and about the child's independence. Other questions gave a measure of the family's functioning, particularly of family cohesion and adaptability and of family coping strategies. Family stress, family resources and family support within the community were measured. Demographic information was also requested, such as the size and composition of the family. In addition, the children were interviewed individually using a picture-based rating scale that measured their own sense of competence and social acceptance.

Head Start families were assigned to one of two treatment groups: enriched or regular. Regular meant that mothers were free to participate in Head Start as they wished, with no specific requirements or encouragements. The enriched group participated in special activities throughout the Head Start year. These included 1) two support groups for the mothers, 2) three computer games designed both to encourage interaction between the mother and her child and to teach the child about decision-making and the use of resources, and 3) two parent-child group activities focusing on role playing and games to play together.

For the computer sessions, the mother was first taught how to run the system, then she taught and worked with her child. The sessions included making a simple color drawing, playing a birthday planning game (here the child negotiated a maze, making decisions which limited or expanded future decisions), and a computer treasure hunt that emphasized systematic search procedures. In most instances, the child ended up sitting on mother's lap in order to operate the keyboard. The role playing and game sessions emphasized each mother and child sharing with other mothers and children in small groups.

Although it was intended to have equal numbers of families in each of the three assessment groups, a number of factors made this impossible. The final breakdown of the participants was thirty in the enriched group, fifty-one in the regular group, and twenty-one in the control group.

Table 1. TYPE OF FAMILY FUNCTIONING IN HEAD START FAMILIES AND IN MIDDLE CLASS NORMATIVE FAMILIES (in percents)

Classification	Head Start Families	Middle Class Families
Extreme	28.8	9.5
Mid-range	33.6	40.0
Balanced	37.3	50.7

Initial Assessment

How did the Head Start families compare with "normal" middle class families at the beginning of the Head Start year? All the Head Start families in our assessment groups were fairly young (the average age of mothers was twenty-eight), they were poor (a median income of $531 a month), but reasonably well educated (74 percent had graduated from high school or earned a GED certificate). The families were atypically large. One third had three or more children and nearly half had two or more adults.

On the average, the Head Start mothers were no different from "normal" middle class mothers in terms of self esteem and sense of control in their own lives. Their children, also, scored no differently on average in measures of competence and social acceptance from middle class children who had taken the same tests.

Mothers tended to rate the independence of their children somewhat lower than did parents of children attending the University of Minnesota nursery school. However, the Head Start mothers were more satisfied than the University of Minnesota mothers with their children's independence. Both the Head Start mothers and the control group mothers rated their children significantly lower on competence and social acceptance than the children did themselves.

The Head Start families appeared to be quite comparable in health and well being to other families of preschool age children. Typically, they had fewer resources, but more support from their immediate family and friends. The Head Start families had experienced more stress than middle class families, but they did not differ in terms of family strength, and there was only one difference in terms of coping strategies: Head Start families turned to religion less often.

Family functioning was evaluated in terms of cohesion (family togetherness) and adaptability (the amount of structure and rules in the family). For these measures, it is assumed that extremes on either end of the two dimensions have negative consequences for the family. Too much cohesion indicates an enmeshed family while too little cohesion indicates a disengaged family. Similarly, too much adaptability indicates a chaotic family while too little adaptability indicates a rigid family. Families are classified as *extreme* when they are extreme on both dimensions, *mid-range* when they are extreme on one dimension but within the acceptable range on the other dimension, and *balanced* when they are within the normal range of both dimensions. Both the Head Start families and the control families differed markedly from reported norms on these measures. Table 1 compares the Head Start families with the middle class family norms.

It is evident that in most respects Head Start families are quite similar to other families, but that the mothers tend to underestimate their child's self worth and the families tend to display patterns considered dysfunctional.

Extent of Mothers' Involvement in Head Start

Setting aside the fifteen or so hours required for the enrichment activities, mothers in the enrichment group invested a mean of 25.9 hours in Head Start activities over the six months of the study. The range was from only two hours to an impressive 153 hours. When time spent in the enrichment activities is added to these other hours, the mothers in the enriched group averaged about 1.6 hours per week in Head Start activities.

In contrast, mothers in the regular group invested a mean of 19.4 hours, with actual hours ranging from 0 to 154. Overall, these mothers averaged less than one hour per week throughout the six months of study, or about half of the time put in by the enriched group.

It is possible, of course, that mothers in the enriched group agreed to be in that group because they had more time available. However, we doubt that such an explanation covers the very large difference documented. It would appear that committing themselves to the enriched program induced these mothers into taking a much more active part in the entire Head Start program. If so, this is a very important finding.

Did Involvement Make a Difference?

Assessments made in April, at the end of the Head Start year allowed us to examine the changes in mother, children, and family functioning that had occured during that year.

Debbie Frenette and son Micael play "itsy-bitsy spider," often a group activity for the parents and their children.

Melrecia Wright is learning to use the computer with guidance from her mother Hope.

Competence and Acceptance. On average, the Head Start children increased in their sense of their own competence and social acceptance during the year. Parents, however, in both the enriched and regular groups, increased their estimate of their children's competence and social acceptance even more; so much so that by the end of the year, the children and their parents were in basic agreement. By comparison, the control group mothers did not increase their evaluations of their children's abilities. In fact, control mothers' assessments actually declined slightly, with the result that they ended the year with an even greater underestimation of their own children then occured in the first assessment. It seems, therefore, that involving mothers in Head Start helps them see their children more positively and more as the children actually see themselves. Such an improvement in parental assessment could have great long-term consequences for the child, perhaps encouraging the child to aspire to greater achievement.

Family Functioning. Most of the families initially classified as extreme in both Head Start groups and in the control group became less extreme during the study year. However, other families became extreme during that same time. Enrichment seemed to have little to do with any move away from dysfunction, but the number of families who moved into extreme forms of functioning during the year differed greatly in the three study groups. The net reduction of extreme family types in the control group was a modest 25 percent. In the regular Head Start group the net reduction was 40 percent. And in the enriched group the net reduction of extreme families was 78 percent! Only two of the families in the enriched group (out of thirty) were classified as extreme by the end of the Head Start year. Thus, Head Start, especially in conjunction with parent involvement, may provide a buffer that reduces the chances of family functioning being at risk. Figure 1 shows these changes in graphic form.

Some Racial and Cultural Differences

With only forty-two white, forty black, and twenty American Indians in the entire sample, it is not possible to separate out the effects of involving parents in Head Start for each cultural group with any statistical confidence. However, we did discover marked differences between these racial groups in how the parent, child, and family variables related to each other. For example, the mother's self esteem was closely related to the amount of cohesion in the family for whites and American Indians, but not for blacks. On the other hand, for whites and blacks, the family's cohesiveness in the fall corresponded closely with the child's independence in the spring, but for American Indians this relationship was reversed. We are currently exploring the possible implications of these differences.

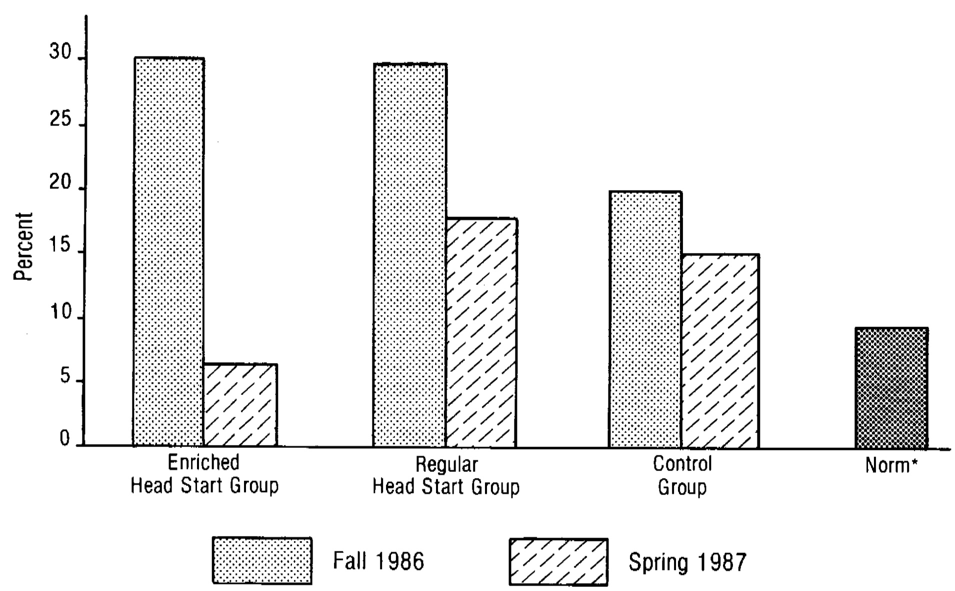
Policy Considerations

Given the cultural variations in our findings, it may be that no single policy for parental involvement will be equally satisfactory for all cultural groups. Of course we need much more evidence before drawing extensive policy conclusions. However, our data from this study alone do speak to several policy issues.

1) It is apparent that Head Start does affect the parent as well as the child.

2) An obvious corollary to the significance of parental involvement is that not all

Figure 1. CHANGE IN EXTREME FAMILY TYPES (in percents)



* Based on FACES (Family Adaptability and Cohesion Scales) in D.H. Olson et. al., *Family Inventories* (St. Paul: University of Minnesota) 1985.

types of involvement are equally significant. Our research focused on the importance of the parent and child interacting in a setting where each would have the opportunity to perceive the other as competent. The enrichment activities were designed to meet this special need. Those families that participated in these activities were the ones that showed the most significant positive changes in family functioning. Although the parents in the regular Head Start program had some similar opportunities (such as working as aides in the classroom), systematic efforts to offer this special kind of parental involvement need to be encouraged.

3) Parental involvement may not be the only type of involvement that is appropriate for Head Start programs. One scholar has argued that involving other extended family members in Head Start could have beneficial effects for both the child and the family.

4) Another important policy problem is how best to capitalize on cultural variations so that all children in Head Start receive the most benefits possible. Our evidence clearly indicates that one cannot ignore racial and cultural variation. While our data are not adequate to generate specific program proposals, we would argue that greater effort must be made to be sensitive to the cultural context in which these families live.

5) Finally, it is apparent that more research of the type outlined here is needed. Even the members of the Consortium for Longitudinal Studies, the research group that documented the long-term advantages of pre-school programs for poor children, expressed concern that the only criterion used for measuring success was academic. Without expanded definitions of success and without further research to investigate them, Head Start could lose much of what it was intended to offer. Merely asking parents if they think things have improved is also not enough. A concerted effort needs to be made to develop methods for evaluating the broad range of Head Start goals. Only when one can consider the impact on the family, the social and emotional impact on the child, and the effect within each cultural community, as well as the impact on the child's academic success, can one begin to evaluate program effectiveness and assess the true social cost of excluding children of the poor from programs like Head Start. At this point, there is good reason to believe that involving parents in Head Start as coparticipants with their children, rather than simply as home-based teachers, fosters the type of family environment which helps the children most in the long run.

Robert K. Leik is a professor of sociology at the University of Minnesota. He joined the University of Minnesota faculty in 1975 to direct the Minnesota Family Study Center. Mary Anne Chalkley is an assistant professor of psychology at the College of St. Thomas. She was completing her Ph.D. in child development at the University of Minnesota during this research project.

Readers interested in a more detailed account of the study reported here will find a chapter by Leik, Chalkley, and Peterson ("The Impact of Head Start on Family Dynamics and Structure") in *Social Policy Implications for Families*, E. Anderson and R. Hula, editors (Westport, CN: Greenwood, 1989). This research was funded by the Administration for Children, Youth, and Families, part of the United States Department of Health and Human Services, with additional assistance from CURA. A second phase in this research, increasing the sample size by 140 new families and following some of those studied earlier now that the children are in primary school, will begin this year with funding from the Ford Foundation and additional assistance from CURA.

Photo on page 1 by John Fraser Hart.

Photos of the Hennepin County Municipal Solid Waste Incinerator on pages 6 and 9 by Judith Weir.

Photos on pages 11, 12, and 13 by Robert Friedman. Parents and children pictured here are from Parents in Community Action but are not those who were interviewed for this study.

New CURA Publications

Environmental Lead Risk in the Twin Cities. Howard W. Mielke and John L. Adams. 1989. CURA 89-4. 22 pp. Free.

Lead is an extremely toxic substance that has been used in large quantities in our technological society. Lead dust has accumulated in the soils of urban areas. The Urban Lead Mapping Project collected soil samples from parks, playgrounds, housesides, streetsides, and midyards in the Twin Cities. The resulting maps, showing the distribution of lead dust in this urban area, are the first of their kind. They show that lead content is highest in houseside soils, particularly in inner-city neighborhoods. Parks and playgrounds in the Twin Cities are quite safe in terms of lead risk. This monograph presents the maps and summary statistics from the Urban Lead Mapping Project along with a brief explanation of the dangers of exposure to lead.

Courses in Survey Research, University of Minnesota, 1989-90. July 1989. Minnesota Center for Survey Research. 19 pp. Free.

Many departments at the University offer courses that address methods of survey research. Those where at least 25 percent of the primary focus is on survey research are listed here. Listings are alphabetical by department and include course descriptions, teachers, quarters when the class will be offered, prerequisites, and the percent of the class devoted to survey research. Only classes on the Twin Cities campuses of the University are covered.

Courses on Aging, University of Minnesota, 1989-90. Monica Colberg. 1989. CURA 89-5. All-University Council on Aging. 23 pp. Free.

The University of Minnesota offers many courses related to aging. This is a listing of those courses in which aging is a primary focus. Courses are listed by campus (Twin Cities and the coordinate campuses) and by department. Listings are complete with course name, number, quarter offered, teacher, credits granted, prerequisites, and course description. Only the time and place are not given. Contact persons and phone numbers are listed for each department.

Courses on the Environment: A Student Guide to University of Minnesota Courses on Environmental Issues on the Twin Cities Campus, 1989-90. Margaret R. Wolfe. 1989. CURA 89-6. 49 pp. Free.

Courses relating to environmental studies at the University of Minnesota are listed by subject area and by department. Course descriptions are included. This publication is intended to be a guide for faculty and students and is supplemental to official University bulletins. An additional section describes special centers, services, and libraries that deal with the environment.

Student Papers in the Public Affairs Library

Research papers prepared by masters degree candidates in the Hubert H. Humphrey Institute of Public Affairs are housed in the Public Affairs Library after they have been approved by the institute's faculty. Because many of these papers are of interest to our readers, we periodically list recently acquired papers (Plan B papers, as they are called). The Public Affairs Library is located in room 50, Humphrey Center, West Bank Campus of the University of Minnesota (612/625-3038). The faculty adviser for each study is indicted at the end of the entry.

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