

Ec. 171, Current

Ec. 177, Wed., Feb. 4

Reschedule midterms to
Feb. 20

1. Objectives of learning.

Avoid waste

Physical

Economic - mainly bad timing

Max. rent

Equity

Rent to lessor

Return on cap. to lessee

Wages to labor

Taxes, on same basis as elsewhere

Liability for env. damages

Stability

Taken care of self, by those on whom
instability is imposed change for it.

Competition, open entry

Refer profits.

Avoid jt. bidding

Small units sold

Infrastructure available to all -
common carrier

Bonus bidding, problems:

Conc. 8 cos. have 64% Ak, increase.

Cumulatively reduce resource base of other firms.

Force go. bidding: Reduce comp.

Efficiency taken back sent to finance.

Abusive ownership.

Risk cap. is outside cap.

A risk. Bid in the dark. Cost of exploration.

Benefits larger firms b. of their diversity.

Fraud by state - sell dry acreage on purpose

Firms discount at 10% - they say.

So participate & earn that 10%.

Regressive, like gambling. Winner take all.

2. High royalty

Not royalty bidding - a Treasury

Defers profit

Means risk. Some risk, anyway.

Problems

1. Defers opt. time, $\therefore$ waste

Can be solved by countervailing delay rental.
(Or put. land, by prop. tax.)

2. Winner can tie up acreage cheap.

Restrict acreage

Delay rental,

Work commitment, countervailing.

$$\text{Sales} - \text{o.c.} = \text{c.f.}$$

$$\text{c.f.} - \text{depr.} = \text{inc.}$$

$$\text{inc.} - i \cdot K = \text{gross rent}$$

$$\text{g.r.} - \text{depr.} = \text{net rent}$$

3. Regressive w.r.t. rent.

4. Stifles input effort.

5. Exempts unrealized apprais.

6. Lease can be chiselled by understating price.

3. High "profit" share (profit is income)

Not bidding, again.

Define profit - what & when to deduct,

a. Running costs

On site, or N.Y. or lead? "Net proceeds" says on-site only. In run, not in personum. No deduct int.
~~Only~~ Only a small bias results, b/c firms bid less for the bonus.

Padding? "Entertainment"? "Base salary" in remote areas.

b. K costs

Exploration? Where, when?

Preliminary

Dry holes

Abandoned leases, or permits?

When?

Expense

W. time

W. profits.

5

If defer K deduction, allow interest?
I suggest allow int., but at low
rate, avoid goldplating.

* Then profit share becomes rent share. (like
trend of inc. rate)

Mead's contradiction, royalty breaks too much,
inc. share expands too much. Counterweighting
forces. Solve by using both.

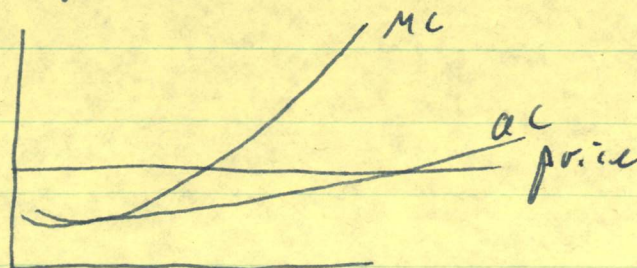
Note how profit share depends on def. of
profit.

4. Work commitment bidding.

Much popular support; no prof'l. support.

Upper limit on bids is above what
is economically justified.

Suppose there is no uncertainty, & simultaneity



Dissipate rent, Tragedy of commons.

6
Again, tho. we cd. have a fixed
work commitment, good idea.

Only problem is getting philosopher-kings.

5. GVC

Gross proceeds (from sale)

Less o.c.

C. F.

Less deprec.

Gross income (+ deprec.)

Less invt. (imputed on unrec. cap.)

Gross rent

Less deprec.

Net rent

20 copies by 10:45 pm.

Midterm. Ec. 177, 2/20/81

Briggs Avas

Answer any 3.

1. Do we use too much energy? ~~and~~
Why, or why not?
2. If energy supplies are predictable, why do experts differ on forecasts of forthcoming supplies, and the role of a cartel in supply?
3. Mead says high royalties ^{in leasehold contracts} cause "dissipation of economic rent." Mc Donald & others say work-commitment bidding causes the same. What is their reasoning?
4. ~~What is the diff~~
Why is there a clash between the goals of ~~that~~ avoiding physical waste, and avoiding economic waste in energy production?
5. How would you adjust "profit-share bidding" for oil leaseholds to convert it to bidding for pure resource rent?
6. How would you determine an optimal rate of recovery ~~&~~ from an oil reservoir of known ~~volume~~ quantity?

News notes, Energy

2/11 James Edwards, Energy Secy, ex Gov. of S.C.,
will push nuclear. Otherwise, will cut
energy budget.

Will A.M. for:

- breeder
- disposal sites
- reprocessing spent fuel
- nuclear warheads

DOE makes time for DOD

2/11 Iraq offers truce to Iran

2/11 Saudi's joining w Pakistan

Profit share

Advantages

1. Solves problem of royalty — (except for int. (on equity, or borrowed.)
Rifle in on flush producers.
2. No need for starting royalties
3. ~~Problem~~ Problem from not deducting o-head is minimized, firms just bid less, & reduce o-head.
"O-head" includes pre-lease, exploratory costs.

Problems

1. Int. remains undeductible.
Same problem as royalty & remains, just reduced.
2. Admin. costs — same as inc. tax.
3. Cap. recovered slowly. Hard on lean firms.

Rent share. Hi rate, no leakage. Theoretical ideal,

a. Guaranteed int. return
a-f effect.

b. Front-end recovery

c. GVL

Bonus, pd. in installments, ex post.

Projects.

1. In-house

2. ^{Summer} Intern program, \$866/mo.

3. Newsletters.

Speaking.

Students, Note

Energy - what leading up to?

Cost of alts.

Include cap. costs
Learn how

Change old habits, re "effic" etc.

Max. output/man

Ignore energy

Ignore int.

- pollution

Last has been ~~was~~ "solved" but
wrongly, by ignoring int.

Max. gross rather than net gain.

Δ man & K coeff, per man

Kuere

What is consumer? He doesn't answer.
l.v. again

Prices vs. costs.

He only discusses pollution. Monomaniac.
Heavy-handed.

Big error - solutions involve reducing cap. for energy

Reflects bankruptcy of ~~int~~ environmental costs.

Provision

COET

1. Rationale for using taxes instead of price controls for equity
2. Can feed tax w/o creating an output penalty?
3. Does COET accomplish this?
Chronic migration.

Ec. 177

Summary of student suggestions

- ✓ 1. Tax policy. Longholes
2. Lease
- ✓✓✓ 3. Nuclear: fission & fusion. Pro as well as con. Nucl. wastes. New admin. policy.
- ✓ 4. Current energy topics. relate to intro. in class.
5. Synfuel, their impact on water supply.
- ✓✓✓ 6. Solar, biomass, geothermal, wind.
- ✓✓ 7. De reg. Rationing
8. Conservation (other than Loris)
- ✓✓ 9. Monopoly & concentration: collusion to anti-supp. efforts. limit dev. A
10. Political aspects.
- ✓ 11. Mass transit
12. Costs of each energy source.
13. Recycling ... energy from munic. wastes.
14. Govt. support of R + D
15. Environmental problems.

1. ALTERNATIVE Taxing policies For oil & gas production
2. " LEASING " " " " LANDS.
- 3.

Suggestions for Econ 177

1. Talk on Nuclear Energy Policy fission & Fusion
2. Talk on Current Energy topics in the U.S. ~~and~~ and the World.
3. More frequent class discussions on different energy ~~prob~~ problems & topics
4. Talk on Syn fuel plants and the impact they would have ~~on~~ on water prices.
5. Talk about Solar Power, Biomass conversion and Geothermal Power.

Deregulation of gas & oil prices as
signed today by pres Reagan.

R. Gong

During the remainder of the course, I would like the following areas to be covered:

- 1) alternative views of energy conservation
(other than Lovlins)
- 2) effects of deregulation & decontrol
- 3) tax loopholes used by the oil corporation
(i.e. intermediary companies to reduce profits tax)
- 4) Oil corporation's control over all energy sources
and their policies to maintain monopoly
to maximize profits:
possible collusion to ~~to~~ limit development

Utilities involvement by The
promotion of Solar Energy

BRIAN A. JOBST

1/27/80

ENERGY

GAFFNEY

Based on the reading I've done in both our texts and skimming the remaining chapters I basically have four suggestions that I'd like to see in 177:

- ① I think Mead's book covers U.S. energy policy quite comprehensively and is generally easy to read, but at times the discussion in some chapters seems to get a little too deep or confusing for me at least. Therefore, I'd like to see us comment on each reading briefly in class, even if it's just a few sentences or questions, to see if we picked up the main points.
- ② Energy is a very contemporary issue and there are constant changes in the energy situation both domestically and worldwide. So, if possible, perhaps we could relate some current newsworthy energy events to the material we cover in class.
- ③ Along these same lines, since a new administration has just entered office there will undoubtedly be many changes in the U.S. energy policy. Perhaps we could discuss these changes and their implications as such changes are announced.
- ④ Finally, I read some of Zevin's chapters and his approach to nuclear energy seems to be, at times, a narrow, short-sighted condemnation. Perhaps

we could get a bit more balance. I've read other material that
bring up positive points he neglects.

Douglas P. Dixon

1/28/81

I would enjoy some discussion about nuclear energy and its economic implications. The most urgent seems to be one of the major balancing points as to whether this form of energy is feasible. Including, also, would be a discussion of other dangers, energy needs.

I would like the following topics to be dealt with in the course because I feel they would be interesting to the class as a whole and also because I hear arguments from both sides and don't know who to believe.

A. Solar Energy - is it economically feasible? Why isn't it being developed more quickly? Who stands to gain and who will lose?

B. The effect of political realities on economic questions in the energy field. By this I mean it seems hard to separate the two from each other and can you consider economic problems in energy without discussing the political ramifications.

C. Is the energy field competitive? If not what can we as a people do to thwart our dependence on big oil.

D. Is there an energy crisis or is there a shortage in fossil fuels and can we develop alternative forms of energy.

potential
I would mainly like to cover¹ future
energy sources - costs, benefits and
implications for each source. Of paramount
interest is the future benefits and implication
of reliance on nuclear sources.

The party

A subject I would like you to discuss is mass transportation. ~~Is~~ Is it feasible, especially here in southern California? Also, who should be responsible for the project if undertaken?

Government or private ~~and~~ industry. If private industry undertook the project, how can they do it in the most economical method? How ~~can~~ could they do it, in other words, and still compete with other industries

1) Examine the costs associated with various sources of energy.

- solar

- nuclear

etc.

Jennifer Thayer

1/28/81

Econ 177

My knowledge of this subject, Energy Economics, is relatively limited so I'm open to anything studied in class. Looking over the topics in the Meddy, Utton book I'm especially interested in energy conservation policies, problems of nuclear waste and strip mining. I'm also interested in recycling processes for sewage and trash, and if there is any way to make them feasible. The aspects of urban sprawl and possible techniques to curb it such as mass transit.

The literature dealing with energy policy, politics and economics is enormous and growing at an exponential rate. The wealth of material makes a course like this only a brief survey. For the remainder of the session the following items would be of interest to me.

1. Technology & Values - The
"Hard - Soft" Debate

2. The Oil Crisis -
OPEC, NATIONAL SECURITY, SUPPLY
AND DEMAND PERFORMANCE

3. Multinational Oil -
STRUCTURE AND OPERATION

4. NUCLEAR, COAL & OTHER OPTIONS.

Dennis L. Soder

Estate Meyer

I would be interested in studying the more "exotic" forms of energy such as wind and solar power as well as studying oil and gas as energy sources. I would particularly be interested in learning why, when looking for substitutes for oil and gas, there is much more emphasis ~~and~~ placed on nuclear power and coal as opposed to these more exotic forms of energy. I would also like to study the impact that environmental regulations have on our choices of future energy sources.

policy must be part of the public agenda—an ongoing process of debate and analysis, reflected in newspapers, journals, public-affairs programs and classrooms. As the inevitable alternative to supply-side economics, industrial policy should truly become the public's business. □

■ THE INVISIBLE DEATH (PART II)

The Lethal Path Of T.M.I. Fallout

Last week, Ernest J. Sternglass, who has long been concerned about the harmful effects of low-level radiation, told of journeying to the scene of the Three Mile Island nuclear accident and growing suspicious that more lethal radioactive gases had escaped following the accident than had been publicly disclosed. These suspicions were enhanced by remarks in transcripts of a meeting of the Nuclear Regulatory Commission. Subsequently, Sternglass obtained a report showing that, contrary to N.R.C. claims, the Metropolitan Edison Company's instruments at the plant had recorded a large leakage of radioactive gases along with the hourly wind direction and speed. These gases contained iodine 131, which, if inhaled by pregnant women, would cause an increase in infant deaths. Thus, a rise in infant mortality rates in areas affected by the T.M.I. fallout could be expected.

—The Editors

ERNEST J. STERNGGLASS

I decided to gather whatever data I could as soon as possible, for an enormous media campaign had been launched by the nuclear industry to convince the public that there were no serious health effects due to the accident at Three Mile Island on March 28, 1979. No one had died, the industry said, and no member of the public had been injured; the safety systems had worked, and there was no reason to abandon this important source of energy at a time when the United States depended so heavily on imported oil from the unstable Middle East.

In mid-August, the latest monthly report from the U.S. Center for Health Statistics for the month of May arrived. Calculating the rates of infant deaths per 1,000 live births, I found what I had expected. Instead of declining from the winter high, infant mortality in Pennsylvania had gone up following the accident at the end of March. Compared with 147 deaths in February and 141 in March, there had been 166 in April and 198 in May, an unprecedented rise

*Ernest J. Sternglass is a professor of radiological physics at the University of Pittsburgh School of Medicine, department of radiology. He is also adjunct professor in the department of history and philosophy of science at Indiana University in Bloomington. He is the author of more than 100 articles on the physics of radiation and the author of *Low-Level Radiation* (Ballantine, 1972) and *Secret Fallout* (McGraw-Hill, 1981), from which this article is excerpted.*

of 40 percent. Yet the number of births had actually declined from 13,589 in March to 13,201 in May. Thus the rate of infant deaths per 1,000 live births had increased even more, namely by 44 percent, from 10.4 in March to 15.0 in May.

Yet, at the same time, the infant mortality rate for the United States as a whole between March and May had declined 11 percent, as it normally did, dropping from 14.1 to 12.6 per 1,000 live births.

These were highly significant changes; the Pennsylvania figures for March and May represented an increase of 57 deaths, which was more than three times the statistically expected normal fluctuation of approximately 16, and thus unlikely to occur purely by chance in less than one in a thousand instances. But how else could I test the hypothesis that these increased rates were likely to be due to the releases from Three Mile Island without having the county-by-county and the Harrisburg figures available to me?

Having learned from the utility's own report that the heaviest releases had occurred when the wind was blowing north, northwest and west, and having seen reports in the papers of high levels of radioactivity being measured in Syracuse, some 150 miles to the north, at the time of the accident, I decided to examine the figures for New York State. By a fortunate coincidence, the U.S. Vital Statistics gave separate figures for New York City and for the rest of the state, most of whose population was located in upstate New York—north, northwest and northeast of Harrisburg, some 100 to 200 miles away. Here, then, was a clear prediction of the hypothesis that could be tested: the figures for the rest of the state outside of New York City should have gone up, while New York City should either have shown no change, or an actual decline.

And this is exactly what the numbers showed: between March and May, infant deaths outside New York City climbed an amazing 52 percent, by 63 deaths, from 121 to 184. For New York City during the same period the number declined from 166 to 129. Again, these changes were many times as large as normal fluctuations, and the number of births changed relatively little, or by less than 10 percent, so that there could be no doubt about the significance of these changes in infant deaths.

So far, the hypothesis had passed its first major tests, but would it hold up for the other nearby states? What about Maryland, to the south, where some of the gases had drifted in the morning and afternoon of the second day, according to Met Ed's report? The numbers were smaller than for the most populous states, but the changes continued to support the hypothesis: Infant mortality rose 26 percent, from 39 to 49 deaths, while the number of births remained essentially unchanged—4,013 in March and 4,076 in May.

What about New Jersey, to the east and northeast of Harrisburg? If the hypothesis was correct, there should not be any significant increase, since by the fourth day of the accident, when the winds shifted toward New Jersey, the rate of release had already sharply declined. Again, the hypothesis held up under the test. Between March and May, New Jersey infant mortality rose by only 8 deaths, from 87 to 95. This is not considered a significant increase, since a spontaneous

statistical fluctuation of approximately 13 is normally expected.

What about Ohio, to the west, which had for decades closely paralleled Pennsylvania in its declining infant mortality figures? Did it show the same 40 to 50 percent rises of Pennsylvania and of New York State outside New York City? It was not to be expected that the gases would have drifted more than 200 to 300 miles west of Harrisburg, counter to the generally prevailing west-to-east movement of air masses across the United States, and so there should really be very little change in the Ohio figures. Again the numbers bore this out: Between March and May, infant deaths declined in Ohio from 177 to 160, the rate remaining constant at 11.5 per 1,000 live births.

There simply could be no other explanation for such a localized pattern of sharply increased infant deaths in the areas where confined winds had blown the radioactive gases, while infant mortality rates were steady or declined in all the surrounding states that were not in the direction of the winds during the first two days of highest releases.

And yet, it would be important to have some figures for the area that was most heavily exposed close to the plant. If the figures around Harrisburg should show much higher rises in infant mortality than the 44 percent for Pennsylvania and the 50 percent for New York State outside New York City, then it would be difficult to reject the hypothesis that it was indeed the radioactive gases from the stricken plant that were responsible for the unusual increase in newborn deaths.

But only Dr. George Tokuhata of the Pennsylvania Health Department had the data for the five-mile and ten-mile zones around the plant, and there was no way that I would be able to obtain them. From everything I had been able to piece together, the numbers in Harrisburg had to show very

large increases if areas as far away as 150 miles in upstate New York showed 50 percent rises in infant deaths. From my earlier studies on fallout clouds, I knew that the effect would roughly decrease in inverse proportion to the distance from the point of release. Thus, for Harrisburg, only ten miles to the north of the plant, the rise in newborn infant mortality would have to be as high as 300 percent to 600 percent, corresponding to a four- to sevenfold increase above normal, to be consistent with the rises in upstate New York.

How could I get at least an indication of whether this was the case? Just at this very moment, a way opened up to obtain this crucial information without the need to secure access to the Pennsylvania Health Department's carefully guarded data.

Earlier in the summer I had been invited to address a public meeting in Harrisburg on the likely health effects of the accident at Three Mile Island. At the end of the meeting, someone introduced himself to me, and asked me whether he could be of any help. His name was Warren Prelesnik; he told me that he was deeply concerned, since he had just moved to the area with his family shortly before the accident, and that he was working in the Harrisburg Hospital as executive vice president in charge of administration.

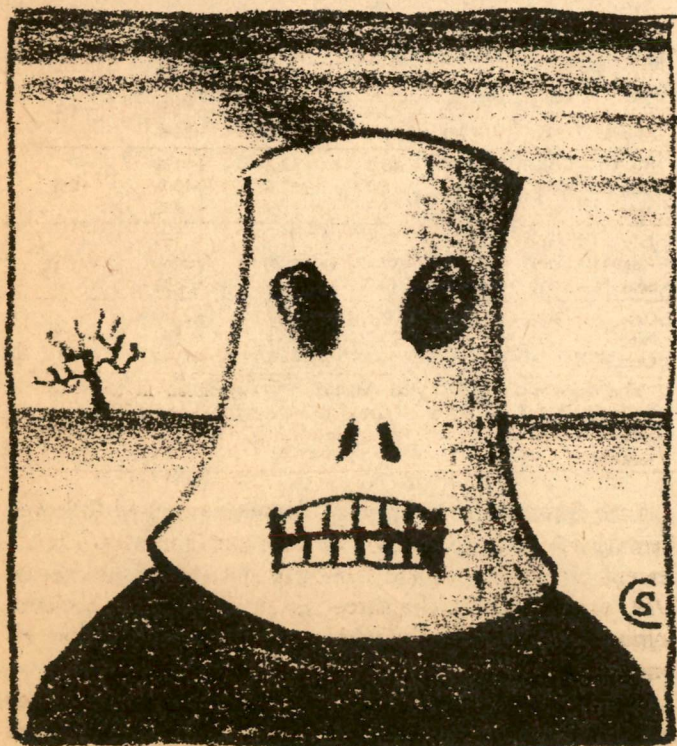
I asked him whether it might be possible to obtain information on the monthly number of births and infant deaths together with their causes over the past few years, and he said that he would try to see what he could do.

More than a month later, when I had already given up hope of receiving any information, there arrived in the mail a letter with a list of the monthly infant deaths, fetal deaths, stillbirths and live births in the Harrisburg Hospital for the previous two years.

At first there seemed to be no obvious change, if one looked at the total numbers of all types of fetal and infant deaths combined. But then I examined separately the category of newborn or neonatal infant deaths—those that were born alive but died within the first year, mainly in the first few hours after birth. Here was the evidence I needed. In February, March and April of 1979, there had been only 1 infant death per month. But for each of the two months of May and June, there were 4. Effectively, since the number of births had not only remained nearly the same but had actually declined slightly, this was more than a fourfold increase in the mortality rate, or of the right magnitude required to fit the observed 50 percent rise in the more distant area of upstate New York.

From an average of 5.7 per 1,000 live births in the three months of February, March and April—before the releases could have had an appreciable effect—the newborn mortality rate had risen to 24.1 for May and 26.0 for June, an unprecedented summer peak that did not occur the previous year. In fact, for May and June of 1978, there had been a total of only 3 infant deaths, while for the same period in 1979 after the accident, there had been 8.

As some of my colleagues with whom I discussed these findings agreed, by themselves the Harrisburg Hospital numbers were of course small, and just marginally significant, representing only about one-third of all the births and



deaths in Harrisburg. But taken together with the vastly more significant and independent numbers for all of Pennsylvania, upstate New York, New York City, New Jersey, Maryland and Ohio, there was now a much greater degree of certainty: It would have been much too much of a coincidence—perhaps less than one in a million—for all these different numbers to show the pattern they did.

At this very moment, there arrived an invitation to address an international meeting of engineers and scientists in Israel. The meeting was devoted to studying the environmental problems of industrialization of Third World nations. It was to be held in December, and I was asked if I would be willing to address the meeting on the environmental health problems connected with nuclear energy.

I could hardly believe that such an opportunity to bring these facts into the open should come at precisely the time when the data from the Harrisburg Hospital had convinced me more strongly than ever of the great danger of nuclear reactors. I decided to accept the invitation and to devote myself in the remaining few months to preparing a detailed paper that would begin with a review of the previous evidence on the effects of low-level radiation from fallout and normal nuclear plant releases, and end with the evidence for the rise of infant deaths after Three Mile Island.

One of the remaining important questions that had to be checked, however, was the time and cause of death. Clearly, if the excess deaths were connected with the radioactive iodine released from the plant, then they should be associated with underweight births or immaturity, since damage to the fetal thyroid—which occurs because of radiation exposure—would slow down the normal rapid growth and development of the baby in the last few months before birth. The development of the lungs, which have to be ready to begin breathing at the moment of birth, is one of the most critical phases of late fetal development. Any developmental slowdown would be most life-threatening if it led to the inability of the tiny air sacs in the lungs to inflate and start supplying the blood with oxygen. Failure of the lungs to function properly would therefore lead to immediate symptoms of respiratory distress, and if efforts to treat the baby should not succeed, it would die in a matter of minutes, hours, or days of respiratory insufficiency or hyaline membrane disease.

Thus, one would not expect to find as large an increase in spontaneous miscarriages well before birth as newborn deaths within a short time after birth, since the lungs did not need to start functioning until the baby was born. Also, there should be no significant increase in gross congenital malformations a few months after the accident, since by the time the baby in the mother's womb had reached the sixth or seventh month of development, all the major organs had already fully developed. Thus, only some six to seven months after the accident would one expect some increase in serious physical malformations, since these infants would have been exposed to radiation in the first three months of critical-organ formation.

The data from the Harrisburg Hospital supported these expectations. There was much less of an increase in the

number of spontaneous miscarriages and stillbirths than in the number of newborn babies that died shortly after birth because of immaturity and respiratory distress, indicating the strong likelihood that it was the effect of iodine 131 and other shorter-lived iodines such as iodine 133 that had damaged the ability of the thyroid to produce the necessary hormones needed for normal growth and development.

In fact, it was for this reason that I had publicly urged widespread screening for hypothyroidism at the time of the news conference in Harrisburg on the second day of the accident, the kind of simple test that could prevent permanent mental retardation if detected and treated early. This test was already being used routinely for every newborn baby born in hospitals of a number of states in New England, the Northwest Coast and Pennsylvania, but not yet in New York or Maryland. There would have to be a rise in the incidence of this condition if my past findings on the increase in underweight births and subtle forms of mental retardation during the period of heavy nuclear-bomb testing were indeed related to the action of radioactive fallout. But not until many months later, long after the Kemeny Commission (the Presidential commission, chaired by Dr. George Kemeny of Dartmouth College, studying the effects of Three Mile Island) hearings had been completed, would I learn that a rise in hypothyroidism had already been discovered by the Health Department of the State of Pennsylvania among the newborn babies in areas where the invisible radioactive gases from Three Mile Island had been carried by the winds.

Pennsylvania and United States Infant Mortality (0-1 Year Old at Death), 1979, With Corrections in July and August* (Data from the U.S. Monthly Vital Statistics)

	<i>Pa. Deaths</i>	<i>Pa. Births</i>	<i>Pa. Rate Per 1000 Births</i>	<i>U.S. Rate Per 1000 Births</i>	<i>Excess of U.S.</i>	<i>Average Excess of Pa. Per Quarter</i>
Jan.	216	13,112	16.5	13.8	+19%	
Feb.	147	11,892	12.4	14.6	-15%	-8%
March	141	13,589	10.4	14.1	-26%	
April	166	12,520	13.3	13.2	+ 1%	
May	198	13,201	15.0	12.6	+19%	+8%
June	163	12,293	13.3	12.9	+ 3%	
July	185*	14,680	12.6	12.5	+ 1%	
August	205*	13,918	14.7	11.0	+34%	+14%
Sept.	199	14,275	13.9	12.9	+ 8%	
Oct.	208	13,161	15.8	12.9	+22%	
Nov.	182	13,271	13.7	13.1	+ 5%	+13%
Dec.	175	11,871	14.7	13.2	+11%	

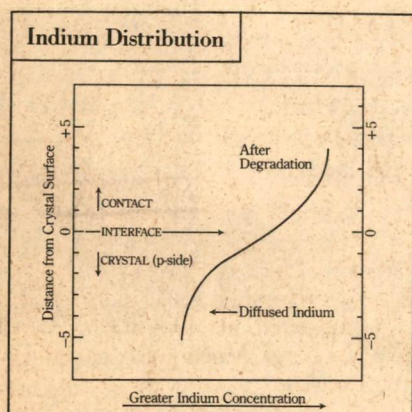
*The figures for July and August actually listed in the U.S. Monthly Vital Statistics for these months are 271 and 119 respectively, which add up to the same total of 390 as the corrected numbers.

If the figures for the State of Pennsylvania had followed their decade-long pattern of infant mortality rates 5 to 10 percent below that of the United States in the summer of 1979, as they did in the three months before the accident (minus 8 percent), there would have been some 268 fewer infant deaths than the 1,413 that actually occurred.

Moreover, when one adds the figures for New York State outside New York City where the August excess over the low

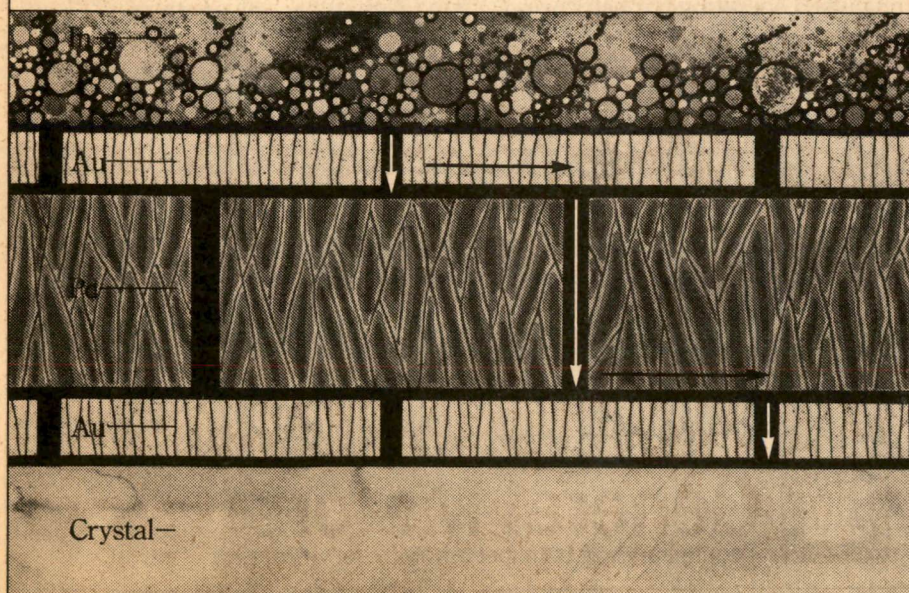
The Strategic Misalignment

Tunable semiconductor lasers can now measure specific gases in automotive exhaust with 25-millisecond response time. A successful strategy for improving laser reliability developed at the General Motors Research Laboratories makes this and other new spectroscopy capabilities practical realities.



Electron microprobe analysis of a crystal-contact interface, indicating indium penetration into the PbSnTe crystal.

Diagram of hypothetical indium diffusion paths for a three-layer contact structure of Au-Pd-Au.



THE ACHIEVEMENT of long lifetime and frequency stability makes the lead-tin-telluride diode laser a practical infrared spectrometer. Earlier innovations brought to this laser the characteristics of increased power, higher temperature operation, greater efficiency and wider tuning range.

Operating in the 5- to 10-micron range, the PbSnTe laser spectrometer can resolve the time-dependent emission of carbon monoxide, sulfuric acid vapor, methane and other species of interest in automotive exhaust. This permits measurement of transients in carbon monoxide to carbon dioxide gas conversion in a

catalytic converter. This capability represents a significant advance over conventional spectroscopy instrumentation. The laser is also being tested by NASA for use in detecting the molecular species involved in chemical reactions in the stratosphere.

New knowledge of the process by which laser reliability is compromised has been revealed in fundamental studies conducted by Dr. Wayne Lo and his colleagues at General Motors. Dr. Lo's investigations have demonstrated that laser lifetime and stability are limited by the development of excessive electrical contact resistance. He has been able to stop increases in resistance by devising a multilayer ohmic contact consisting of different metal films. This configuration has extended laser operating lifetime to more than 1,000 hours and increased shelf-life to an estimated 25 years.

Slow degradation due to a gradual increase in contact resistance was observed in idle lasers stored at room temperature, but not in lasers maintained at a maximum temperature of 77 K, despite several hundred hours of continuous operation. These results suggested the temperature-dependent process of diffusion.

Degradation occurred primarily on the p-type side of the laser, where the contact consisted of a thin layer of gold followed by a

layer of indium. Electron microprobe analyses revealed that indium, a semiconductor donor, was diffusing through the gold layer into the crystal, apparently causing a reduction in hole carrier concentration near the p-surface. This effect was counteracted to a great degree by sandwiching a thin layer of platinum between the layers of indium and gold. Laser reliability reached a full year.

When degradation was still observed, although to a reduced extent, Dr. Lo advanced the hypothesis that diffusion and transport were taking place along grain boundaries in the polycrystalline contact layers. He proposed replacing the Pt-Au barrier with a three-layer structure. Since palladium film structures have fewer grain boundaries than those of platinum, providing fewer leakage paths for the indium, Pd was tested in place of Pt.

DIODE LASERS composed of $\text{Pb}_{0.86}\text{Sn}_{0.14}\text{Te}$ and fabricated with a variety of contacts were maintained at 60°C in order to accelerate aging, with periodic interruptions for testing. The results showed that a multilayer structure of In-Au-Pd-Au, in which the grain boundaries tend to be misaligned, provides maximal reduction of indium penetration, confirming Dr. Lo's hypothesis.

The misaligned boundaries force diffusion to take place laterally, which slows transport into the crystal. The additional layer slows the process even further.

Solving the contact problem represents the culmination of efforts that began at General Motors with the development of an "ingot-nucleation" vapor transport method for growing crystals. The resulting crystals are of high purity, with a dislocation density of less than 1000 cm^{-2} . Lasers made from these crystals incorporate a low temperature cadmium-diffused p-n junction. This process, invented by Dr. Lo, increases the laser's output to five milliwatts.

A tuning range of 500 cm^{-1} and pulsed operating temperatures of up to 140 K are achieved by a two-step annealing process. This technique induces a graded carrier concentration that increases infrared light confinement in the laser structure, thus reducing losses and increasing output.

"These innovations," says Dr. Lo, "combine to produce a laser that allows us to make measurements previously impossible."

THE MAN BEHIND THE WORK

Dr. Wayne Lo is a Senior Research Scientist in the Physics Department at the General Motors Research Laboratories.



Dr. Lo was born in Hupei, China. He did his undergraduate work at Cheng-Kung University in Taiwan. He received an M.S. from the University of Rhode Island and a Ph. D. in electrical engineering from Columbia University in 1972. His doctoral thesis concerned the characterization of deep-level states and carrier lifetimes in gallium arsenide light-emitting diodes.

Before undertaking graduate studies, Dr. Lo was instrumental in setting up the first American transistor production plant in Taiwan. In 1973, he joined General Motors, where he is currently in charge of semiconductor laser and spectroscopy research.



General Motors

People building transportation to serve people

point in March was a startling 69 percent—namely 20.1 versus 11.9 per 1,000 births—the total deaths above normal expectations for Pennsylvania and New York combined rose by 353 to the much larger figure of 621 for the accident at Three Mile Island. And no one had as yet suggested any errors in the published figures for New York State.

So great were the excess mortality rates for the rural and small-town areas of upstate New York that I decided to try to check them with yet another set of data, namely figures reported weekly by the larger cities directly to the Center for Disease Control in Atlanta and published in the *Morbidity and Mortality Weekly Reports*.

What I discovered there confirmed the findings based on both hospital records and the Monthly U.S. Vital Statistics. In city after city in the path of the invisible gas clouds drifting west and north, infant mortality in July 1979 had risen sharply over the same month in the year before the accident.

For Pittsburgh, it was a jump from 5 to 17 deaths, a rise of 240 percent. For Syracuse, the deaths rose from 10 to 18, or by 80 percent. And for Albany, the change was from 6 to 10, an increase of 67 percent.

But when I examined the figures for areas such as Philadelphia and New York City, not reached by the most intense clouds of radioactive gases, instead of rising, infant mortality declined, as it has been doing since the mid-1960s when fallout from the U.S. and U.S.S.R. atmospheric bomb tests began to decline. For Philadelphia, the number of infant deaths in July declined from 61 in 1975 to 50 in 1979. For New York City the decline was from 136 to 127.

Ironically, the need to believe that peaceful applications of the atom were possible played into the hands of those in the military who wanted to use nuclear weapons in limited wars, since both required the assumption that low-level radiation from distant, worldwide fallout or from nuclear plants was essentially harmless. Thus, the most concerned and idealistic scientists who had worked on the bomb and who later dedicated themselves to the realization of the peaceful benefits of the atom, because they were willing to believe in the harmlessness of very small amounts of radiation and the negligible magnitude of the doses from nuclear reactor operations, were in effect contributing to the increased likelihood of nuclear war.

I had begun to realize that the deeply felt hope for safe, clean and economical nuclear power kindled by the nuclear scientists tragically aided the plans of leaders of the nuclear nations to find ways to use nuclear weapons in all types of military confrontations. Only the continuing denial of the seriousness of worldwide fallout would give credibility to threats to use these weapons.

Only a few months before Three Mile Island, James Reston, writing in *The New York Times*, asked what "the present danger" facing our nation really was. He went on to quote Abraham Lincoln from an address given in Springfield, Illinois, on January 27, 1837. Lincoln's words now take on a particularly strong relevance:

At what point shall we Americans expect the approach of danger? By what means shall we fortify against it? Shall we expect some trans-Atlantic military giant to step the ocean and crush us at a blow? Never! All the armies of Europe, Asia and Africa combined, with all the treasure of the earth (our own excepted) in their military chest with a Bonaparte for a commander, could not by force take a drink from the Ohio or make track on the Blue Ridge in a trial of a thousand years.

And then came this most strangely prophetic passage:

At what point then is the approach of danger to be expected? I answer, if it ever reach us it must spring up amongst us; it cannot come from abroad. If destruction be our lot, we must ourselves be its author and finisher. As a nation of free men we must live through all time or die by suicide.

As Reston concluded, "It could be, of course, that Mr. Lincoln is out of date in this nuclear world, but at least his point is worth debating. The 'present danger' may be the failure to debate what really is."

But when vital information is secretly kept from free people, they are no longer free, and there can be no more meaningful debate than of the most crucial problem facing our nation and the rest of the people of this world, namely whether we shall learn to live through all time by finding a way to end the nuclear cancer threatening our nation, or die by nuclear suicide.

If we have any moral or ethical obligations at all as human beings, they surely include the obligation to insure the survival of our species and thus the opportunity for our children and their descendants to develop to the fullest the miraculous potential of the human mind. As the French philosopher-scientist Jean Rostand has phrased it so eloquently on behalf of humanity as a whole, "The duty to survive gives us the right to know."

Postscript

Within the last few months, information has emerged that points to an unprecedented sharp rise in infant mortality in Russia similar to what occurred in Pennsylvania, upstate New York and New England following the release of radioactive gases from the Three Mile Island nuclear plant.

As discussed by Nick Eberstadt in the February 19, 1981, issue of *The New York Review of Books*, infant mortality in Russia, after declining for decades, suddenly rose by more than one-third in a five-year period between 1971 and 1976. The article is based on an exhaustive study carried out by Christopher Davis of the Center for Russian and East European Studies at the University of Birmingham, England, and Murray Feshbach of the Foreign Demographic Analysis Division in the U.S. Department of Commerce. They examined the reasons for the unexpected health crisis that suddenly gripped the U.S.S.R. during the last decade. Despite a continued expansion of medical facilities, increased housing and a slow but steady improvement in the amount of food, not only infant mortality but total mortality rates—especially among those in their 50s and 60s—began to rise significantly after decades of decline, a phenomenon never seen before in any developed nation.

From its lowest level of 22.9 deaths per 1,000 live births in 1971, infant mortality rose to an estimated 31.1 per thousand in 1976. As Davis and Feshbach pointed out, this means that 38,704 more infants died in 1976 than would have died if the infant mortality rate had been the same as in 1971.

After examining possible changes in reporting and such demographic factors affecting infant mortality as changes in urban-rural differences, changes in the number of births in different regions, increases in the birthrate, shifts in the age of mothers and in the birth order, the authors conclude that none of these factors could explain the observed sudden rise.

Turning to the various social, economic and health factors that could be responsible, such as changes in the eating, smoking and drinking habits and employment patterns of pregnant women; maternal illness; frequency of abortions; utilization of medical services; housing; environmental pollution, and influenza epidemics, Davis and Feshbach concluded that only the last two could have had a significant impact. And among the new sources of pollution, they, as well as Eberstadt, cite airborne radioactivity such as that produced by nuclear weapons testing and releases from nuclear reactors, which in Russia were constructed without the massive concrete containment buildings such as the one that prevented most of the radioactivity at Three Mile Island from escaping into the environment.

Unexpected upward changes in infant mortality associated with prematurity and epidemics of influenza among the newborn children occurred in the United States, Western Europe and Asia after the large nuclear weapons test series of the late 1950s and early 1960s. These were followed some years later by an increase in cancer deaths and chronic diseases among the older population. And the more recent Chinese nuclear tests that began in 1964 also were followed by sudden upsurges in infant mortality as far away as the Eastern seaboard of the United States in 1976-77. The bombs were set off in the westernmost province of China close to the heart of Russia's Central Asian Republic of Kirgiziya, where infant mortality jumped by 50 percent in two steps after the U.S.S.R. H-tests of 1961 and the Chinese H-tests of 1967.

Only after the new reactors were put into operation (beginning with the 400-megawatt commercial nuclear power plant at Voronezh in 1969) near the more densely populated urban areas of European Russia, where 80 percent of the population lives, did infant mortality for the U.S.S.R. as a whole start its steady rise.

Since then a study by Gloria Duffy at the RAND Corporation has revealed that the installed capacity of nuclear power stations close to the cities of European Russia increased twenty-two times by 1979. The increase in the megawatts of electrical generating capacity year by year paralleled precisely the rise in infant mortality documented by Davis and Feshbach.

As an article in the February 1981 issue of the *Bulletin of the Atomic Scientists* by Frank Barnaby puts it, Russia is now "a nuclear engineer's paradise." Unconstrained by any public discussion of the risks and benefits of nuclear power,

the construction of giant nuclear energy complexes close to the cities is proceeding at an ever accelerating pace.

Barnaby indicates that "there are good reasons to believe that there have been significant nuclear accidents in the Soviet Union and Eastern Europe," some of which "have involved nuclear reactors." He goes on to say that "unfortunately, Soviet authorities refused to release the considerable amount of information they must have accumulated about nuclear accidents."

As Davis and Feshbach note in the conclusion of their paper, "a full-scale analysis of infant mortality experienced in the Soviet Union and of the causes of the recent rise is precluded by a lack of data and information." Official infant mortality rates have not been published since 1974, and life-expectancy figures have not been available since 1971-72. The suppression is significant, and suggests that the U.S.S.R. has reason to be concerned about what the figures show. □

■ L.A.'S BIG THIRST

The California Water Wars

HAL RUBIN

In the past decade, droughts and water shortages in many parts of the nation have raised questions about traditional American water policies. There has long been a view that if we build another dam or reservoir or irrigation canal and bring water from where it is to where it isn't, our water problem is solved. But in an age of scarcity, another view is taking hold. From California to the New York island, there is a growing awareness in this land that rural and urban conservation are needed to curb waste and misuse of water that are better suited to an age of abundance. That means using recycled water, improving irrigation practices and managing ground water more intelligently.

In short, there must be an alternative to more and more Pharaonic plumbing projects that create ever greater social and environmental problems. One such project is California's Peripheral Canal. The Peripheral Canal story provides a glimpse into a future in which water wars, like the one now going on in California, will be commonplace unless we come up with a better way.

Water has broken up more alliances and friendships in California than alcohol. A century-long conflict has caused rifts in the California Farm Bureau Federation, driven a wedge between environmentalists in the Sierra Club and the Planning and Conservation League, set agribusiness interests to feuding and put land developers in opposing camps.

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In California, money negates the law of gravity, causing water to flow uphill over the 3,000-foot-high Tehachapis into Los Angeles and San Diego counties. The elemental fact in the Golden State is that the north has the water, but the southern half, which is the most arid region of the United States, has the people and the political clout. Three-quarters of the precipitation falls in the northern third of the state, but 80 percent of the demand exists in the southern two-thirds of the state. These figures help explain why Gov. Jerry Brown, an avowed apostle of "small is beautiful," and his legislature recently approved a massive engineering project—the Peripheral Canal—thus giving southern California another major victory in the state's continuing civil war over water.

For half a century, and with genuine anguish, the overlords of agribusiness, banking, industry and real estate have watched helplessly as millions of acre-feet of Sacramento River water poured annually down from the northern mountains, through the Delta estuary, and into the San Francisco Bay. Being men of action, they devised strategies that not only would halt the profligate dumping of good water into the Pacific Ocean but would also correct other of the Deity's geologic mistakes that cause water to flow where and when it cannot be used so as to further enrich the already rich. First, they siphoned off the waters of the Owens Valley in 1913, and of Mono Lake, about 250 miles northeast of Los Angeles, in 1940. Then, still thirsty, they eyed the northern rivers.

During the Depression the Federally-sponsored Central Valley Project (C.V.P.) was launched under the direction of the Bureau of Reclamation. Then in the 1950s came the State Water Project (S.W.P.) under the aegis of the California Department of Water Resources. The two projects have, between them, built an impressive statewide network of forty-two reservoirs, fourteen major canals and thirty-one pumping stations that store and transport water from the wet north to the arid southland. The California water system is an engineering achievement without parallel; what was once desert is now the world's most productive agricultural region, and 90 percent of the state's water is soaked up by agriculture, which produces an annual crop valued at at least \$15 billion. C.V.P. and S.W.P. water also nourishes untold billions in industrial and real estate wealth, mainly in the southland.

The Peripheral Canal will cost about \$650 million. Since the authorizing bill provides for important additional reservoir facilities in northern California, the total cost of the package is \$3.4 billion in current dollars. If the costs are spread over the full construction period, and an allowance is made for a 6 percent annual inflation rate, the readjusted figure is \$7 billion.

Originally, the Federal Government was to have borne half the costs, but funding did not come through. And so California will go it alone, paying for the project out of receipts from water revenues, revenue bonds and tidelands oil windfalls. According to Department of Water Resources

planners, no new taxes will be necessary, and Governor Brown says the "big ditch" will alleviate the state's water problems through the year 2000.

The Peripheral Canal will be a 42-mile-long channel about 30 feet deep and 400 feet wide that draws off Sacramento River water before it reaches the Delta, a marshy inhabited area located directly east of San Francisco Bay. Skirting the eastern fringe of the estuary, the canal will carry water to the Delta-Mendota Canal and the California Aqueduct, which will then transport it to the San Joaquin Valley and southern California.

Actually, northern water has been going south for a long time through the man-made concrete riverbeds, but now it is mainly secondhand water from the San Joaquin River, heavily laced with agricultural wastes (pesticides, herbicides, insecticides, fertilizer residues and minerals leached from the soil), salts left behind by intrusions of sea water and traces of industrial and domestic wastes. The Peripheral Canal will export Sacramento River water that is still relatively fresh and clean. According to planners in the Department of Water Resources, the Delta is the last place at which "surplus" water can be captured and diverted for other uses before it flows into the ocean. The big ditch appears to be the most feasible method to increase the supply for the valley-floor farmers and the megalopolis to the south.

When it is operational, the Peripheral Canal will release about 1.6 million acre-feet annually into the Delta via twelve conduits, and the rest, about 7.7 million acre-feet, will go south. (An acre-foot is the amount of water that will cover one acre to a depth of one foot.) The basic premise of the canal supporters—that much of the water now draining through the Delta from the Sacramento River is "surplus" and can be diverted without adversely affecting the region—has been contested by opponents of the project. Although in 1977 the Sierra Club and the Planning and Conservation League endorsed the Peripheral Canal (the Sierra Club described the authorizing legislation as "the most positive water bill that has come along"), many conservationists believe that the California water plan is a blueprint for ecological disaster. They charge that if Los Angeles gets a new source of water, it will become even more crowded and smog-ridden. They also prophesy that the Bay Area will turn into a salt flat, and that irrigation will make the Central Valley a desert. The anti-canal forces quote approvingly environmental crusader Alvin Duskin's statement: "Northern California water will go to L.A. to make more L.A."

Several years ago the California Farm Bureau Federation was strongly behind the original version of the bill, but its enthusiasm waned as the amendments increased. Conflicts flared over the north coast rivers that are included in the Federal wild river system, which means they cannot be dammed to provide additional water for agriculture. After the passage of Proposition 8 in November 1980, which closes five California rivers to future development, the California Farm Bureau Federation and some of the Central Valley agribusiness groups who would benefit most from