Environment

EMFs on the brain?

Male electric utility workers with high exposures to low-frequency electromagnetic fields (EMFs) face more than twice the risk of brain cancer as less exposed workers — but no greater risk of developing leukemia, a new study finds.

The study — one of the largest ever to explore whether a link exists between EMFs and cancer in such men — upsets prevailing notions about the dangers of these fields. Earlier studies had pointed to an increased risk of leukemia, but not of brain cancer, among utility workers.

Epidemiologists David A. Savitz and Dana P. Loomis of the University of North Carolina at Chapel Hill looked at death records of 138,905 linemen, electricians, power plant operators, and other workers employed by five major electric companies from 1950 to 1988. The researchers then estimated the EMF exposure of these men by choosing current workers at random in each job category to wear monitors during their shifts. Then, using the work histories of the 138,905 men, they calculated the exposure of each individual during his career.

The workers' death rate proved lower than the general population's — a common finding among people in industrial occupations. But among utility workers, those with higher exposures to EMFs were up to 2.5 times as likely to die of brain cancer as those with lower exposures. Of 20,733 deaths, 144 resulted from brain cancer. Leukemia rates, however, did not rise, except among electricians employed for many years.

The findings, funded by a $5 million grant from the Electric Power Research Institute, appear in this week's AMERICAN JOURNAL OF EPIDEMIOLOGY.

Its authors call their work more reliable than some earlier studies showing a link to leukemia, which correlated deaths and job titles without adjusting for how much exposure a job entailed. Savitz' team also adjusted for the possible effects of carcinogenic chemicals encountered by the workers.

But two recent studies that also measured utility worker exposure directly — one conducted in southern California, the other in Canada and France — yielded different results, Savitz and Loomis note. The French and Canadian study found an increased risk of leukemia but not brain cancer, while in the California study neither ranked higher.

"The results themselves do not put the issue to rest," cautions Savitz about his study, but "at the margins, it shifts things a little bit."

New lube from PCB-spiked oil

Drums of oil tainted with polychlorinated biphenyls (PCBs) cause big headaches for companies recycling oil from cars, trucks, and industrial engines. There aren't many ways to clean PCBs from the oil; usually, it's stockpiled or incinerated. Now, researchers have devised an industrial-scale method that gets rid of the PCBs and yields usable oil.

The team began with the usual process for refining used oil and showed it could destroy PCBs, says chemist John R. Dickson of Safety-Kleen Corp. in Breslau, Ontario. First, the researchers distilled the oil, both to remove water and to separate the oil into three fractions of varying viscosity. Then they heated it under high pressure with hydrogen and a catalyst to split chlorine atoms from the PCBs, turning the chlorine into gas.

As Dickson's group reports in the January ENVIRONMENTAL SCIENCE AND TECHNOLOGY, a test run on 850,000 liters of oil split into fractions containing up to 47 parts per million (ppm) of PCBs — a relatively high proportion — yielded oil with less than 0.5 ppm of PCBs, the threshold for detection.

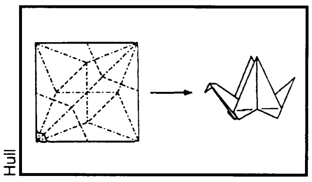
Dickson says the process will be economically viable with a sufficiently large volume of used oil. The U.S. Environmental Protection Agency and the Ontario Ministry of the Environment have shown interest in the technology, he adds.

Mathematics

Ivars Peterson reports from San Francisco at an American Mathematical Society meeting

Paper folds, creases, and theorems

Without using scissors or glue, a skilled practitioner of origami can crease and fold sheets of paper into an astonishingly wide array of forms — ranging from cranes and winged demons to tessellated squares and rectangles. In creating and inventing such figures, artisans have generally relied on a variety of paper-folding rules learned and developed through years of practice. Now, mathematics is starting to come into play.



Crease pattern for the traditional crane. "Mountain" creases are drawn with a dash-dot-dash line; "valley" creases with a dashed line. Hull

Long fascinated by origami, mathematics graduate student Thomas C. Hull of the University of Rhode Island in Kingston has embarked on a mathematical study aimed at linking crease patterns with the geometry of the resulting forms. He is a member of a growing community of origami enthusiasts intent on pursuing the mathematical intricacies of their craft.

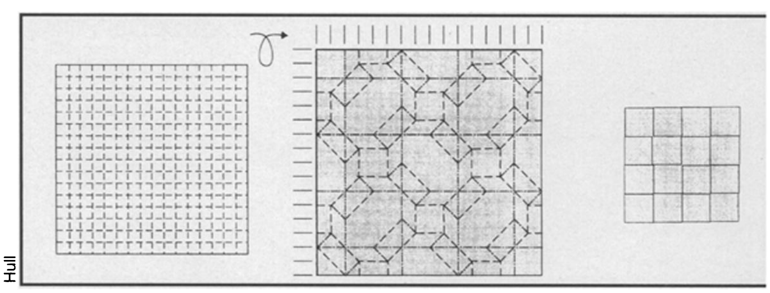
Hull's approach involves primarily a branch of mathematics known as graph theory. Here, a graph consists of a collection of points connected by lines. "Thinking of the crease pattern as a graph — but with specific angles between the lines — turns out to be very useful in trying to create a mathematical model of origami," Hull says. "For example, by studying those properties, you can come up with conditions that origami needs in order to fold flat."

Using graph theory and other mathematical tools, Hull has proved a number of theorems, extending ideas developed by two mathematicians in Japan and putting into mathematical form results well known to origamists. These and other findings have in turn inspired new origami creations.

"By understanding the rules, you can build better models," Hull says. Conversely — as he notes in a paper to be published in the proceedings of the Second International Meeting of Origami Science and Scientific Origami, held last November in Otsu, Japan — origami has served as a source of ideas for his own mathematical research on planar graphs.

One active area is the creation of origami tessellations, where the crease patterns and folded objects look like mosaic tiling (see illustration). Aided by his mathematical knowledge, Hull has discovered several new designs. He is now looking for a way of folding a sheet of paper into an aperiodic tessellation — one in which identical tiles fit together to create a nonrepeating pattern.

"There are lots of interesting problems here, with links to other kinds of mathematics," Hull notes.



Hull

To create a tessellation of "woven squares," first fold a square into sixteenths vertically and horizontally. Turn the sheet over and carefully add the diagonal creases shown in the middle diagram. Fold the paper into its final configuration. "Discovering for yourself how the creases collapse is a puzzle," Hull says. "In doing this, you learn a lot about how origami. . . works."