Ivars Peterson reports from the annual meeting in Detroit of the American Association for the Advancement of Science

Pentagon objections shorten paper

When Charles A. Zraket presented his paper on "The Impact of Command, Control, Communications and Intelligence on Deterrence," parts of the original paper were missing. Department of Defense officials had asked him to remove "sensitive" sections that, in their opinion, revealed too much about the limitations of the elaborate electronic information systems that control military operations.

Zraket, executive vice president of The MITRE Corp. in Bedford, Mass., told SCIENCE NEWS that the paper's topic was related to his work at MITRE, which designs and engineers control systems for the Defense Department. Their contract calls for DOD to clear for public release any papers written on the basis of classified projects.

"I sent it in," said Zraket, "and when I got it back, it came with a note saying there were some security problems with it. At first, I thought it would be a real problem, but they were very cooperative and showed me where they thought there was some sensitive classified stuff in there. I agreed and took it out."

"It was the first time that it had happened to me," Zraket said. "I had never written a paper that I was going to give in a completely public forum, so the whole idea that this thing exists as a normal procedure just surprised me."

In his presentation, Zraket spoke mainly about the need to increase the ability of command systems to survive under extreme conditions. It is also necessary to test, exercise and operate these systems under disruptive conditions, at least to take out the technical ambiguities, he said. However, there is a limit to how "survivable" a system can be made. It was Zraket's attempt to quantify these limits that the Pentagon found objectionable.

"What was taken out could have further explained a lot of things," Zraket said, "but the major points got made anyway. It just didn't have a lot of the backup data with it."

Fractals for modeling ecosystems

Fractals are extremely irregular curves or surfaces that live in a realm somewhere between the first and second dimension or between the second and third dimension (SN: 8/20/77, p. 122; 1/9/82, p. 28). These objects do not fit the normal integer dimensions of classical geometry. The mathematics of fractals seems to describe a wide variety of natural processes such as diffusion and percolation. In computer graphics, fractal mathematics can generate realistic mountain scenes and other landscapes (SN: 11/20/82, p. 328). Mathematician Harold M. Hastings of Hofstra University in Hempstead, N.Y., argued that fractals are the natural mathematical framework for much geology, atmospheric science and ecology.

Many natural phenomena form mosaic patterns, Hastings said. Clouds form a mosaic in the sky; mountains and valleys form a mosaic on the surface of the earth, as do islands and lakes. The distribution of many minerals and ecological species also appears as a mosaic pattern. All of these mosaics are formed from "tiles" of many sizes. The areas and distribution of these tiles can be described by fractal mathematics, said Hastings.

Hastings has used concepts of fractal diffusion to model ecosystem dynamics and patchiness as revealed in field data from the Okefenokee Swamp in Georgia. He and his colleagues compared vegetation maps showing the location and extent of cypress patches with random vegetation maps created using fractal simulations. The results yielded a natural relationship between relative patchiness and species persistence (that is, how long a species survives in competition with other species). Thus, a measurement of relative patchiness, as defined by fractal mathematics, gives an estimate of species persistence without the need for long past histories, Hastings said.

These ideas are now being extended to modeling the spread of acid rain and other pollutants in ecosystems.

Mixing environmental hazards

The process of converting coal into a liquid fuel produces a complex mixture of organic compounds. Distillation separates the crude coal liquid into fractions that are themselves mixtures of many compounds. In such mixtures, the toxicity of particular constituents may depend on the nature of other contaminants present. Because living organisms are more likely to encounter mixtures rather than individual compounds, the potential health hazards of mixtures must be known. Recent experiments have provided evidence that the presence of crude coal liquid can significantly inhibit or enhance the ability of various substances to induce mutations.

Burton E. Vaughan of Pacific Northwest Laboratory in Richland, Wash., reported that researchers at the laboratory have shown that the addition of crude coal liquid inhibits the mutagenicity of pure benzo-α-pyrene. Adding more coal liquid increases the blocking effect. Comparable results can be demonstrated for the addition of crude liquid to coal liquid distillates collected in the 700°F to 800°F boiling point range. In contrast, when crude portions are added to distillates collected at more than 850°F, the mutagenic activity of these distillates nearly triples. These distillates contain high proportions of nitrogen-containing polyaromatic compounds, which by themselves are more highly mutagenic than substances like benzo-α-pyrene.

Vaughan noted, "As these interactions may occur when an organism is exposed to complex mixtures, it becomes essential to couple testing of specific compounds with chemical fractionation and testing of the mixture." He added that Environmental Protection Agency lists of the potential health hazards of selected compounds were open to question because they did not take account of blocking and synergistic effects.

The problem is further complicated when complex mixtures, like petroleum or coal liquids, spill into the environment and are taken up into food chains. The various compounds in a mixture travel at different rates and undergo processes like absorption, emulsification and separation into water, oil and air phases. An organism like a fish, when exposed to a coal liquid, "sees" a continually shifting spectrum of specific compounds.

Artificial blood and NMR imaging

Fluorine in the organic molecules (perfluorocarbon compounds) that make up synthetic blood sends out a powerful radio signal when it is placed in the magnetic field of a nuclear magnetic resonance (NMR) imaging apparatus. Thus, these compounds are very "visible." Current diagnostic NMR units, used to provide details of the body's chemical structures and functions, generally rely on detecting hydrogen atoms (or protons), usually associated with water. But protons are present in enormous quantities, making it difficult to pick out individual details. The advantage of using fluorine imaging is that there is virtually no fluorine present in the human body. A University of Cincinnati group of researchers, headed by Leland C. Clark Jr., has suggested that artificial blood in small doses would be a simple way to make blood vessels "light up" for an NMR imaging device.

According to the researchers, fluorine imaging would produce "pictures" of blood vessels and blood flow patterns throughout the body. Clark says, "So far we have done enough to know that the concentrations that we can get into the bloodstream are sufficient to do satisfactory imaging. We are one step away from imaging a whole animal."

The researchers noted that another advantage is the safety of a fluorine-based NMR imaging technique compared with comparable X-ray methods for doing the same job. Work is now under way to determine the best fluorocarbon compound for NMR imaging. The compound also must be physiologically nontoxic and leave the body within a reasonable time after its use.