project is a joint effort between ZooMontana and Deaconess Research Institute, Billings. Projected future projects include on-site propagation efforts with endangered species in the zoo collection, off-site conservation biology projects related to regional rare/endangered plants and animals, the development of on-site laboratory research facilities, and both on-site and outreach education programs.

In Vitro Fertilization and Cloning: Doors to the Future [MAS]

Peggy Walsh

In Vitro fertilization (IVF) and cloning are the doors to the future in the fight against hereditary diseases and birth defects. Tay Sachs disease, Duchenne muscular dystrophy, cystic fibrosis and sickle cell anemia are detectable in the developing embryo. Defective embryos, as well as normal ones, can be cloned and studied to unravel their genetic secrets. Detecting the genes that predispose people to such common diseases as depression, high blood pressure, cancer, obesity, and heart disease during prenatal testing is the goal of geneticists. However, IVF and cloning are in danger of being stopped. Ethical questions are being raised and people's emotions are being fired up by the media. Clinics are cutting back on their IVF research. George Washington University, where cloning first took place, has no plans for future study into cloning. Responsible people need to get serious about setting standards and regulations for genetic research.

Environmental Sciences and Engineering

Sediment Basin Design Criteria [MAS]

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David R. Yonge
Washington State Department of Transportation, Olympia

The Washington State Department of Transportation designs, operates, and maintains stormwater detention basins. These basins are used to control storm water runoff from highways, thereby controlling flows in down gradient areas. Historically, storm water basin design has been based solely on hydraulic considerations. Recent initiatives by the Washington State Department of Ecology have indicated that storm water quality has become a high priority. Consequently, future design must consider water quality as well as flood control.

A scale model of a typical detention basin was constructed to control the variables associated with removal

efficiencies (flow rate, contaminant type, contaminant concentrations, particle size distribution, and basin configuration). Experiments to determine removal efficiencies for suspended solids with diameters <75 μm were conducted and the results were compared with the Type 1 sedimenta-tion theory for an ideal basin. Preliminary investigations into the removal efficiencies for lead, zinc, cadmium, and copper were performed at one flow rate and optimized piping configuration. Removal of suspended solids ranged from 65-80%. Type 1 sedimentation theory for an ideal basin yielded good predictions of sediment removal. This implies that Type 1 sedimentation theory could by used to estimate sediment removal in full scale systems under similar system conditions. Care should be taken when predictions are required at high surface overflow rates or for highway runoff that contains a significant fraction of small particles. Removal of metals ranged from 28-40% indicating that removal of smaller particles is necessary to achieve better removal efficiencies for metals. This study was conducted in cooperation with the U.S. Department of Transportation.

Evaluation of Substrate Types for Anaerobic Bioreactors [MAS]

W. Drury and R. Nehl
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Cow manure, hay, sawdust, and tree bark chips (hogfuel) were tested for use in anaerobic bioreactors for acid mine drainage treatment by placing them in cylindrical columns. Ground water with neutral pH but elevated metals and sulfate concentrations was pumped in an upflow direction through the columns for 6 months. A fifth column, filled with manure, was tested in a downflow direction. Effluent pH for the manure columns was continually neutral, while the effluents of the other columns was initially acidic and rose to neutrality after 60-85 days. Sulfate removal averaged from 14% (hogfuel) to 48% (downflow manure). Copper, zinc, cadmium, and iron were all partially removed from solution in the reactors. Manganese was not removed in any reactor. Hydraulic conductivity was lowest in the downflow manure column (0.001 cm sec^{-1}) and highest in the upflow manure column (0.1 cm sec^{-1}). The preferable flow direction is not clear because of the likelihood that variation in filling the columns with substrate caused the large difference in hydraulic conductivity. It cannot be determined as to which substrate performed best because all substrates were equivalent in sulfate and metals removal during the last month of the experiment.

Assessment of NOx and CO Emission from Gas Cooking Ranges in Low Income Houses Which Undergo Weatherization [MAS]

Pankajam Ganesan
Industrial Hygiene Department, Montana Tech, Butte

Efficient weatherization can conserve significant amounts of energy in residential buildings especially in cold climate regions like Butte, Montana. Weatherization makes the homes relatively air-tight and may contribute to the buildup of indoor pollutants that are emitted by appliances like gas cooking ranges. Because of the growing number of weatherization projects, especially in the low income housing sector, it is important to evaluate the effects of weatherization on indoor air quality (IAQ). Although relatively low levels of CO and NOx may exist in such weatherized homes with gas appliances, studies indicate that chronic exposure, even at very low concentration levels, may cause health effects. This research project selected 4 low income houses in Butte to evaluate IAQ before and after weatherization. The project is in progress and samples have been taken from 1 house. Three houses furnished with gas cooking stoves and one house furnished with an electric range will be sampled before and after weatherization. The indoor concentration of CO and NOx will be measured continuously for about 6 days in each house. The Monitor Labs Nitrogen Oxides Analyzer and Desibi CO Analyzer will be used to measure NOx and CO concentration levels. The data will be analyzed and interpreted to quantify the impact of weatherization.

Safety and Health Risks from Indoor Air Pollution [MAS]

Pankajam Ganesan
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Indoor air pollution which presents a greater risk of illness than exposure to outdoor pollutants is one of the major environmental concerns facing us today. Because of long hours spent indoors and a wide variety of populations exposed, it is important to address the indoor air quality (IAQ) problem. Indoor air may become contaminat-ed by a variety of pollutants from several sources. Bio aerosols, formalde-hyde, radon, carbon monoxide, oxides of nitrogen, sulfur dioxide, aldehydes, and hydrocarbons are a few of the pollutants found in the indoor atmosphere. Health risks from these pollutants vary from minor discomfort to major lung cancer. Factors such as source strength, house volume, occupant behavior, and ventilation rates affect the level and composition of pollutants found in a given house. In general, lowering of ventilation rates increases the pollutant concentration indoors. However, a lower ventilation rate provides better thermal efficiency. Thus, reducing air flow between indoors and outdoors is an effective way to conserve energy, but is also likely to contribute to the build up of indoor pollutant levels. Regulatory efforts are on the way. EPA, ASHRAE, NIOSH, OSHA and many other organizations are proposing standards for IAQ.

Three-Dimensional Diffraction Tomography using Ground Penetrating Radar [MAS]

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Ground Penetrating Radar (GPR) is a proven method of imaging the subsurface and is widely used to characterize waste sites. Most interpretations using GPR have relied upon raw data records or records that have utilized standard seismic data processing packages. We have developed a method that will provide three-dimensional (3-D) images of the subsurface using geophysical diffraction tomography. The method described produces images for the transmitting and receiving antennas located on the surface at a fixed offset and the implemented algorithm provides images which are easy to interpret and requires little processing knowledge so that it may be used by non-specialists. By assuming the backscattered radiation from an object is weak, the radiation may be related to the object using the Helmholtz equation. Assuming the offset between the transmitting and receiving antennas is small, the 3-D Fourier transform of the object function may be related to the two-dimensional (2-D) transform of the scattered radiation field. By solving for this relationship for several different frequencies within the bandwidth of the transmitting antenna, an accurate representation of the object may be created. This method was tested using computer generated models and two field studies. The studies demonstrated the ability of diffraction tomography to image both conducting and nonconducting objects at known locations and the ease of use of the algorithm. Diffraction tomography for GPR data proved useful for generating 3-D images of the subsurface that would aid development of remediation plans and monitoring procedures for waste sites.

Treatment of Anaconda Smelter Site Soil for Arsenic Removal [MAS]

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The objective of this research was to experimentally investigate the potential for removing arsenic from soil. The soil used for the experimental work was collected from areas surrounding the copper smelter in Anaconda, Montana. The results show that arsenic can be removed by leaching under acid conditions. Major factors influencing arsenic recovery was found to be solution pH, solid-liquid ratio and time for leaching. Metals extraction has also been investigated and results were reported in this presentation.

Preventing Pollution in Your Community [MAS]

Felice Stadler
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Montana's growing toxic pollution problem demands a new approach to dealing with industrial pollution, one which will require industry to revisit its waste generating processes. Citizens of Montana can be ensured that their air, water, land, and workplace are free of toxic hazards only when neighboring industry commits to preventing pollution. While some argue that toxic pollution is a problem reserved for states like New Jersey or California, at the same time residents of Montana's cities are being told that their gardens are unsafe for growing vegetables, that the air poses a health risk to their children and their elderly population, that their water is undrinkable or unusable for irrigation. The solution to these problems is not through tightening permits, but through getting industry to plan for ways of reducing waste at its source. It is the latter approach that has been shown to be economically beneficial for industry, technologically possible, and environmentally sound. To move from pollution control to pollution reduction will require a change in philosophy and approach on the part of state and local health officials and large and small businesses. However, this is what is needed if we aim to reduce the current threat that toxic pollution poses to citizens, workers and the environment.

Implementation of the Precautionary Principle and Clean Production in Hungary: Needs, Constraints and Potentials [MAS]

Joel A. Tickner
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Forty years of heavy industrialization and neglect have had a devastating, costly, and still unquantified impact on the health of the Hungarian people and environment. During this period of economic and political transformation, the opportunity exists to protect the Hungarian environment based on a new, sustainable paradigm: that of the precautionary principle and clean production. The precautionary principle aims to prevent harm to the environment, even before scientific knowledge establishes a cause-effect relationship between a pollutant or process and environmental degradation. Clean production is the continuous application of an integrated preventative environmental strategy to change processes and products to reduce risks to humans and the environment. The economic and environmental benefits of clean production have been extensively demonstrated internationally. The political, economic, and technical feasibility for implementing the precautionary principle and clean production in Hungary was examined. Because an adequate legal structure, capital investment and education and training are prerequisites for the

implementation of these concepts, the role and constraints of environmental law development, the Hungarian economic situation, privatization and joint ventures, and multilateral and bilateral development assistance were thoroughly analyzed. Hungary's current economic crisis, lack of comprehensive environmental legislation, and ad hoc privatization process pose serious barriers to the implementation of clean production. Certain projects undertaken by multilateral and bilateral lending institutions are influencing Hungary's economic development towards the unsustainable Western free-market model, without considering the needs of the Hungarian people. Potentials for the precautionary principle and clean production exist in the form of new and existing environmental legislation, requiring prevention as an underlying principle and allowing for citizen participation and enforcement of environmental laws and the self-determination of local communities. National and international funding and technical assistance are available for clean production demonstration, information, and training projects.

Mathematics, Statistics and Computer Sciences

Integrating Mathematics and Science at the Preservice Level [MAS]

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Because the school is taking a more global, holistic view of the purposes of education, schools must begin to restructure conventional approaches to the processes of teaching and learning. Curricula integration can provide an enhanced understanding of the various disciplines associated with traditional curriculum and provide relevant situations for a more process rather than product-oriented curriculum. The best place to begin the restructuring process is at the preservice level. While it is commonplace to think of mathematics and science as disciplines that can be linked naturally, the meaning of such integration is less clear. The purpose of this presentation was to identify several different models currently being used to integrate mathematics and science, and to show that the model chosen influences the nature, as well the depth and the extent of the integration. This presentation describes the component parts of an integrated Elementary Mathematics and Science Methods Course at Montana State University - Billings. The strengths and limitations of implementation as well as suggestions designed to demonstrate integrated methodology are discussed.