motives that I am describing here goes beyond that assumption, although it certainly presupposes a capacity for parallel processing. The motivational complexity of thought is more easily seen as depth than as breadth. It is what makes people interesting, and it is also what gives them the capacity for being bored. It is what the "shallow" characters of poor fiction lack, and it is the source of the inventive spontaneity of real people. People succeed in using experience with one problem in solving another because, after all, they want to solve both; and both solutions are only parts of an intricate system of needs and goals. Miller, Galanter, and Pribram (*10*) have emphasized the hierarchical structure that human intentions often exhibit. Such a multiplicity of motives is not a supplementary heuristic that can be readily incorporated into a problem-solving program to increase its effectiveness. In man, it is a necessary consequence of the way his intellectual activity has grown in relation to his needs and his feelings.

The future of artificial intelligence is a bright one. The intellectual achievements of computer programs are almost certain to increase. We can look forward with confidence to a time when many complex and difficult tasks will be better performed by machines than they now are by men, and to the solution of problems which men could never attempt. Moreover, our understanding of human thinking may well be furthered by a better understanding of those aspects of intelligence which the programs display. This process has already begun: many psychologists, myself included, are indebted to computer technology for a wealth of new ideas which seem to be helpful in understanding man. But two systems are not necessarily identical, or even very similar, because they have some properties in common.

The deep difference between the thinking of men and machines has been intuitively recognized by those who fear that machines may somehow come to regulate our society. If machines really thought as men do, there would be no more reason to fear them than to fear men. But computer intelligence is indeed "inhuman": it does not grow, has no emotional basis, and is shallowly motivated. These defects do not matter in technical applications, where the criteria of successful problem solving are relatively simple. They become extremely important if the computer is used to make social decisions, for there our criteria of adequacy are as subtle and as multiply motivated as human thinking itself.

The very concept of "artificial intelligence" suggests the rationalist's ancient assumption that man's intelligence is a faculty independent of the rest of human life. Happily, it is not.

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MEETING REPORTS

Synthetic Detergents in Water and Sewage Systems

The program of the Society for Industrial Microbiology at the AAAS annual meeting included an informative symposium on "Synthetic detergents in water and sewage systems" (27 December 1962).

Since the introduction of synthetic detergents for general household use in the late 1940's, these materials have become increasingly popular until they now command about 75 percent of the household retail market for cleaning agents. The use of these products not only has caused a tremendous accumulation of animal fats (formerly used in the production of soap), but also has introduced problems in the disposal of wastes containing these materials. In contrast to the common soaps, these alkyl benzene sulfonates (ABS), particularly the branched-chain types in common use, are resistant to degradation in sewage disposal plants, cesspools, and septic tanks, and are often found in streams and ground water. While toxicity does not appear to be a problem, operation of sewage disposal plants can be adversely affected by vast accumulations of foam, and "heads" of foam equal to the amount of water sometimes appear on tap water. Numerous industries are now being adversely affected by the frothing and foaming which results from the presence of finite and measurable amounts of surface active agents in water supplies.

Particular difficulty with residues of ABS in water, according to reports at this symposium, is now experienced in areas where the water table is quite near the surface. When many new homes with septic tanks are being built, and other nearby homes draw water from wells, these synthetic compounds make their way into the drinking water. The possible simultaneous entry of intestinal viruses is considered a real public health hazard.

Recycling sewage effluent after passage through the usual disposal process diminishes the ABS concentration greatly, although this is an expensive treatment. One interesting experimental method described at the symposium is percolation of the sulfonate-laden sewage through sandy soil in a container (lysimeter) that is designed to permit samples to be taken from various levels in the soil for analysis. The mixed bacterial population in the soil can then largely degrade the detergents during a fairly long detention time. Experiments at tempera-

tures low enough so that bacteria were not active showed that an actively metabolizing microflora is quite necessary for the removal of ABS and adsorption on the soil particles has no significant role in removal. The use of activated charcoal in the adsorption and removal of these sulfonates is sometimes a necessary but expensive expedient. Adsorption with aluminum salts, often used as flocculants in water purification, and with ferric salts has not been found promising except in certain limited industrial usages. This type of removal is greatly influenced by *p*H, since the adsorbed material must be the ABS anion.

Several of the participants in the symposium cited the inadequacy of available analytical procedures. The methylene blue test provides a very poor quantitative estimate of the intermediate compounds in the case of this biological degradation. This is due more to the ineffectiveness of the chloroform extraction of the intermediates than to lack of sensitivity, although certain ions and other contaminants in sewage may adversely affect interpretation of the test. In one experiment an organic compound, molecularly identical with ABS except for one oxidized carbon atom (a carboxyl group), was added to a test synthetic sewage. The standard methylene blue assay procedure was then used, and only 47 percent of the test material was recovered; the results demonstrated clearly the weakness of this assay.

The need for effective analytical techniques with respect to the polyethylene glycols is even more urgent. These materials are being more widely used in an expanding variety of products, but there is no test specifically sensitive for determining their presence in water.

There are existent "biologically soft," or easily degraded, synthetic detergent compounds. Examples of these are the sulfate esters of long-chain alcohols and certain sulfonate compounds with unbranched carbon chains. The "biologically hard" detergents are the ABS compounds with branched chains in which the branching stops the progressive bacterial oxidation of the hydrocarbon chains, and the polyethylene glycols of large molecular weight, which may be too large to penetrate bacterial cells and thus become subject to oxidation. There was some suggestion that future legislation may restrict the marketing of detergents to the easily biodegradable products. However, intensive studies of the degradability of the branched-chain (tetrapropylene derived) ABS complex may indicate better means of disposal of this more economically produced material.

A promising new technique for analyzing degradation of these detergents in sewage and waters is gas chromatography. It was reported that microorganisms in river water degraded several selected isomers of straight chain ABS to intermediates with progressively shortened, oxidized side chains. These were further degraded to unknown, unextractable compounds, perhaps even to carbon dioxide and water.

Although most of the papers in the symposium reported experiments with the mixed bacterial populations of sewage or river water, there were two papers describing work with pure cultures of bacteria obtained by soil enrichment. One of these described a bacterium capable of growing on ethylene glycols ranging in complexity from one to several hundred repeating units. These glycols, containing ether linkages, can serve as the sole source of carbon for the bacterial growth. In studies of the smaller, structurally simpler glycols it was noted that the efficiency of oxidation varied directly with the number of ethylene glycol units in the molecule, whereas the efficiency of conversion of the carbon of the substrates to bacterial cytoplasm varied inversely. Substitution of methyl, butyl, and phenyl groups for glycol groups impeded growth of the bacteria, whereas compounds with carboxyl groups attached were effective growth substrates.

The utilization of the "biologically soft" detergent, sodium lauryl sulfate, and a mixed sulfonate preparation by pure cultures of bacteria were reported. These materials served as sole sources of carbon after "enrichment culturing," and either one of two isolants was able to degrade sodium lauryl sulfate so completely that it could no longer form suds after the period of bacterial growth. These bacteria grew on and oxidized a variety of long-chain acids and alcohols, and one of them could grow on just the ring compound of the sulfonate molecule, that is, benzene sulfonate. When cultured in a medium containing both a very small amount of rich natural organic matter (yeast extract) and the detergent compounds, the rate of growth of the bacteria on the detergents was greatly increased. However, only 20 to 25 percent of the ABS provided was consumed by the growing cells of this single pure culture of bacteria. Three of five purified isomers of dodecyl benzene sulfonate supported growth of the bacteria, whereas the other two isomers were toxic and killed the cultures. The desirability of learning more about the degradation of branched-chain ABS (derived from tetrapropylene) by both the mixed population of sewage seed and by pure strains isolated by "enrichment cultures" emerged as the dominant idea from this symposium.

There were two contributed papers. The first reported that the polyethylene films, because of their sturdiness and the various thickness available, serve well as surfaces for testing disinfectants. The second paper described experiments on the keeping quality of hides, particularly during the prolonged holding time between skinning and processing. The surfactant benzalkonium chloride preserves the untreated hides for longer periods without adversely effecting quality.

W. J. PAYNE
Department of Bacteriology, University of Georgia, Athens

Neuromuscular Function

For the last decade the laboratory of Ernest Gutmann and his associates at the Institute of Physiology of the Czechoslovak Academy of Sciences has been a leading center for research on the biochemical and physiological aspects of neurotrophic relations between nerve and muscle. Thus it was appropriate that an international symposium on the Effects of Use and Disuse on Neuromuscular Function was held 18–22 September at Liblice, near Prague, Czechoslovakia.

The purpose of the symposium was to evaluate current knowledge of the effects of neuromuscular use and disuse with respect to the nature of the still unidentified trophic influence. The participants always returned to this key point even though many of the papers were only peripherally related to it.

In introductory talks, Sir John Eccles (Canberra) reviewed the general physiological relationships between nerve and skeletal muscle which indicate neuro-