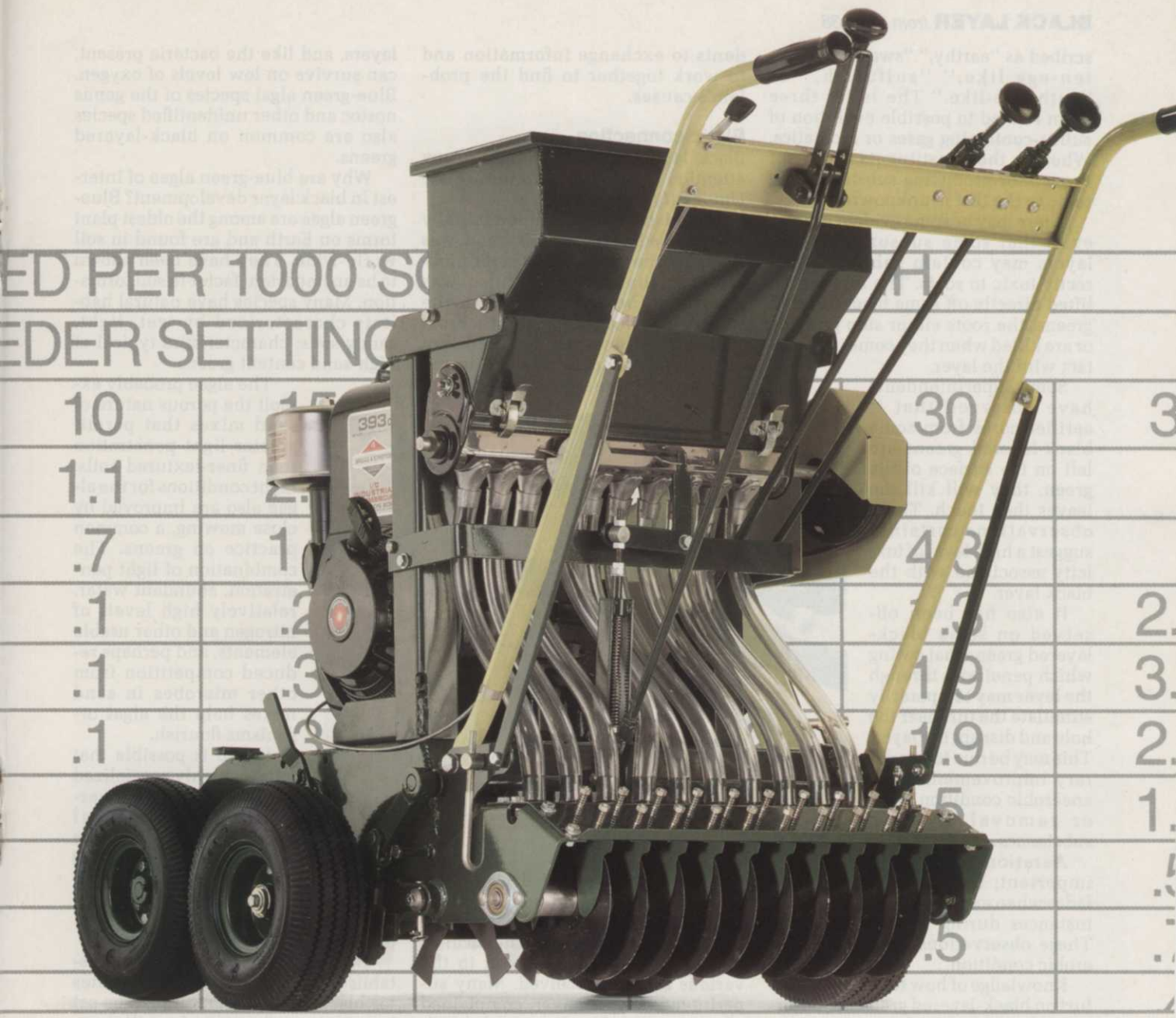

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scribed as "earthy," "swampy," "rotten-egg like," "sulfurish," or "outhouse-like." The latter three seem related to possible evolution of sulfur-containing gases or aromatics. Whether the constituents of any of these odor-producing substances are toxic to the turf is unknown.

There may be some evidence, however, that some subsurface black layers may contain substances directly toxic to roots. The turf can be lifted directly off some black-layered greens; the roots either stop growing or are killed when they come into contact with the layer.

Some superintendents have observed that if aerifier cores from some black-layered greens are left on tbe surface of the green, they will kill the leaves they touch. These observations certainly suggest a high level of toxicity associated with the black layer.

It also has been observed on some black-layered greens that coring which penetrates through the layer may temporarily stimulate the turf near the hole and disrupt the layer. This may be due to temporary improvement of an anaerobic condition and/or removal of toxic substances.

Aeration seems very important; the layer's color often fades when exposed to air and in some instances during winter dormancy. These observations suggest an anaerobic condition.

Knowledge of how to control loss of turf on black-layered greens is, unfortunately, scarce. Reducing irrigation to a minimum and increasing aerification seems to have the greatest effect on slowing black-layer development, but these operations are unlikely to end the problem. Using wetting agents and fungicides with algicidal properties also may help. To date, however, I have not seen black layer eliminated by any chemical or cultural means; but many creative superintendents have learned to manage the problem somewhat.

It also seems that the problem may decrease in severity with time, irrespective of cultural and chemical practices. Once established, however, it seems to always be active at some level.

Our prospects for effective control of this problem seem to rest squarely on the ability of the research community and superintendents to exchange information and to work together to find the problem's causes.

Biotic connection

Black layer was first brought to my attention in 1978, on the Iowa State University golf course.

The black-layer condition initially was viewed as a curiosity and was thought to be peculiar to specific problems on that course. It also was thought to be associated with the green's physical components. From 1978 to 1984, however, the number of black layer samples received in my laboratory increased dramatically, and were being received from midwestern, eastern and south central states, and Canada. It soon became apparent that no physical, chemical or cultural factor was common to the various samples received. Many superintendents, however, complained of poor water infiltration and/or drainage of greens.

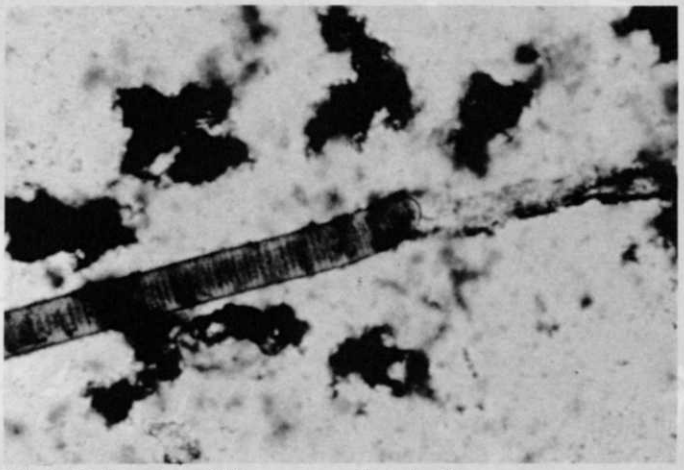

Photo 2: Species of blue-green algae in the genus *oscillatoria* glide on extracellular mucilage produced by the algal organism.

During 1985's growing season, all black layer samples were carefully examined for the types and prevalence of microorganisms associated with the disorder. This involved isolation of organisms in leaf and root tissues, in the top one-eighth inch of the sand mix, in the subsurface sand not involved in the black layer, and in the black layer. Some common denominators evolved from these efforts.

Perhaps of greatest interest is that the black layer is essentially devoid of aerobic microbes. However, mixed cultures of anaerobic bacteria (bacteria that can survive on extremely low levels of oxygen) have been isolated regularly from black layers. Species of pythium and another unidentified fungus also are found in some black layers, and like the bacteria present, can survive on low levels of oxygen. Blue-green algal species of the genus nostoc and other unidentified species also are common on black-layered greens.

Why are blue-green algae of interest in black layer development? Blue-green algae are among the oldest plant forms on Earth and are found in soil world-wide. They have been shown to be an important factor in soil formation. Many species have natural habitats characterized by wet, light, sandy soils; characteristics typical of high-sand content greens.

The algae probably exploit the porous nature of sand mixes that permit greater light penetration than finer-textured soils. Light conditions for the algae also are improved by close mowing, a common practice on greens. The combination of light penetration, abundant water, relatively high levels of nitrogen and other usable elements, and perhaps reduced competition from other microbes in sand mixes help the algal organisms flourish.

It also is possible that today's highly specialized pesticides may inadvertently promote algal growth. General biocides (mercury and arsenic) once commonly used may have contained algal growth more than many of the less toxic and more biodegradeable compounds of today.

Once the blue-green algae are established on a green, the prerequisites for black-layer formation may be set into motion. Species of oscillatoria and nostoc are filamentous blue-green algae; that is, they are worm-like filaments and are mobile. Their movement is facilitated, in part, by producing an extracellular mucilage upon which they glide over the surface of the sand (Photo 2).

Mucilage probably protects the algae from desiccation and also functions as an adhesive, holding the algae to sand particles and binding particles together. These materials are hydrophilic, quite stable, and adhere strongly to the sand particles.

It is believed that the extracellular mucilage, in combination with organic matter produced by the death of algal organisms, gradually fills and plugs the pores between sand particles at the green's surface. The initial effect of this process, prior to any black-layer formation, may be a slow

continued on page 44

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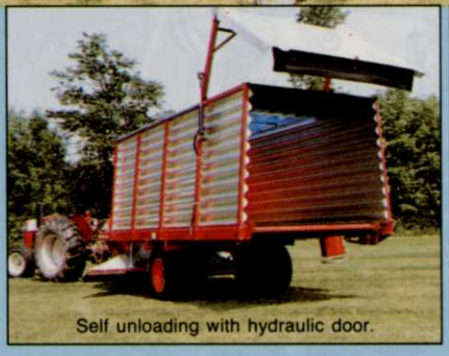
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86-58

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BLACK LAYER *from page 42*

ing of water infiltration and drainage due to a biologically induced perched water table at the green's surface.

Surface or subsurface black layer formation may be started at this point.

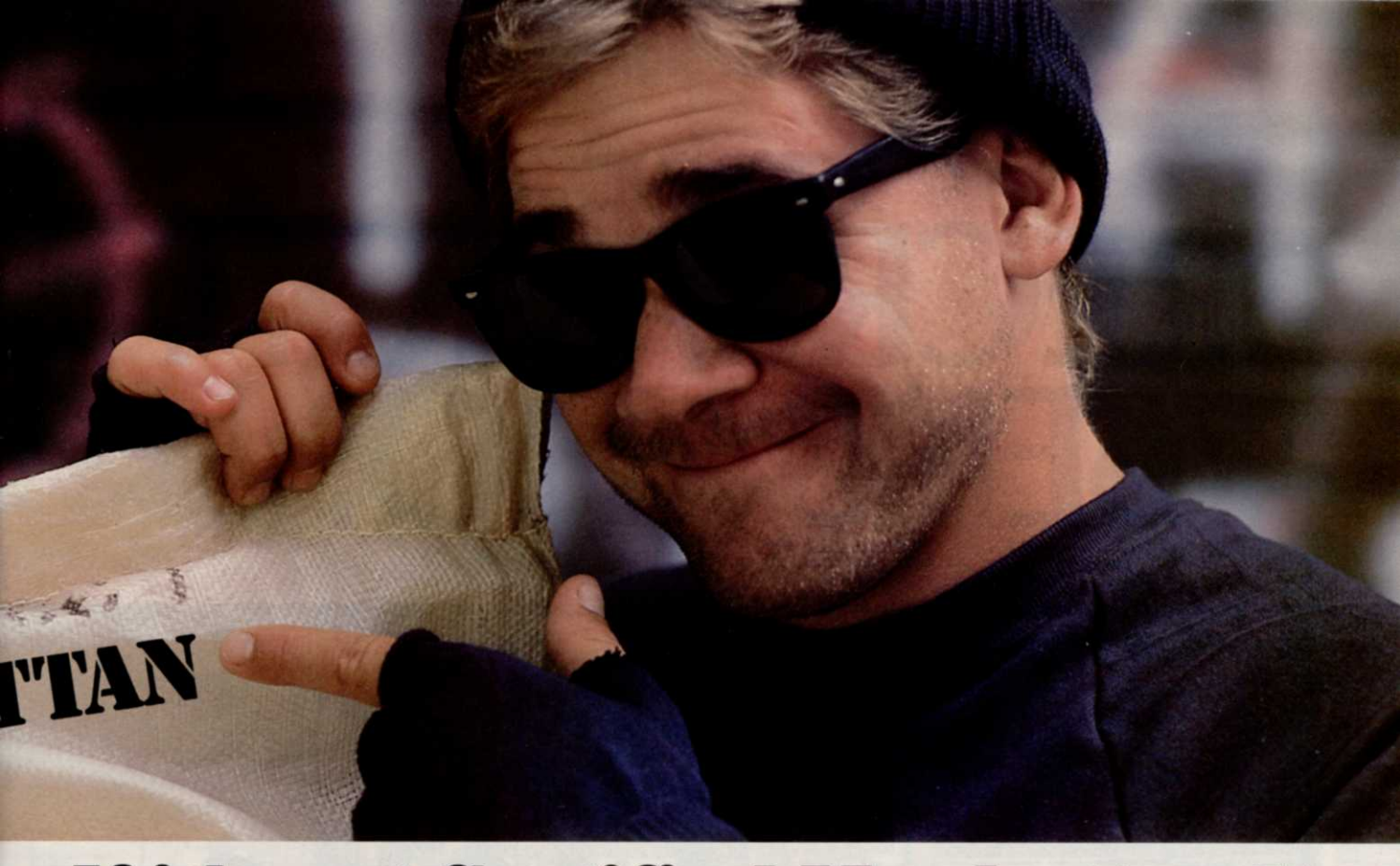
If growth of the blue-green algae is excessive, the green's surface may be tightly sealed and accumulation of mucilage, dead algae, and infestation of these products by other microbes (bacteria and fungi) may result in surface black layering. If the algae proliferation is slower, the mucilage and other organic products of dead algae may move more slowly into the sand mix's profile and eventually form a barrier below the surface. This barrier of mucilage and other organic substances from the algae may then serve as substrate for anaerobic bacteria and some fungal species.

It is not entirely clear what contributes to the black layer's color, but some of the color is probably due to deteriorating organic matter (perhaps algae and organic substances, and tissues from grass roots). Also, the mucilage supports bacterial and fungal growth and probably promotes mineralization of the organic matter in the layer. This activity would further contribute to the layer's color and may be further influenced by fertilizers and iron and sulfur amendments. Iron and sulfur can be metabolized by algae and bacteria, often in different ways, depending on the presence or absence of oxygen.

Black layer might be described as anaerobic decline of creeping bentgrass.

The black layer problem seems to be the result of an abnormal opportunistic microbiological ecosystem. The system's components (blue-green algae, bacteria, and perhaps some fungi) are set into motion by the physical characteristics of high-sand content greens and the cultural regimes required to maintain them.

The superintendent may have little control over the development of black layer. He is often locked into the requirements of the sand green cultural regime and can make only minor changes in his operation. If enough components of the ecosystem emerge on the green, black layer will form. The concept of an abnormal microbiological ecosystem forms the basis for research being conducted at Iowa State University on the black layer problem. **LM**



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THE RECREATION SENSATION

by Heide Aungst, managing editor

Those wanting to escape the congestion of San Diego can head to the peaceful oasis of Lake Poway, just 20 miles from the city. The park offers visitors 34 acres of lakes and recreation areas. But the favorite spot among children is the playground. Park director Lee Lewis chose BigToys wooden play structures to establish a rural theme which carries through the landscape. "We originally planned a high sierra theme, but converted over to a more applicable theme with woods. We got rid of synthetic equipment," Lewis says.

The various types of play equipment allows Lewis to segregate the 1/4-acre play area by age group. He has placed the equipment in designs which avoid collisions between children. Lewis' crew inspects the equipment regularly to minimize risk and maintenance costs. Lake Poway has not had any law suits since the installation of the equipment 10 years ago.

To keep the sanded play area weed-free, Lewis sprays it annually with Roundup. Children rarely track sand onto the turf because landscape timbers, provided by the California Conservation Corp., separate the sand from the turf. The turf surrounding the play area is Northrup King's Medalist blend of fescue and bluegrass. All turf areas are irrigated. The crew mows once a week at 2 1/2 inches. Lantana (left) grows as a ground cover around the area. Sycamores provide shade for tuckered-out youngsters.

BigToys: Circle No. 190 on Reader Inquiry Card.

It took an act of Congress, but visitors to our capital city can enjoy a work out in front of the capitol on the Parcourse Fitness Cluster. Congress approved the measure to put the center on the mall, and it opened for public use in April 1986.The redwood and stainless steel equipment conforms to the natural landscape of the historic area. "The mall is a very active place. At lunch there's hundreds of joggers. They can run right from work," says Ken Williams, the landscape contractor who installed the system. Williams arranged the equipment in four clusters covering an all-weather asphalt area 16 X 64 feet. The National Park Service maintains the area by sweeping the asphalt at least once a week and checking for damage to the equipment.The arrangement of the equipment lets the park service easily mow the surrounding turf which consists of K-31 fescue, Palmer and Citation ryegrass and Merit bluegrass.

Joseph Kanter, chairman of the First National Bank of Florida, donated the equipment. An avid jogger for 40 years, Kanter has reportedly run the equivalent of the earth's circumference. He chose the Parcourse equipment because it fits the needs of all ages and levels of fitness, including the disabled.

The amount of the donation is private, but Williams says such an installation would run about $4,500, with the equipment valued at $13,000.

Parcourse: Circle No. 191 on Reader Inquiry Card.
Williams Landscaping: Circle No. 192 on Reader Inquiry Card.

Kids have always had fun down on the farm. That tradition continues, with a more modern twist, at the Juilfs Park playground in Cincinnati, Ohio. The land used for the park began as the Juilfs family farm. The park designers, Jennings of Ohio, reconstructed the old farm silo into an observation tower. The play area, constructed in 1986, uses wooden equipment from Quality Industries to maintain the family-farm flavor.

The 150 ft. X 130 ft. sanded playground took six months to grade and construct. The sand depth is 15 to 18 feet and has not needed to be treated for weeds. Eight different slides, including a zoom slide (above left) and underground slide, make the playground an adventure for kids of all ages. The bench swing (above right) gives adults a break while kids play on the equipment. Trees provide shade and an aesthetically pleasing perimeter to the play area. The staff planted three 25-foot sycamores. Other trees planted include six red maples, six October glory maples and one pin oak. Already in the area was a swamp willow, four scotch pines and one white pine.

The park management crew originally sodded the turf area with bluegrass, but overseeds because of wear from heavy traffic with 80 percent K-31 tall fescue and 20 percent Regal ryegrass. The crew mows the non-irrigated area twice a week.

The entire play area cost about $43,225. The project won the 1986 Ohio Parks and Recreation Association's "Outstanding Award" for recreation facilities costing less than $75,000.

Quality Industries: Circle No. 193 on Reader Inquiry Card.
Jennings of Ohio: Circle No. 194 on Reader Inquiry Card.

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PART I OF II

COMPUTERS IN THE GREEN INDUSTRY

Green industry companies are turning to computers to help manage their businesses. But before you invest, ask yourself these questions.

by Rudd McGary and Ed Wandtke

All businesses run on information. The ability of a company to control and use information will generally make the difference between a highly successful company and one that either "just makes it," or "goes under." The green industry is no exception.

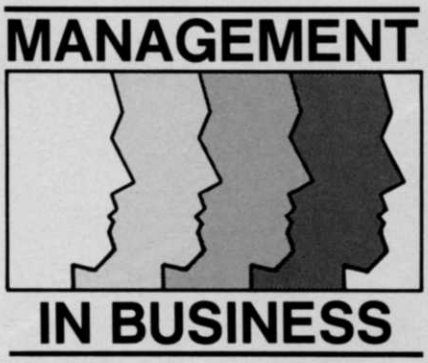
As parts of the green industry grow and mature, owner/operators must have easy access to information in forms that will help them manage their companies better. In addition, billing and accounting generally used by the green industries need to be monitored so that cash flow is controlled internally.

Enter: the computer.

More green industry firms recognize the need for a device that will help process data in their day-to-day operations. One answer is to handle the various jobs manually by increasing staff. Another is to explore the benefits of working with computers, which are many. But many questions need to be asked before deciding on the type of computer to buy.

Let's get rid of some of the myths that surround computers, both large and small.

Wandtke and McGary are senior consultants with All-Green Management Associates in Columbus, Ohio. Dr. McGary focuses on marketing and management issues. Wandtke focuses on operations and financial questions.



First, the function of the computer, in most cases, is to organize input so it is useful to the operator. The forms of the programs generally will determine how the information is to be formatted. For instance, a spread-sheet program yields numerical information arranged in standard manual spread-sheet form. A word processing program lets the operator work on alpha information in forms such as letters. An A/R program organizes work in accounts receivable, and so on.

The myth is that the computer will analyze these numbers or words. The operator has to know how to interpret the information to correctly use it. Some highly-sophisticated programs do analysis, but the type of programs to be reviewed next month don't lend themselves to that. So remember, this is a G-I-G-O system here: "Garbage-In-Garbage-Out." Putting the wrong information into the computer will yield the wrong information back. It might look nicer, but it will still be wrong.

A second myth is that people who use computers find extra time in the work week. In some cases, the work load is reduced (particularly if everything was done manually), but introducing a computer to a business has not generally yielded more free time. What usually happens is a reduction of work load when the machine is introduced. But it then levels off as the operator begins to put more information into the machine to process. Not time but more information is the product.

A third myth is that purchasing a computer will automatically make for a better company. Certainly, if computers are used correctly, a business can be helped immensely. But if the company had an ineffective system of controls to begin with, a computer shouldn't be expected to magically correct the problems.

Questions on computer systems

The most commonly-asked question about choosing a computer system isn't necessarily the most important for the long term. "What will it cost me?" doesn't deal with the problem. Here are some questions that should be asked before price.

1. How does your system presently work? A manual system can be transferred to a computer in some form. If a manual system is truly efficient, the assumption can be made that it will work on a computer.

2. What do you want to control? The most common first use of computers in the green industry is accounts receivable. Billings, aging of receivables and customer lists are most often better done on computers. Other functions might be inventory control, accounts payable, general ledger, routing, sales controls, marketing information, payroll, design capabilities, vehicle maintenance and personnel information. First, ask yourself what you want to control and then seek out a software vendor.

3. Who should I buy from? Each of the programs listed next month were written by reputable, knowledgeable companies. Certainly you should take the time to talk to more than one.

4. Do I have to buy hardware from the same company selling the software? In some cases yes, in others no. If the program is written to be PC-compatible, there is a wide choice. In other cases, the software is written for a specific machine and often the soft-