Cushman three-wheel Package-Kar during World War II.

TURF VEHICLES

Cushman Truckster today with boom sprayer on rear. Photo courtesy: Broward County Schools.

Every minute counts today whether you are manufacturing automobiles or managing acres of recreational landscape. Time is money, as Henry Ford cleverly proved by speeding up his production lines more than 70 years ago. Seconds quickly add up to hours during a work week. By eliminating wasteful motion and letting machinery carry the load, you can increase productivity and do a better job.

People in the 1920s were amazed that Ford could pay auto workers five dollars per day AND build a car affordable to a larger percentage of the population. Ford realized that the success of his industry was based upon making his vehicles affordable to a maximum number of people. He had to have high volume to bring the cost of automobiles down. So he had to be able to create enough demand to assure high volume.

Ford's thinking is relevant today and can be applied to the golf and sports turf market

continued on page 22

Club Car's Carryall I and Carryall II.

Turf Vehicles

continued from page 21

in this country. Industry studies have revealed that the number of golf courses in this country is not sufficient to meet the anticipated demand by golfers in the coming decade. The National Golf Foundation and the United States Golf Association have jointly predicted that more than 4,000 new golf courses must be built in the next ten years to begin to meet this demand. Without these new courses, the cost of golf will rise to a point that prohibits many potential golfers from playing.

The situation in Japan is a perfect example of what happens when the cost of golf goes unchecked. The price of membership at Japanese private courses is hundreds of thousands of dollars. The cost of a round of golf is several hundred dollars. Playing golf there is a privilege available to only a small portion of the population.

The situation is possibly more critical for U.S. colleges, universities, schools, and parks, which are faced with a tremendous demand for sports facilities. The rising costs of construction and maintenance are restricting the number of public and private recreational complexes. The problem is so severe that some colleges have been forced to limit the number of sports they provide for students. In some cities, Little League Baseball, soccer, and football clubs have been forced to shut down for lack of fields. Park districts are beginning to run out of space for fields.

Clearly the golf and sports turf industries must find ways of controlling construction and maintenance costs. In fact, they have been doing that for more than 20 years. Small, yet significant improvements are being made in the efficiency of labor. Advances in irrigation, mowing, aeration, fertilization and pest control have shaved hours off the payrolls of sports complexes. This has not only reduced the cost of construction and maintenance, it has helped the industry adjust to a shortage of skilled labor.

Yet there will always be a certain amount of hand work that can't be eliminated if we are to continue to provide the level of play demanded by athletes. Machines can't replace labor when it comes to pin placement, setting tee markers, trimming, marking out-of-bounds, striping fields, preparing infields, repairing divots, placing bases and goals, and other important spot work. These jobs require a "human touch" and must be followed up by supervision.

Furthermore, the increased attention paid to our use of chemicals and higher expectations regarding the condition of sports turf require greater attention to detail and increased supervision. The turf manager and his staff must be able to cover acres of ground without wasting time. They can't do that on foot, and many sites simply aren't accessibile by conventional vehicles.

The importance of time and motion in the sports turf industry can be compared to the aircraft industry during World War II. Thousands of aircraft had to be built as quickly as possible to supply the war effort in Europe and in the Pacific. Aircraft needing maintenance had to be repaired within hours instead of days. To make matters worse, there was a shortage of conventional ground vehicles to move mechanics and parts to aircraft spread across acres of tarmac.

The War Department desperately needed small vehicles to transport technicians and their gear quickly from hangers to planes. From this unusual set of circumstances arose the ancestor of the utility turf vehicle. Cushman, an engine manufacturer in Lincoln, NE, created the three-wheel motorized scooter before the war to increase the versatility of its line of two-wheel scooters. Instead of one wheel in front and two wheels in back, the company placed two wheels and a parts basket in front. The engine drove a single rear wheel.

After the War, the company sought a way to continue production of the scooter by adapting it to other uses. The growing popularity of the golf industry made the scooter a natural. To enable the scooter to handle the rolling terrain of golf courses as opposed to flat airports, Cushman engineers turned the frame around and powered the two rear wheels with the engine. The company added a bag carrier to the rear and entered the golf car business. It also engineered a version with a cargo box in the rear which became the forerunner to the utility turf vehicle.

During this decade, other companies responded to the popularity of golf cars. They included Club Car, E-Z Go and Harley Davidson. For the next 25 years, these companies would concentrate their efforts on golf cars, not utility turf vehicles. They utilized two-cycle engines because they were quieter and did not require a reverse gear, since a two-cycle engine can operate in both directions. Later, Club Car and E-Z Go would respond to the growing turf vehicle market.

"In the '60s, the turf vehicle market consisted only of three companies," recalls Don Smith, vice president of Smithco, "Cushman, Rogers, and Smithco. We designed our Red Rider with a fold-down ramp for easy loading and unloading of walk-behind greensmowers. Superintendents would ocassionally put a small box on the back of an old golf car and use it like a turf vehicle. That was the market for nearly 20 years."

Superintendents continued to experiment with turf vehicles. "The first accessory was a sprayer," says Cushman's Clarke Staples, "They put a sprayer in back and attached the boom up front. They also wanted a dump box, so we installed a hand-pump jack and hinged the box to the frame."

As spreaders, topdressers, aerators and larger cargo beds were added, it became clear that a number of adjustments were necessary. Four wheels provided more stability than three. Frames, engines, suspensions, and transmissions had to be beefed up to carry and pull larger loads. Options such as power take-off, hydraulic assist, and quick connectors were incorporated to operate a greater assortment of accessories.

E-Z-Go GXT-800.

Now the operator had the use of a hydraulic dump bed, spikers, aerators, topdressers, sprayers, spreaders, and even a power converter to provide alternating current for electrical hand tools. "It was clear that turf managers wanted to use the vehicles for as many purposes as possible," adds Staples.

In somes cases, these accessories outweighed the importance of basic transportation. Specialized vehicles started to enter the market, including sand trap rakes, line markers, infield dirt groomers, sprayers, spreaders and sweepers. Companies such as Hahn, Toro, Jacobsen, Deere, Smithco, Ingram and Kromers began making dedicated versions of turf vehicles.

To maximize versatility, Cushman pioneered a three-pin quick connect system in 1973. This allowed some accessories to

The five-wheel Deere AMT 622.

be mounted directly to the frame instead of to the cargo bed. In fact, the cargo boxes could also be disconnected by pulling three pins, two for the hinge and one for the hydraulic lift.

This specialization, in addition to the growing demand for turf vehicles, reopened the market for manufacturers of smaller, less versatile products. "There are three parts of the market today," reports Michael Alexander with Club Car. "There is the high-end, multi-use truck-type vehicle. These are heavy-duty and offer the greatest number of features. The low end is designed for economy—basic reliable transportation at a low cost. Then there is a growing middle range of vehicles. These provide some of the most popular features at a moderate price. I believe every manufacturer would agree that the need for low- and mid-range turf vehicles is on the rise."

Each feature has its price. While water-cooled, four-cycle engines are quieter and more durable under constant, heavy use, they add to the price of a vehicle. A two-cycle engine is an economical option for vehicles that carry smaller loads, explains E-Z Go's Ron Skenes.

The same is true for continuously-variable transmissions. They eliminate shifting and increase operator control. That's fine for most loads. However, if the vehicle regularly carries heavy loads up steep inclines, there is an advantage to being able to downshift into a low gear.

continued on page 24

Turf Vehicles
continued from page 23

Club Car and E-Z Go offer vehicles for all three ranges. Club Car has offered a cargo box option to its line of golf vehicles for 15 years. Four years ago it introduced the Carryall II as a multi-purpose, high-range turf vehicle. Last year it added the Carryall I for an economical alternative. All its vehicles come with an aluminum frame and cargo bed to reduce weight and prevent corrosion.

E-Z Go serves the high-end with its GXT-1500 and lower ranges with its GXT-300 and GXT-800. The 1500 has a four-cycle gas engine with a five-speed synchromesh transmission. It can carry a payload up to 1,500 pounds in its diamond-plated, corrosion-resistant large cargo bed. The 300 and 800 carry a payload up to 1,000 pounds powered by a two-cycle engine.

Cushman's strength is in the heavy-duty vehicle. Starting with its Runabout and progressing to its three- and four-wheel truckster, the company includes a four-cycle engine and three-speed synchromesh transmission in these models. The turf manager has an option of a 22 hp air-cooled engine or a 27 hp liquid cooled powerhouse. All three vehicles boast a 1,600-pound payload. Cushman also originated the use of most accessories available today for turf vehicles.

The company reinforced its position in the medium-duty category with the Eagle two years ago. This four-wheel multi-purpose vehicle has rack and pinion steering for a tighter turning radius. It is powered by a smaller (12.5 hp) air-cooled engine and can carry a 1,200-pound payload.

Kawasaki Mule 1000.

Smithco has expanded its line of turf vehicles from the original "Little Red" to the huskier four-wheel drive Bandit and the two-wheel drive Runaway. The Red Rider was introduced in 1967 with an 8 hp air-cooled engine and 1,000 pound payload. The Bandit and Runaway can carry up to a 1,500-pound payload with their 23 hp twin-cylinder Kohlers. The Runaway is the model that offers a sprayer, spreader and hydraulic-dump box as options.

Deere entered the golf vehicle market with a two-range approach. The 1500 is designed to compete with other heavy-duty haulers carrying 1,500 pounds of payload. Powered by a 16-hp air-cooled engine and a three-speed synchronized transmission, the four-wheel vehicle looks more like conventional turf vehicles than its cousin the AMT 600-622. The five-wheel AMT uses four of its wheels to push itself over nearly any terrain. The variable-speed transmission and 8.5 hp or 10 hp air-cooled engine take the driver and up to 600 pounds of supplies just about anywhere.

Toro has focused its attention on the middle range with its Workmaster. The three-wheel vehicle carries a payload of 1,000 pounds powered by a 14 hp air-cooled engine and hydrostatic variable-speed transmission.

Other contenders to the moderate-duty turf vehicle market are Kawasaki and Yamaha. Yamaha recently introduced its Pro-Hauler while Kawasaki has made a few waves during the past two years with its four-wheel Mule 1000. Yamaha has experience in both the golf car industry and the ATV (all terrain vehicle) markets. Kawasaki, like Yamaha, has produced ATVs for a number of years and utilized some of this technology for the Mule.

Three other companies are crossing over from another market into the turf vehicle market. Daihatsu, Mitsubishi, and Chikusui have been manufacturing "mini-trucks" for industrial use for years. Their success in

engineering versatility into a small truck chassis is now being applied to the golf and sports turf industries.

The Daihatsu Hi-Jet is the veteran vehicle in this category. Powered by a three-cylinder, water-cooled engine, the Hi-Jet can be adapted to carry either 1,750 pounds or six people. Truck-like equipment such as a cab, rack and pinion steering, MacPherson strut suspension, four-wheel drive, and hydraulic dump, have secured a strong position for the vehicle in various industries. In fact, it is common at airports, the birthplace of the original turf vehicle.

Mitsubishi's Mighty Mit and Chikusui's GX-20 are built along the same lines. They have higher maximum speeds than more conventional turf vehicles and a tighter turning radius. It is therefore important to restrict their speed on golf courses or sports complexes. As yet, these vehicles do not offer many of the standard turf accessories, but have other accessories which make them versatile.

Utility turf vehicles are no longer a luxury for a pampered turf manager. They save a considerable amount of time on the job, if only during travel from one location to another. At walking speed, let's say three miles per hour in this case, it can take a superintendent or crew member more than an hour to traverse each yard of a regulation-length course without stopping. At the same speed, it takes a sports turf manager more than a minute to walk from one end of a football, soccer or baseball field to the other.

The Hahn 435.

Minutes add up quickly during numerous trips. A turf vehicle takes just a fourth of this time at 12 mph. By carrying important equipment and supplies, the vehicle can also eliminate many unnecessary trips. They place hoses, irrigation parts, small mowers, spreaders, fertilizers and pesticides within constant reach.

That benefit alone is enough to justify the expense of a turf vehicle. Add to this the tremendous ability to keep a closer watch on your crew. Things get done right the first time. You can be anywhere on your facility in seconds with needed advice or direction. A turf vehicle and a radio can save hours of wasted time.

If that weren't enough, manufacturers have given these vehicles the ability to perform a variety of tasks besides transportation. In some instances, this saves the cost of buying a separate piece of equipment.

Unlike Ford's production line, you can't turn a knob to increase the pace at which your staff works. But you can still save hours of wasted motion by using the turf vehicle and other efficient turf management techniques as management tools.

In this way, you will help keep the cost of sports turf maintenance and construction down . . . and make sports and recreation available to a larger percentage of the population.

MISSOURI APPROVES GRANT FOR SPORTS TURF RESEARCH

The State of Missouri has approved funding for the first year of a three-year sports turf research project to be conducted by Dr. David Minner, assistant professor of horticulture at the University of Missouri. Nearly $18,000 in funds were made available by the Missouri Research Assistance Act to be added to $12,000 in private contributions by small businesses in the state.

The first phase of the project will evaluate the traffic tolerance of nearly 200 turfgrass cultivars, including those of Kentucky bluegrass, perennial ryegrass, tall fescue, zoysiagrass, and bermudagrass. It will also seek to determine the best times during the year to renovate sports turf in the state. Based upon his findings, Minner will publish guidelines and recommendations for the sports turf industry in Missouri.

Minner has applied for an additional $48,000 to fund the second and third year of the project. To receive the funding he must obtain another $22,000 in private contributions. The total research package amounts to $101,000.

The second phase of the research will test products that will provide athletic fields and playgrounds that are safer and more durable than present surfaces. Minner will specifically explore reinforcing natural grass with synthetics to produce a more wear tolerant, resilient surface. Several products will be screened for their compatibility with current management techniques by using wear simulators.

In the third phase, the most promising materials from the first two phases will be installed under actual playing conditions. The goal is to find the most effective combination of turfgrass, root zone and management practices for heavily-used sports surfaces.

The work will be conducted at the University of Missouri South Farm in Columbia. Minner will update turf managers on his progress each summer during the Missouri Turfgrass Field Day. For further information, or to make contributions, contact: Dr. David Minner, Department of Horticulture, University of Missouri, 1-40 Agriculture Bldg., Columbia, MO 65211, (314) 882-7511.

GCSSAA DONATES $25,000 FOR TURFGRASS RESEARCH

The Golf Course Superintendents of America Association recently contributed $25,000 to USGA/GCSAA Turfgrass Research Committee to support ongoing scientific work on new turfgrass varieties that would require less water and be more disease resistant. The presentation was made by GCSAA President Dennis D. Lyon, CGCS, at the annual USGA/Golf Writers Association of America banquet during the U.S. Open in Rochester, NY.

According to William H. Bengeyfield, national director of the USGA Green Section, more than $2.8 million has been distributed by the committee since 1983. The committee currently supports 25 research projects, he said.

PENNSYLVANIA APPOINTS EXTENSION TURF SPECIALIST

Dr. Peter J. Landschoot has been appointed assistant professor of turfgrass science at the the Pennsylvania State University.

Landschoot, who received his bachelor's and master's degrees in agronomy at Penn State, has been conducting post-doctoral research at Rutgers University on the distribution and control of root-infecting fungi associated with patch diseases of turfgrass.

His new duties include developing and coordinating the Penn State Cooperative Extension programs covering all phases of turfgrass management, developing fact sheets and producing educational videos, updating material on PENpages, a statewide information system and coordinating regional turgrass conferences in conjunction with the agronomy department faculty and the Pennsylvania Turfgrass Council.

Additionally, he will conduct research on the effects of fertilizers on turfgrass growth and the influence of certain management practices on turf diseases. He also plans to develop screening procedures that will aid in the selection of more disease-resistant strains of turfgrass.

Landschoot received his Ph.D. in plant pathology from the University of Rhode Island. He is a member of the American Society of Agronomy and the American Phytopathological Society.

SHEARMAN TO HEAD NEBRASKA AGRONOMY DEPARTMENT

Dr. Robert Shearman, professor of turfgrass at the University of Nebraska in Lincoln, has been selected to head the university's department of agronomy. Shearman, who started the turfgrass program at the university, has been very active in the Nebraska Turfgrass Association. He also chaired the state's annual turfgrass conference. His research at Nebraska has been widely published in the turfgrass industry.

Shearman received his Ph.D. and M.S. at Michigan State University in Lansing, studying under Dr. James Beard. His bachelor's degree is from Oregon State University in Corvallis.

We just eliminated your last excuse for buying a converted golf cart.

Introducing the Cushman® GT-1. Suggested retail price: $3,395.00*.

When you can have Cushman quality at a competitive price, there's no reason to accept second best.

The new Cushman GT-1 utility vehicle will outperform and outlast any converted golf cart on the market. Its frame and chassis are stronger and more durable. You'll find a bed made of 14-gauge steel instead of 16-gauge steel. One-inch axles instead of 3/4-inch axles. And a proven Kohler industrial engine that's more reliable and easier to maintain.

When you need a utility vehicle that's been specifically designed for work instead of one that's been converted from play, contact your Cushman dealer for a GT-1 demonstration. Or call toll-free 1-800-228-4444 for more information today.

CUSHMAN®

BUILT TO LAST

*Does not include sales tax, freight or dealer prep. Prices may vary with dealer.

5440 Cushman, P.O. Box 82409, Lincoln, NE 68501

Fall Renovation

Turfgrasses, like any other part of nature, operate on their own biological clock. They instinctively respond to their environment, changing their growth according to sunlight, temperature, moisture, nutrition and season.

Controlled by this biological clock, cool-season grasses enter the fall driven by nature to repair damage they sustained during the growing season and to replenish their reserves before the onset of winter. When you consider that turf has devoted its energy before this time to recovering from winter damage, producing seed in the spring, and surviving the heat and drought of summer, you can appreciate that fall is tremendously important to its recovery and survival.

If all we did was fertilize and mow turf in the fall, it would easily fulfill its mission of recovery and renewal. But ours is working turf—it must withstand tremendous traffic and use long into the fall. Even though growing conditions are at their best, sports turf requires more attention in the fall than at any other time of the year.

Research has shown that the fall is the best time for establishing, fertilizing, and encouraging root development of cool-season turfgrasses. Triggered by decreasing temperatures and sunlight, these plants divert their energies from foliar growth to root growth and nutrient storage.

Timing becomes critical in providing adequate shoot growth during this busy sports season without severely disrupting the plant's ability to prepare for winter. Each week is important to the establishment of newly-seeded or overseeded turfgrass. Furthermore, established cool- or warm-season grasses must be allowed to "harden off" to avoid problems with winterkill or spring transition.

Nearly every cultural practice comes into play in late summer and fall. Use-related stresses such as compaction, excessive thatch, poor drainage, inadequate irrigation, and soil chemistry should be corrected *prior* to the onset of fall. The purpose is to provide as close to ideal growing conditions as possible for renovation and seeding.

The renovation process should always begin with a soil test. An analysis of pH, nutrients (major and micronutrients), soil type, and bulk density is important in planning maintenance. Now is also an excellent time to check thatch/mat depth and take a soil profile to uncover any disruptive subsurface layers.

The goal is to have important nutrients *available* during the fall growing season for established and seedling turf. Acidity or alkalinity of soil can significantly reduce the availability of these nutrients. Based upon soil test recommendations, you may need to adjust pH levels with calcium carbonate (agricultural limestone) or dolomite limestone on acid soils, or sulfur on alkaline soils. The optimum pH range for most turfgrasses is from six to seven.

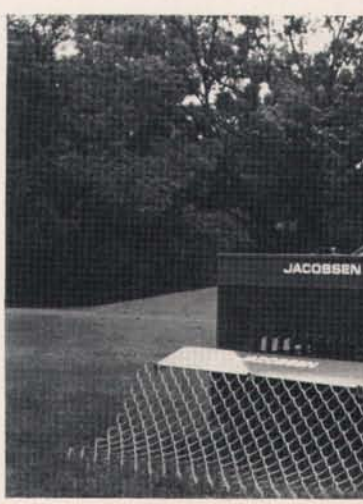
Nitrogen increases the growth of both turfgrass roots and shoots. It is essential for maintaining shoot density and gives turf the ability to recover from injury quickly. However, when too much nitrogen becomes available, root growth is restricted because shoot growth is favored over root growth. This can cause serious problems in the fall since it is a critical period for root growth and storage of food reserves. Lush, overfertilized turf is also prone to winter injury. Therefore, only moderate levels of quick-release nitrogen should be applied in the fall.

Phosphorus is perhaps the most important nutrient for renovated or seeded turfgrass in the fall. Unlike nitrogen and potassium, phosphorus does not leach into the soil. It has to be placed where it is needed. During the fall, that is on the surface for seedlings and in the root zone for established turf. Core aeration prior to applying phosphorus can assist in placing the nutrient where it is needed.

Phosphorus stimulates root growth and branching. It speeds up maturation of seedling turf and improves winter hardiness. The need for phosphorus in seedling turf is greatest in the first four to six weeks after planting. Turf can tolerate high levels of phosphorus without damage. However, such levels can reduce the availability of iron and hamper the effectiveness of the inorganic arsenical herbicides, such as DSMA and MSMA.

Turf utilizes more potassium than any other nutrient except nitrogen. It is subject to leaching, so regular applications are necessary to maintain adequate levels. Potassium plays a pivotal role in turf growth and development. Seedling turf has an especially great demand for the nutrient, and stores extra potassium for use later. Overall, potassium improves winter hardiness, wear tolerance, rooting, and disease resistance.

Since all three of these nutrients are vital during the fall, turf managers should either use complete fertilizers, nitrogen carriers that contain phosphate (monoammonium phosphate or diammonium phosphate) and



Jacobsen slicer/seeder for renovati

Major work such as drainage improvement is best performed in the fall. Photo courtesy: Cambridge Sportsturf Systems-West.

potassium (potassium nitrate), or supplement nitrogen applications with superphosphate and potassium sulphate.

The nutrient applied most frequently to sports turf besides the three mentioned above is iron. This metallic micronutrient plays an important role in photosynthesis and can have a dramatic effect on turf color. It can be used as a color enhancer to avoid the effects of using high rates of nitrogen.

Iron may be present in the soil but unavailable to the plant. Correcting soil alkalinity, improving drainage, and removing heavy thatch layers help to improve iron's availability. When these problems can't be resolved, foliar applications of iron can provide a short-term improvement in color. For long-term results, chelated forms of iron should be incorporated into the root zone when possible.

Soil tests will also reveal deficiencies in other nutrients. These include calcium, sulfur, magnesium, manganese, zinc, copper, boron and molybdenum. Many of these problems can be solved by correcting alkaline soil conditions. Fertilizers containing these nutrients are available. However, it is wise to contact your extension turf specialist for his or her recommendations.

An increasing amount of attention is being paid to the biological activity of soils. Recently, a number of universities initiated research on the effects of environmental and management stresses on soil microbes, bacteria, nematodes, insects, and earthworms in the soil. Scientists are evaluating the impact of soil moisture, pesticide applications, sand root zones, and other turf management practices on these organisms. "We need more information on the role these things play in our turf environment," states Keith Karnock, associate professor of agronomy at the University of Georgia in Athens.

One purpose of this research is to study the effectiveness of a number of "biostimulants" or "non-fertility growth enhancers" currently on the market. They include products such as PBI Gordon's Bovamura, Emerald Isle's Sand-Aid, Ringer's Restore, and Soil Technologies' Turftech. Testimonials of improved color, root growth, thatch reduction and even disease prevention have turf managers asking university specialists how these products perform. Some experts believe that organic fertilizers, especially activated sewage sludge products, also contribute to the biological activity of soils. To date, university researchers do not have definitive answers.

A lot of research is needed to get a clear picture of the effectiveness of non-fertility growth enhancers on various turf species, moisture conditions, soil temperatures, and time of year, adds Karnock. He suggests that turf managers conduct their own tests on small areas first. His results from a three-year test on bentgrasses will be ready next year. Dr. Dick Schmidt at Virginia Polytechnic Institute in Blacksburg, has also been conducting a number of tests in this area.

continued on page 30

ge areas.

Fall Renovation

continued from page 29

Excessive thatch, compaction, subsurface layers, hydrophobic soils and the coverage of irrigation systems are all items that should be corrected in late summer or early fall. They can disrupt or reduce the effectiveness of renovation procedures.

Since cool-season turfgrasses are in a recuperative state during the fall, the more severe operations are safest at this time. Practices such as verticutting, deep cultivation (fracturing subsurface soils), heavy aeration, amending soils, installing supplementary drainage, seeding and sodding can be accomplished with the greatest success. This is the time to spend your budget where it will have the most impact.

Due to the growth of the industry, a wealth of new technology is improving the effectiveness of renovation.

By utilizing these renovation methods safely in the fall, the higher cost of reconstruction can be avoided. Due to the growth of the golf and sports turf industries, a wealth of new technology today is improving the effectiveness of renovation as opposed to reconstruction. These procedures also reduce the amount of time a turf area is out of play.

Reconstruction is usually called for because original specifications and construction were inadequate. Barring complete replacement of the root zone, most deficiencies can be corrected today without reconstruction. However, the cost of the equipment necessary to perform things such as sand injection, deep cultivation, extensive trenching, pipe pulling and regrading is typically beyond the resources of any one sports complex. Fortunately, contractors in many areas are buying this equipment to perform these services for you.

A few examples of contract renovation devices are the units utilized to install the Cambridge System of sand slits and perforated drain lines, the Verti-Drain deep shatter aerator, the Green Care Drillmaster and Vibramaster, and the Yeager-Twose Turf Conditioner. These machines allow deeper cultivation of the root zone to improve drainage and aeration. They break through subsurface layers and encourage deep root growth.

Hydro Resources of Mesa, AZ, has just introduced a "no-till" subsurface injector for fertilizer and water-absorbent polymers. Vibrating blades cut beneath the surface and lift the soil so nozzles can inject granular material within the root zone instead of on the surface. The polymers store water and fertilizer in the root zone where they release them to roots upon demand. They swell and contract with moisture for a period of three years or longer before breaking down.

A vibratory plow is the same technology used to install the small drainpipe of the Cambridge System and fill the cut to the surface with sand. Sometimes referred to as sand injection, this process has been used to improve drainage on golf greens, fairways, and stadium fields with minimal surface disturbance.

An option to sand injection has been the use of prefabricated drain channels which are inserted into narrow trenches. This technology is available to anyone with access to a trencher. Disc-tooth trenchers are an economical alternative to conventional models and cut a narrower slit for the drain channels.

These drain channnels are usually placed in a herringbone pattern, similar to the branches extending out from the trunk of a tree. The spacing between the channels depends upon the type of soil and the amount of water you need to remove in a given period of time. The heavier the soil is, the closer the channels need to be to each other.

Back on the surface, sports turf managers can solve problems with depressions near goal mouths and worn out crowns of fields by topdressing, a technique used for years by golf course superintendents to keep greens smooth and firm. Topdressers are now available that can spread layers of material as thick as 1/4-inch evenly and quickly.

Regular topdressing of heavy play areas can avoid the expense of periodic regrading and reestablishment. The topdressing should be compatible with the root zone mix and the same material should be used each time to avoid layering. Core aeration prior to topdressing can help mix the material into the existing soil to improve drainage.

Water infiltration and percolation can also be improved by surface-applied wetting agents. They can be applied as granules or injected as liquids through the irrigation system. They are also effective for temporarily correcting localized dry spots and water-repellent thatch layers.

Of course, nothing will help moisture problems if the irrigation system does not provide uniform coverage. Check all heads and nozzles prior to renovation to assure an even distribution of water. For optimum fall root growth you want to provide moisture deep into the root zone. Repeat irrigation cycles and check moisture depth with a soil probe until you are certain that water has percolated down eight or more inches into the soil profile. This is your reservoir.

continued on page 32