sembled and moved inside the Pontiac Silverdome, the huge domed stadium where the Detroit Lions play football.

But this field isn't for American football. It's for the sport the world calls football but Americans call soccer. Only one game will be played on it this year, an exhibition match on June 19 between Germany and England. Then, after 15 days indoors, the turf will be taken outside and stored for 11 months, says Tom King, who is directing World Cup USA 1994 Inc. from the Silverdome.

Game Plans

In June of 1994, four World Cup Soccer games will be played on natural turf inside the Pontiac Silverdome. Not only did the United States, a country of mediocre status in the world soccer community, win the right to host this prestigious 52-game world playoff series, it gained approval to play four of the games indoors.

Never before has World Cup Soccer been played indoors. FIFA, the International Federation of Football Association, world soccer's ruling body, was convinced to allow it — with the condition that games be played on natural turf, not artificial. And the two men who sold the idea that it could be done were Michigan State University turfgrass researchers John "Trey" Rogers and Paul Rieke.

Since then, they have been working for about a year to solve the problems that come with growing grass indoors. That's the overall goal: to learn how to grow and maintain turf in indoor facilities.

"A few years ago, I made up a list of personal and professional goals I would like to accomplish in my life," says Rogers. "Among them was, 'Grow grass indoors for athletic events.'"

Right now, the goal is short-term — they just want to grow grass indoors long enough to play the games on a perfect soccer field. They need great grass for just a few days.

"When you've got one billion people who are going to observe the results of your efforts, there's a tremendous amount of pressure," says Rogers. (The last World Cup final game, when West Germany played Argentina in Italy, was watched on television by an estimated 1.5 billion people.)

Since grass doesn't get growing in Michigan until mid-April, it was decided that Pacific Earth Resources, and its subsidiary Pacific Sod, would grow sod in California and ship it to Michigan, where the scientists and soccer buffs would take over.

A key figure in this scenario is Rogers. The 33-year-old Arkansas native is the project's lead researcher at Michigan State University.

The Process

The sod was transplanted into about 2,000 mostly hexagonal metal boxes. The grass was laid onto 6 inches of topsoil made of eight parts sand, one part sandy loam and one part Michigan peat.

"You want a soil that is easily drained but not easily compacted," says Rogers. "You want it to resist compaction and have open pore space, but it must have stability, too. If the soil is too loose, it would be difficult to grow grass on it and would be easy to tear up."

The sod itself was grown from a blend of six varieties of seed. Three varieties of Kentucky bluegrass made up 85 percent of the mixture. The remaining 15 percent of the mixture is comprised of three perennial ryegrasses. Two varieties of each were chosen for sports tolerance and one of each for shade tolerance.

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World Cup Soccer
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Every soccer ball is covered with a skin of 32 hexagons and pentagons, which close into a perfect sphere. On a flat surface, hexagons alone work perfectly, six fitting around one. But the hexagonal shape wasn't chosen for its elegant soccer ball image. It was selected for the practical reason that three seams come together at a point, instead of four, as on a square. The field is expected to be tight.

The hexagonal boxes are each 7 1/2 feet in diameter. Each weighs approximately 3,000 pounds filled. About 2,000 boxes are needed to fill the Silverdome floor. The hexagons, like tiles, fit tightly together. The field edges are trimmed off with fill-in triangles to make the rectangle.

The hexagonal pans are made of two parts. The bottom pan is designed to be moved easily by fork lift. Around the pan top is a removable metal lip slightly larger than the pan. This allows the grass to overgrow slightly. When the lips are removed and the pans shoved together, the seams become invisible.

The grass will be moved into the Silverdome four days before the exhibition game on June 19. In those four days, it will knit together and be mowed before soccer field lines are painted on the field.

It will be left inside for a week after the game so the scientists can experiment and observe. What did 22 players running on the turf for two 45-minute halves do to the sod? Then the grass will be taken outdoors and stored for 11 months before the next soccer games, June 18, 22, 24 and 28, 1994.

Growing grass inside the Silverdome is a challenge. The inside of the domed stadium doesn't seem dark to the human eye, but grass sees it differently. Light that penetrates the Teflon-coated fiberglass dome is long-wavelength red light, and only about 10 percent of the outside light penetrates. Red light causes grass to grow long, spindly leaves and shallow roots. Shorter-wavelength light toward the blue end of the spectrum produces short, study growth and deep, strong roots that will stand up to athletics.

As part of this project, a 6,500-square-foot research dome nicknamed "Silverdome West" was constructed at MSU's Hancock Research Center in East Lansing, about 75 miles west of the Silverdome. The dome is a replica of the Silverdome, made of the same material, suspended the same way by fans that produce internal air pressure. Sod was inside the structure last November.

Part of the research was aimed at finding how much and what kind of supplemental, artificial light would be needed to maintain grass indoors for about two weeks. Studies were also done on water, fertility and growth regulators. It was expected that evaporation would be low, Rogers notes, but some water will have to be added over the top. Some nitrogen and potash will be needed to maintain soil fertility and help the turf recuperate after games.

Beyond Soccer

If this seems a bit much for five soccer games, Rogers and his colleagues are looking at a much bigger picture. "I think the Europeans might be the first to embrace the concept of growing grass indoors," says Rogers.

If the researcher and his colleagues can make grass grow indoors in the short-day seasons, it will be a major accomplishment. Rogers thinks he can make grass "survive but not thrive" for

35 days indoors with current knowledge and technique, but extending that to year-round will be a substantial challenge. The potential applications of developing science and technology for growing grass indoors are far reaching — indoor golf in the winter months is just one possibility.

"One of our objectives is to develop a list of recommendations for lawn care under shady conditions," says Rogers. "A number of golf courses already use plant growth regulators on problem areas, such as greens and shady spaces, but it's being done a 'best guess' basis. We think our research should provide some answers about how much to use under various conditions."

As World Cup 1994 nears, the pressure rises. Rogers, who once "lived" at Silverdome West, now "lives" at the real Silverdome. When the games begin, the world tunes in, and everything has to be perfect.

"Soccer is kind of changing my life," says Rogers.

If the Silverdome field performs to expectations, much more than that, in the world of indoor field-played athletics, may change as well. ❑

World Cup Overview: Big Numbers

World Cup Soccer 1994 is expected to bring billions of dollars into the United States — an estimated $120 million into the Pontiac area alone. That makes the $500,000 MSU research project for growing natural grass indoors seem like small potatoes. The project was funded by the MSU College of Agriculture and Natural Resources, the World Cup Soccer Committee, the state of Michigan and the Silverdome.

Michael Abington, the executive director of the Silverdome, thinks the 80,638-seat stadium may be filled for one or more games. On February 22, 1992, the U.S. team played the Commonwealth of Independent States team (the former Soviet Union) on artificial turf at the Silverdome. About 38,000 people watched the U.S. win, 2-1. Soccer fever hasn't reached the pitch in the United States that football fever has — or that soccer has abroad. However, preliminary World Cup ticket sales have exceeded expectations.

For the 1994 World Cup, 140 nations have entered teams, but only 24 will enter the World Cup round. Those 24 are being decided now, in some 500 qualification matches all over the world. The United States team will play because the U.S. is the host country. Germany will play because it is the defending champion. The other 22 teams must earn their right to play.

There are 52 games in the World Cup. The first round eliminates eight teams and results in 16 teams entering a single-elimination tournament. Semifinal winners play for the World Cup and second place. Semifinal losers play for third and fourth places.

Eight other U.S. cities will host games: Boston, Chicago, Washington, Orlando, San Francisco, Dallas, Los Angeles and New York/New Jersey.

Striping trial research at the University of California at Davis evaluates current striping techniques with one possible new approach, which involves the addition of a plant growth regulator (PGR) to the marking paint. Photos courtesy: Bob Milano.

Sports Field Marking:

Consider the Alternatives

By Bob Milano

Initial striping application.

A sports turf manager must strive for a smooth, uniform turf surface to provide maximum safety, playability and aesthetics. Yet today's turf managers face ever-increasing demands as the level of expectations for playing fields rises to meet those portrayed by televised sporting events, while, for most of us, resources to manage our facilities continue to diminish. Still, innovative sports turf professionals often manage to meet and exceed expectations.

Field marking and striping is an important aspect of a playing surface. Marking and striping are the final touches that transform a green canvas into a football field or baseball diamond. Striping is the key element that lays the framework and sets the tone for the entire facility.

Current Options

In most instances, there are three alternatives, sometimes used in combination, for field marking:

- White latex paint.
- Powder-type (chalk) materials.
- Herbicides (contact and systemic).

Latex paint provides an outstanding visual quality, optimum playability, excellent safety and good facility flexibility. In most cases, painted lines will be removed by normal maintenance activities in 10 to 14 days. Overall, painting is the preferred method, but it is also the most expensive. Materials, equipment and labor, combined with an average weekly application requirement, can stretch the average maintenance budget to the breaking point.

Powder-type marking materials generally have poor visual qualities on turf as the material sifts into the turf thatch and is easily disrupted by users, irrigation and maintenance activities. Although the material is reasonably safe, it can cause eye or skin irritation to event participants. It also can build up over time to damage the turf. One striking advantage of this method is flexibility. The chalk can be washed easily from the turf surface immediately after completion to accommodate a different activity.

Herbicides are the final and most widely used field marking material in California and other areas. Herbicide applications, both contact and systemic, result in adequate playability and moderate visual quality but in the long run have serious drawbacks. Although this technique at first may appear to be the most economical, it can reduce overall facility safety and limit facility flexibility. Converting a soccer layout to a softball layout may take weeks since new turf establishment in the bare lines will be required.

Problems and Solutions

The application of non-selective herbicides to sports field marking is in direct conflict with the primary function of field management: growing grass. Unfortunately, most limited resource agencies utilize glyphosate as field marking material for reasons of economics and convenience. Initially, this approach appears reasonable, but many times we fail to calculate the cost of increased user injuries, additional repair costs and an overall lower quality facility. Safety and increased attention by both recreational and competitive users will require all sports turf managers to respond to this challenge.

The eradication of turf strips for field marking creates "vegetationless" trenches. These bare areas are prone to erosion, slickness and hardness similar to most bare soil. Repeated applications transform the intended narrow 4-inch lines into larger, poor-draining bald areas or even deep ruts, thus magnifying the hazard. In most instances, these trenches are located at critical points on the playing surface such as the sideline, goal mouth or end zone, further increasing injury potential.

A study by the Sports Research Institute, the National Athletic Injury/Illness Reporting Service and Pennsylvania State University revealed:

• 20 percent of sports injuries are field-related.

• 44 percent of ankle, foot and knee injuries are field-related.

• 10 percent of sports-injury-related lawsuits claim inadequate maintenance.

Although striping and marking comprise only a small percentage of the entire turf playing surface, any reduction in injuries is beneficial. In addition, continued use of broad-spectrum herbicides for striping increases weed invasion into these areas, limits the flexibility of the facility, and will eventually require expensive turf renovation of the areas.

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Field Marking

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Facility managers must begin to factor in these costs when calculating the overall cost for field marking and striping until a better alternative is found.

One possible solution to this problem is now being studied at the University of California at Davis. In a joint effort, the Division of Plant Biology Cooperative Extension, UC Davis, UC Davis Grounds Division and the Sports Turf Managers Association are conducting a field trial. The research is evaluating the most prevalent current striping techniques with one possible new approach, which involves the addition of a plant growth regulator to the marking paint. The objective of this new approach is to extend the visibility of striping by slowing the growth rate of the painted turf, and thus the loss of painted turf to mowing.

Methods and Materials

A uniform tall fescue/bluegrass sports turf area adjacent to the UC Davis soccer field was selected for the trial. The work evaluates traditional marking compounds, including white latex paint, Diquat and glyphosate, with paint mixed with PRIMO plant growth regulator.

Evaluations were made utilizing light reflection values as a comparison tool. This method was selected to correspond with the function of the line, which is to provide a contrast with the turf and define an area or zone on the playing surface.

Preliminary Data and Observations

Although only a portion of this research is complete to date, a few early observations can be made:

- Fourteen days after the first treatment, the paint was only 26 percent lighter than untreated turf, while the PRIMO-modified painted turf ranged from 45 to 55 percent lighter (in essence, twice as visible).
- The PRIMO-modified paint applications were, statistically, significantly lighter than paint alone after repeated mowings.
- PRIMO-alone treatments showed no difference in turf coloration and light reflection.
- Some regrowth of desirable turf occurred in the Diquat-treated areas.
- As expected, the glyphosate application resulted in a 50-percent wider strip (plus or minus 6 inches).
- Weed invasion of the glyphosate lines is beginning.

Continuing Research

Although no final conclusions can be drawn at this time, the potential for growth regulators to be applied with latex paint for sports field marking looks bright. The preliminary data and visual observations clearly indicate that PRIMO is working and has the potential to help provide safer athletic fields. (However, the product is not currently registered for use in California and is only being researched and studied at this time.) In order for this technique to become common, the benefit it provides must be balanced by increased convenience and costs equal to, or less than, current modes. It's hoped that the results of the continuing research will help evaluate feasibility.

Field markings are as critical as uniformity, smoothness and texture of the overall turf surface. As turf managers, we must respond to challenges and provide the safest, most cost-efficient facilities possible. Specifically, we must evaluate our current marking techniques as part of our overall program and select the wisest approach. For example, chalk-type marking might be the most appropriate choice for a one-day soccer festival, while several light applications of Diquat on a practice football field might allow some regrowth for safety. Large trenches, devoid of vegetation, will soon become unacceptable from both a liability and user point of view.

We must all accept the challenge and consider this an opportunity to provide the safest, most playable and aesthetically pleasing facilities possible. I believe we can accomplish this through innovation and professionalism, combined with public and user educations. ❑

Editor's note: Bob Milano is grounds operations manager, UC Davis Physical Plant, and a board member of the national Sports Turf Managers Association.

This continuing cooperative research project is the result of ongoing commitment and effort from UC Davis' academic and maintenance staff. The author wishes to thank Clyde Elmore, UC Cooperative Extension weed specialist; John Roncoroni, staff research associate; Guy Kaiser, research assistant; Mark Lucas, athletic field groundskeeper; and Tony Franchi, student groundskeeper. All have contributed greatly to the project and its continued success.

Summer Patch Control: Departure From Folklore

By J.M. Vargas Jr.

Annual bluegrass was believed to die from high temperatures for many years. Research has since shown that annual bluegrass actually dies from three major pests in warm weather: anthracnose, the black turfgrass ataenius grub and summer patch.

The most devastating and most difficult to control of these is summer patch, caused by *Magnaporthe poae*. It is also a serious disease of Kentucky bluegrass when grown in areas of the world that have very warm summers; i.e., where the nighttime temperatures remain above 70 degrees Fahrenheit for a month or more.

Symptoms and Occurrence

The disease first appears in the warm weather of summer as yellow- to bronze-colored, irregular-shaped patches, ranging from 6 inches to 3 feet in diameter. Examination of the roots with a dissecting scope reveals dark-colored ectotrophic hyphae called "runner" hyphae.

Usually after a rainy period or heavy downpour, heavy or excess irrigation during the warm summer period will also bring on symptoms of the disease. Modeling studies have shown a direct correlation between moisture pushing the oxygen out of the soil and the development of symptoms. The other key factor for symptom development is having the soil temperature remain above 70 degrees F at a 2-inch depth for at least 48 hours.

Even though symptoms occur during the warm weather, the initial infection occurs in the spring of the year when the soil temperatures first reach 65 degrees F at a 2-inch depth. Only the outer cortical tissue of the root is infected at this time. *M. poae* remains in the cortical tissue causing little noticeable damage until the soil temperatures reach above 70 degrees F, and the rain or heavy irrigation regimes push the oxygen out of the soil. The lack of oxygen weakens the roots of the grass plant and allows the pathogen to invade the vascular tissue of the plant, where it interferes with water and nutrient uptake and the movement of photosynthesis products from the foliage to the roots.

Cultural Management

Managing summer patch with cultural practices requires a two-pronged approach. Maintaining adequate soil fertility, coupled with an adjustment of your irrigation schedule, will often result in adequate control.

Fertility. Good fertility starts with having adequate levels of all the nutrients present in the soil. Most of these can be applied based on soil tests. Nitrogen, of course, is the exception. Having adequate levels of nitrogen is not only important in managing summer patch, it is essential. Without adequate levels of nitrogen, even fungicide treatments will not be effective.

Research has clearly shown that to effectively manage summer patch, a half-pound of nitrogen per 1000 square feet every three weeks is required. The slow-release carriers like Turf Restore and IBDU have been more effective in managing summer patch than quick-release forms of nitrogen, like urea. In spite of "folklore" which suggests nitrogen should not be applied in the summer because it will only make the plant more susceptible to stress, research shows moderate levels of nitrogen to be essential in order to manage summer patch.

Irrigation. Light daily irrigation ranging in amounts from .1 to .4 inches (depending on the amount of supplemental rainfall, temperature and evapotranspiration) will help reduce the severity of summer patch. The most effective time to apply this irrigation water is mid to late afternoon. This allows time for the foliage to dry before entering the nighttime period. It also helps to cool the plant off during the warmest part of the day, to better allow it to survive the summer stress period.

This type of irrigation regime does not push the oxygen out of the soil, which will bring on summer patch symptoms.

What about the old theory that light daily irrigation will result in the turfgrass plant having a short root system? Like many of the turf management practices commonly recommended, it is based on "folklore" rather than good scientific data. Rhizotron and other studies have shown that soil *temperatures* during the warm summer months determine the length of root growth. Also, remember that we are recommending *light* daily irrigation, not to be confused with *heavy* daily irrigation. Heavy irrigation will deplete the soil of oxygen, resulting in plants that will definitely have short root systems.

Chemical Controls

For many years, trying to manage summer patch with fungicides proved to be erratic at best and futile the rest of the time. The key turned out to be timing.

The best fungicides for the management of summer patch are the sterol inhibitors; Bayleton and Rubigan, for example. But to be effective, they have to be applied before symptom development occurs.

Bayleton and Rubigan need to be applied as soon as the soil temperatures reach 65 degrees F, with a second application made 30 days later. In areas where summer lasts for more than three months, an additional application may have to be made 30 days later.

Once the disease symptoms are present, the benzimidazole fungicides, like Fungo 50 and Clearys 3336, managed the disease the best. However, some loss of turf is encountered when trying to manage summer patch curatively. A second application three weeks after is usually required with these fungicides. Remember, to be effective, these fungicides need to be drenched into the root zone.

Unless adequate levels of nitrogen are also applied, these fungicide treatments will not be effective. ❑

J.M. Vargas Jr. is a professor in the department of botany and plant pathology at Michigan State University.

Mark Satterfield, UC Davis irrigation technician, trouble-shoots a wiring problem with an irrigation control wire analyzer. Photos courtesy: Bob Milano. (Inset) Close-up of an irrigation control wire analyzer.

Take a Systematic Approach to Irrigation Trouble-Shooting

By Bob Milano

An outstanding sports turf irrigation system is like an outstanding umpire — the best of them work unnoticed. For field playability and aesthetic reasons, a sports turf irrigation system must be invisible at game time — all sprinkler heads must retract flush with the field, all valves buried beneath the soil, all controller neatly hidden from view. Like a great umpire, an irrigation system is meant to enhance the game, without intruding upon it.

Out of sight, however, doesn't mean out of mind, particularly for sports turf managers. For them, an irrigation system will always remain a complex network of underground pipes, valves, wires, sensors and sprinklers, the prime objective of which is to apply water to the turf as uniformly as possible. Even with today's sophisticated irrigation technology, that's easier said than done.

Systematic Analysis

The "perfect" irrigation system has yet to be installed, nor it is likely to be. Varying site conditions, soils, use, compaction, wind and construction tech-

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GETTING READY FOR A GAME
Hunter I-40s At Comiskey Park

In Chicago, White Sox turf manager Roger Bossard relies on Hunter I-40 sprinklers to keep his turf green and playable at the new Comiskey Park.

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Irrigation Trouble-Shooting
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niques will all influence the effectiveness of any irrigation system. As a result of these and numerous other factors, ongoing field adjustments and repair will always be required to attain the most beneficial water distribution.

To address the site variables and the numerous components of an irrigation system, only one strategy will work: a system analysis approach. A fully functional sports turf irrigation system is not a collection of unrelated parts and components. It is a fully interrelated composition of valves, screens, piping, pumps, nozzles, wires, sensors and control working in unison to evenly distribute water over the turf surface.

With all of these components and their various functions playing a role in the overall success of the system, the conclusion is only logical: When repairing, maintaining or trouble-shooting turf irrigation, the entire system must be considered.

Fielding Problems

Imagine a softball field that has several extremely dry hard spots. Dry spots are one of the most common, nagging problems in turf maintenance. Too often, the "solution" is simply to increase irrigation run times on the controller. Sometimes it works, sometimes it doesn't. However, this problem can almost always be solved by taking a step-by-step systematic approach, which enables you to pinpoint the problem and make informed decisions on potential solutions. Such an approach might include these steps:

- Inspect the area visually. Is there an obvious problem? Are the water requirements of the turf being met?
- Probe the "dry" areas. Are they actually dry?
- Test-operate the system from the controller. Does the system appear to be operating properly and as scheduled?
- Pressure-check the system at the sprinkler nozzle. Do any of the screens, filters of wye-strainers need cleaning?
- Measure and record the sprinkler head spacing distances. Do any of the spacings seem too close or too far apart?
- Perform a catch can test or a complete water audit if possible. Is the distribution obviously poor?

This systematic approach will yield quick identification of obvious problems, while simultaneously assuring that the other components of the system are operating properly. Most importantly, data is gathered to evaluate possible system adjustments or modifications.

Landscape irrigation systems, particularly those for athletic fields, must operate at peak efficiency for field safety, turf health and maximum aesthetic benefit.

Assuming that no blatant problems were discovered, the process can continue by utilizing gathered data (head spacing, operating pressures and distribution uniformity) to make adjustments to the equipment. These adjustments may include nozzles, flow controls or head spacing.

Lastly, these changes cannot be *assumed* correct. They must be re-evaluated and contrasted with the original data to verify that improvements to the water distribution were made.

Consider a soccer field, where the entire midfield area is dying. Entire portions of turf wilting and beginning to die, as if no matter has been applied, is another common sports turf problem. A systematic approach to this problem might include these steps:

- Visually inspect and probe the area. Is there an obvious problem?
- Test-operate the system from the controller. Do any or all of the stations operate?

Let's say you find that one valve will not operate. Continue the systematic process:

- Check the remote control valve flow. Is there a water supply to this valve?
- Operate the valve using the bleed screw. Does everything work normally?
- Use an irrigation control wire analyzer to determine the extent of the problem. Is the analyzer conclusive?

To continue resolving this problem, let's assume the remote control valve and the controller are in good working order. We had deduced through our investigation a single control wire to this valve is not functioning properly. Now we can continue with the scenario.

- Check wiring at the controller. Is it in good contact with the correct points?
- Visually check the wire splices at the control valve. Could simply resplicing solve the poor circuit connection?
- Visually inspect the site for any recent disturbances or activities that could have severed the control wire. Were there any recent excavations or paving repairs?
- Using a wire tracer or fault locator, identify the underground wire location or possible broken site or both. Is this information conclusive or simply a guess?

More often than not, an approach such as this will quickly and efficiently identify the problem so proper repairs can begin. In this case, we identified the broken wire in the trench line of a new underground street lighting circuit and spliced in a repair connection.

Because of our successful systematic trouble-shooting efforts, we were able to avoid "trying" other potential solutions to the problem. These alternatives included: placing a new underground control wire, installing a valve-double piece of equipment, wiring two valves together to operate simultaneously, or installing a battery-operated unit. None of these solutions were correct for this hypothetical situation.

Landscape irrigation systems, particularly those for athletic fields, must operate at peak efficiency for field safety, turf health and maximum aesthetic benefit. To achieve this objective, maintenance, repair and adjustments will be necessary, and the methodology used during these processes must involve a systematic approach.

Jack Miller, University of California at Davis landscape technician, simplifies this philosophy when he says, "Digging is the last thing you want to do!"

The step-by-step systematic approach to irrigation system maintenance, trouble-shooting and repair is not a "work avoidance" strategy — it's a reminder to carefully analyze and evaluate the problem using a total system approach before beginning repairs. By following this methodology you can eliminate unnecessary steps and false solutions, minimize work that provides no net benefit to the system as a whole, and provide a safe, playable and pleasing natural athletic surface by resolving the true problems of the system. ❑

Editor's note: Bob Milano is grounds operation manager, University of California at Davis Physical Plant, and a board member of the national Sports Turf Managers Association.