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Disabled golfer Tom Houston has been crusading to promote accessible golf since 1989.

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devices onto the greens so players can putt from them. That decision has been left to the Justice Department, according to Robb.

- At least 5 percent of practice tee areas must be accessible.
- No additional requirements are involved for spectators with disabilities attending a tournament or competition on a course. However, golfing facilities hosting such play "must comply with all other requirements of the ADA," which the guidelines describe as "the general obligation to provide an equal opportunity to individuals with disabilities to enjoy the services provided."

If these measures worry you now, you should've attended the early meetings on the issue. Architect Dick Phelps of Phelps Golf Course Design in Evergreen, Colo., was a member of the advisory group for the Access Board in the mid-1990s. Advocates for the disabled were thinking players in hand-operated wheelchairs would be rolling themselves up and down fairways, on to greens and even into bunkers.

"When we first started on this thing, it was a whole lot more restrictive than it eventually boiled down to be," Phelps recalls. "It was pretty scary."

Early conversations broached the idea of making every inch of a course accessible. Suggestions included capping cart paths at a 5-percent grade, making all bunkers playable for wheelchair golfers and other difficult course revisions. "The irony was that several of the disabled golfers on the committee were more moderate in their opinions" than others, Phelps says.

On the final guidelines, Phelps adds, "I think they're very fair, more fair than I thought we might have come up with."

He sees potential problems in sandy or swampy areas, where golf car accessibility might be hard to achieve. But in most areas, he says, providing access will not be difficult with today's earth-moving equipment. Single-rider cars — which are manufactured by several companies — have been tested on greens and found to apply no more pressure per square inch than the most popular mowers. "People walking on the green put down more foot-weight pressure than these things do," says Samuelson of the cars.

Since mowers must be driven onto the tees and greens, single-rider cars should be able to follow the same paths. "But tiered greens could be more of a challenge," Phelps notes.

He estimates that complying with the new ADA provisions may run up course-construction costs "a couple of percentage points," but notes that adding length to holes is a greater cost factor for today's course owners.

"I think it's up to the attitude of the architect," Phelps says. "If the architect says, 'Yeah, we can do that,' I don't think it's that difficult and it won't detract from the artistry of the golf course."

Other issues

Don Tolson was certified superintendent during the construction and opening of Fox Hollow, the highly rated public links course in Lakewood, Colo. (he has since moved to Stock Farm Club in Hamilton, Mont.). With Dennis Griffiths & Associates as architects, he helped plan Fox Hollow as a disabled-friendly course soon after ADA passed (it's been the site of an annual disabled golfers' tournament). When the course opened in 1992, at least two tees per hole and all greens were accessible. There were also no curbs on the cart paths to restrict disabled golfers and their cars, except where they were needed for drainage. All grades were set with an eye on access codes.

"If (a tee or green) was on a fairly steep grade, we started farther back with the path," Tolson says. "It didn't change irrigation patterns or mowing patterns or anything.

"It never added construction time or cost to the project. One of our goals in the beginning was to [build] it without compromising the quality and aesthetic aspects of the course — and we did that."

Disabled golfer Tom Houston, a 62-year-old 18-handicapper from Merritt Island, Fla., was also on the advisory group for the Access Board. He's been on a crusade to promote accessible golf since 1989 and has cajoled his way onto more than 600 courses in 49 states ("I won't take 'no' for an answer," he says). Houston, paralyzed from the waist down, developed his own wheelchair cart with 6-inch-wide front tires and 3-inch-wide back tires. He says he leaves no marks on tees or greens and can stay on top of most sand.

"I can play the whole game, which is important to me," Houston says. "Golf is a chance for a person with a disability to get out and play a game with able-bodied people and play it by the same rules." He says this is rare since most disabled people must play by "special rules."

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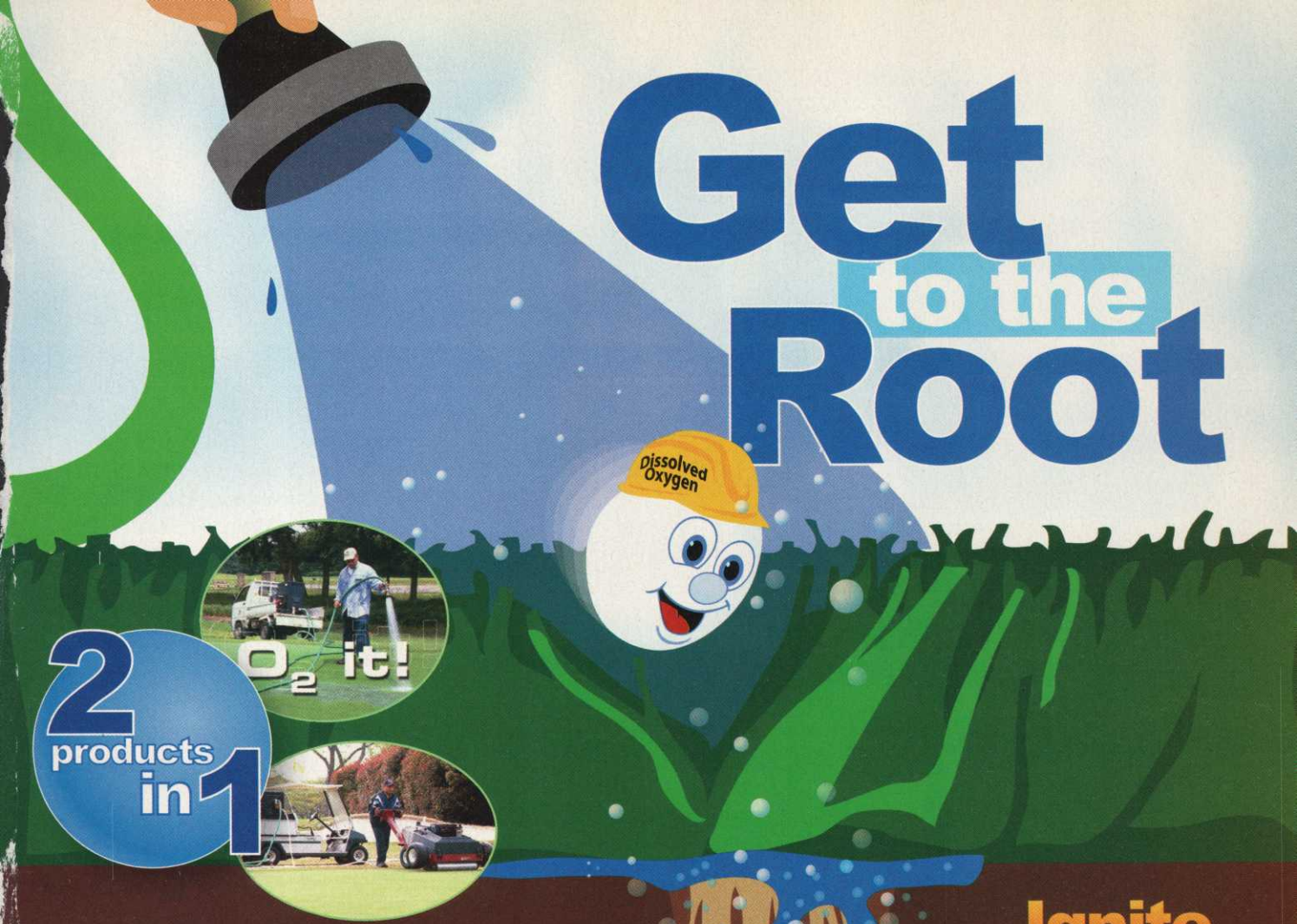
Get to the Root



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Is Your Course Accessible?

Advocates say golf is an inclusive sport for people with disabilities, including the blind.

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Houston maintains that compliance will not be that burdensome for golf courses, and he argues that the modifications allowing access to greens and tees, which flatten grades, will also benefit the growing number of senior golfers for whom steep grades can be a problem on foot. His biggest quibble with the new guidelines is that they do not stipulate the same access to bunkers. The Access Board reasoned that bunkers are hazards and not desirable places for golfers, but Houston has another take — his score is suffering when he must ask a playing partner to get his ball out of the sand for him. "I'm taking a penalty stroke when I shouldn't have to take a penalty stroke," he says.

Tolson says the only place Fox Hollow didn't succeed in its accessibility was the bunkers. Players there also must get someone else in their group to toss the ball out to them and take a stroke. He used his experience at the Colorado course to help in construction at Stock Farm. Though the Montana track is private and opened in 1999, before the recent new guidelines, it is set up with easy grades to accommodate older golfers with hip problems and other debilities. Tolson views the new ADA provisions as being in harmony with the need for all courses to accommodate the higher number of those golfers today, particularly seniors, who suffer from decreased mobility.

"What (golf courses) need to comply with is pretty much standard on most courses anyway— as long as they can comply with the philosophy of where people can drive [a car]," he says.

The biggest current controversy centers on the single-rider cars and their utility for a wide range of disabilities. Houston calls it "the unresolved part" of the access debate — specifically whether golf facilities must be required to keep single-rider cars in stock to accommodate a disabled golfer should one come to play. That decision lies in the hands of the Department of Justice, which has not made a ruling.

But a court ruling on golf courses operated by the city of Indianapolis took up the issue. In the accessibility settlement brought on by that case, the city was required to purchase and have on hand at least two single-rider cars for golfers who might need them. The two cars can be moved among the various municipal courses so that each one does not have to stock them. This decision may have set the stage for future rulings. "That doesn't mean it sets a total precedent . . . it's hard to say," Houston says.

Robb, the advocate for accessible golf, says that the Justice Department must rule on this and other issues such as whether all courses must allow single-rider cars on putting surfaces. Those rulings have yet to come. He says the department has indicated it will make the call on these access questions, but adds that "it is very possible that litigation will beat them to it."

Houston maintains that single-rider cars, unless they fit more disabled golfers in the future, are not the answer. He says there are too many individuals that can't use the cars because of their unique disabilities. "Maybe 10 percent of the paralyzed population could use one of these cars, and that's not a big enough percentage," he says. "We have to get to 50 percent."

Samuelson agrees that no one car can be fitted for every disabled golfer.

Houston suggests that disabled golfers obtain their own equipment and bring it to the courses. This also takes the burden off operators who might be forced to decide who can play safely on their courses or use course-supplied equipment if that is mandated.

"Pretty much everything you hear about single-riders are opinions and not based on any specific research results," Robb says. "It is a hot topic.

"Single-rider cars *do* provide greater access and, for some, are the only reasonable way to play. Unfortunately, we still do not have answers as to how many golfers will or could use them, as well as safety and training issues." ■

Allar is a free-lance writer from Floyds Knobs, Ind.

Learn More

For more information on accessibility issues, contact these Web sites:

www.accessgolf.org
National Alliance for Accessible Golf. The site offers a toolkit for golf course owners, operators and superintendents to assist in improving the accessibility of golf courses to golfers with disabilities.

www.ncaonline.org
National Center on Accessibility

http://golfcenterdisabilities.usga.org
USGA Resource Center for Individuals with Disabilities

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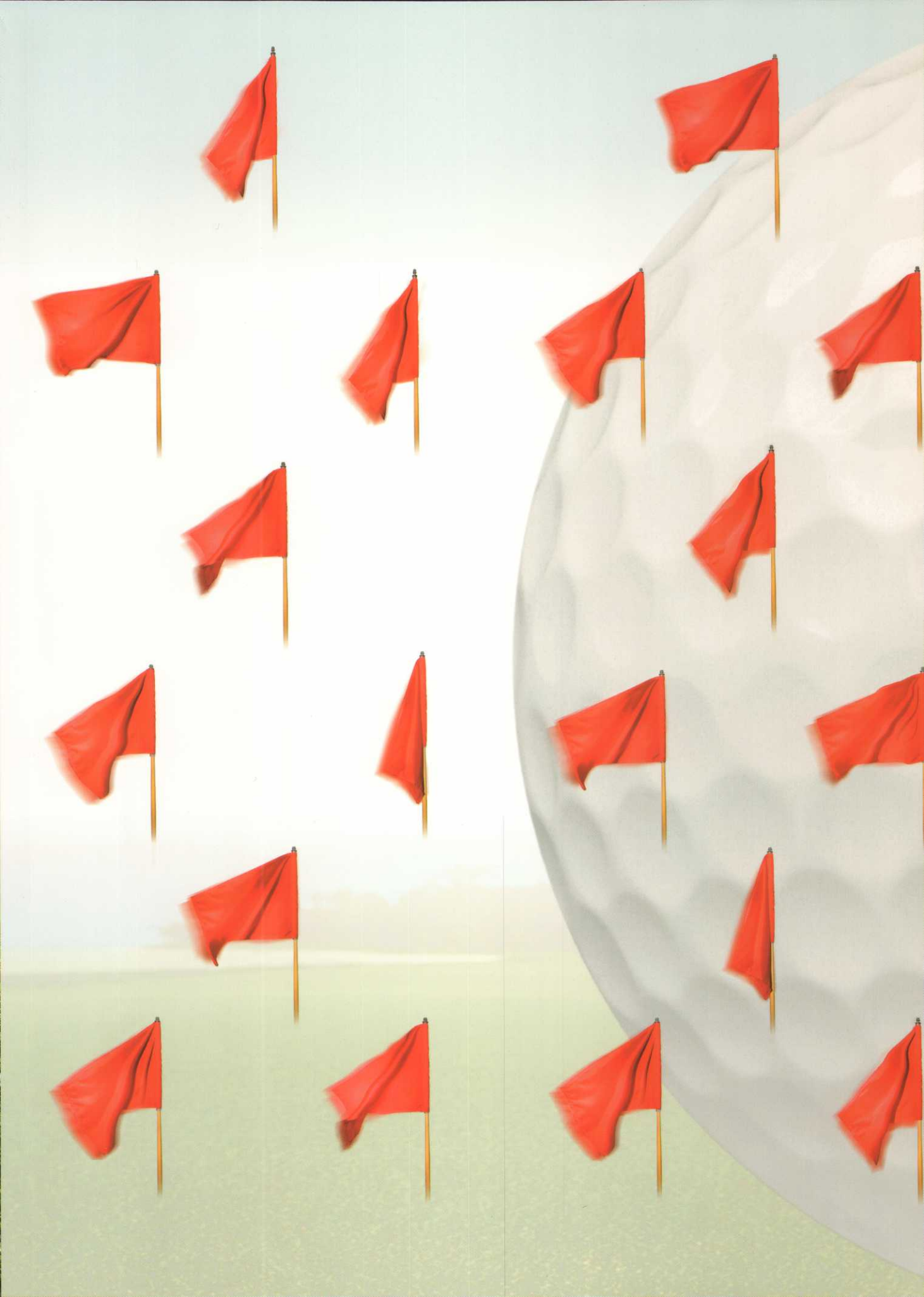

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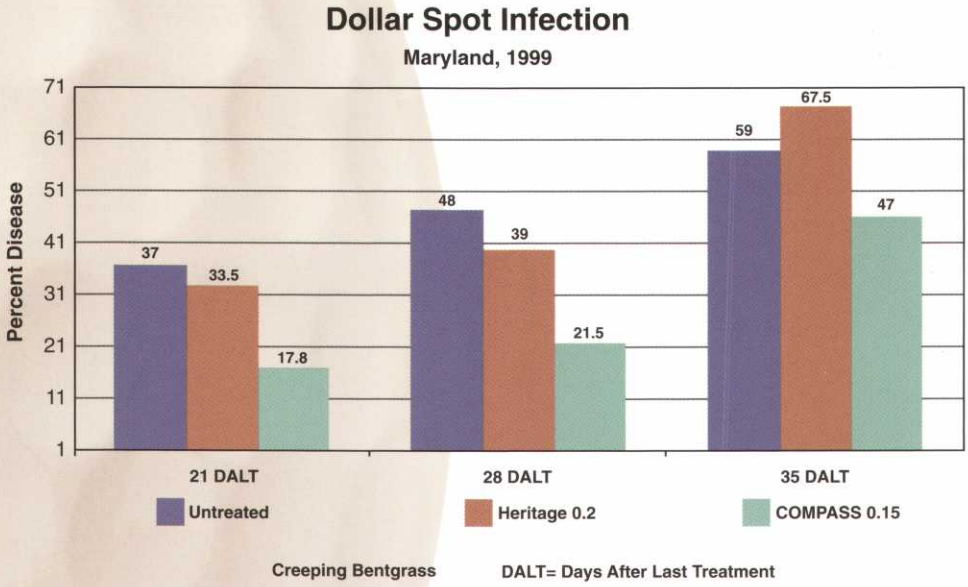

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IRRIGATION AIDS

Soil-Moisture Sensors Can Help Regulate Irrigation

By Dale Bremer and Jay Ham

Competition for water is increasing between industry, the environmental and the public. The subsequent rises in irrigation costs are compelling turf managers to reduce water consumption.

In highly managed turfgrass such as golf courses, managers are under pressure to maintain green, lush turfgrass regardless of weather or other environmental conditions, which sometimes results in frequent overwatering or inefficient use of irrigation water. Often, the decision to irrigate is based on incomplete information about the water requirements of turfgrasses, evapotranspiration (ET) rates, and available water in the root zone.

New technology, which includes advances in soil-moisture sensors, could improve irrigation efficiency by providing critical information from the root zone for irrigation management decisions.

Irrigation at golf courses will likely be controlled by complex central computers that use a combination of data from soil-moisture and weather station sensors to make irrigation decisions.

Traditional methods

Traditionally, turfgrass is irrigated through the experienced eye of the turf manager. This could include but is not limited to irrigating:

- at the first sign of wilt when the turf begins to change from a healthy green to a blue, gray or purplish hue;
- turf is slow to spring back when compressed by foot traffic or wheel traffic;
- when a narrowing of leaf blades is noticed; or
- when canopy temperatures climb above that of hydrated or well-watered turf. Placing a hand on well-watered turf and then on stressed turf can often sense the latter, which feels warmer.

Although these methods are relatively quick and easy and may be somewhat effective in maintaining green turf, they are also highly qualitative and do not result in the most efficient use of irrigation water (Waltz and McCarty 2000).

Basing irrigation on ET requirements is a quantitative method that is used by a number of turf managers. This method uses environmental data collected from on-site or nearby weather stations to estimate ET. The idea is to calculate daily ET using mathematical models. This estimate of ET is technically called "reference ET."

The reference ET is usually adjusted according to the requirements of a partic-

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ular turfgrass because different species of turfgrasses use differing amounts of water. The value becomes the basis for deciding how much irrigation to apply. The goal is to reduce the overapplication of irrigation water by applying only what the turf requires, which avoids excessive runoff and leaching below the root zone.

In terms of water savings, the ET method is generally an improvement compared to watering by frequency or even by experience. However, the ET method also has its limitations. Unfortunately, even our best estimates of ET are not completely accurate. Furthermore, when using the ET method, an equal amount of water is applied on all areas of the course, meaning allowances are not made for differences in slopes, variation in soil types or differing microclimates. All of these factors affect ET rates in turfgrass.

Studies show ET rates can vary as much as 20 percent in urban environments and on a golf course. The result is that water may be overapplied or underapplied.

University studies show that ET rates can vary as much as 20 percent in urban environments and on a single golf course (Feldhake et al. 1983; Jiang et al., 1998). The result is that water may be overapplied or underapplied in some areas.

Irrigation based on sensors

For turf managers, soil-moisture sensors are useful tools in irrigation management because they provide physical, quantitative measurements of soil water in the root zone. A network of automated permanent sensors installed throughout the irrigated area can provide real-time information on moisture conditions in all irrigation zones. Soil-moisture sensors can indicate when soil has dried to the point where irrigation is required.

These sensors can also indicate when the soil profile is full of water. The latter may be most useful in greens, where overwatering is the tendency. In this way, healthy turf is maintained by avoiding plant stress caused by soil that is too dry or too waterlogged.

Soil-moisture sensors also could be coordinated with nearby sprinkler heads, so irrigation amounts could be adjusted according to different water-use rates. Consequently, the incorporation of soil-moisture sensors into an irrigation management strategy may result in the conservation of costly irrigation water (Horst and Peterson, 1990).

Although the primary benefit of sensors is water conservation, they may also result in the improvement of water quality. By preventing overwatering, less water is lost to runoff and to deep percolation into the soil. Consequently, less pesticides and nutrients are transported into streams and groundwater supplies.

The improvement in water quality is an important benefit in an era of increasing public environmental awareness and regulations.

At Kansas State University, research is under way to control irrigation automatically using dual-probe heat capacity sensors, which is a new technology that provides measurements of soil-water content near the surface (Song et al., 1998)(Fig. 1).

These sensors are wired to a central computerized control system that can be programmed to trigger and curtail irrigation when soil water content reaches specific levels. All sensors in this study were built in the laboratories at Kansas State University.

Other soil-moisture sensors are available that also may be used to control irrigation automatically. For example, time domain transmission sensors and automated heat dissipation matric water potential sensors can measure soil water content at shallow depths and could be used to control irrigation.

Several factors must be determined when using soil-moisture sensors to control irrigation in turf. For example, the soil-moisture thresholds where irrigation should begin and end must be established, and these may vary among soil types and turf species.

Initially, correlations among soil-moisture, canopy temperatures and physiological stress (such as photosynthetic rates) will be investigated at Kansas State. These variables will be measured under different irrigation treatments where they are triggered at progressively lower levels of soil-moisture under turf at fairway height.