rolled up and stored away, and the court was played on in the summer as usual.

The next project was even more ambitious, covering three outdoor tennis courts instead of just one. Since then, Ralph and his associates have been involved in hundreds of air-supported structure projects throughout North America and around the world. And today, a three-court tennis dome would be considered a relatively small project compared to the very large field house domes that can cover as much as 100,000 square feet of interior space.

THE TECHNOLOGY

An air-supported structure, also known as a dome or a bubble, is a truly unique building system. The entire structure is supported by maintaining a slightly higher air pressure within the fabric membrane than the atmospheric pressure outside. This is achieved by an inflation fan constantly introducing fresh air to the interior of the structure.

The inflation unit that maintains the internal pressure of the dome is also a furnace, keeping the interior of the structure at a comfortable temperature. To ensure that dome remains inflated at all times, a standby inflation system is always ready to take over the inflation requirements, even during a power failure.

The interior lighting system is either comprised of fixtures installed on stands around the perimeter or hung from the fabric membrane, or a combination of both. The industry standard for sports lighting is 1,000 watt metal halide fixtures. These fixtures require a ballast to drive them, which can be placed around the perimeter of the interior, at the base of the light stand poles if applicable, or can be housed in a remote cabinet or other storage building outside of the dome. Several other technologies are being introduced as sports lighting solutions, which hopefully will eventually lead to energy savings without sacrificing light levels required for competitive sports.

The fabric membrane is manufactured using architectural grade vinyl coated polyester fabric, and the pattern is specific to every project to create the shape of the structure. This outer material is backed by a 15 to 20 year prorated warranty, and can

▲ **Main heat** and inflation unit and standby inflation fan (Greenville, PA).

be expected to last anywhere from 18 to 25 years before needing to be replaced. A liner fabric is added to the interior of the membrane to improve thermal and acoustic qualities. Insulation material is placed between the outer structural fabric and the inner liner fabric to maximize energy efficiency, bringing the equivalent insulation value from R2 to R10. On medium to large-sized domes, structural cables are installed over top of the fabric membrane to help stabilize it.

▲ **Interior view** of fabric connections for mechanical equipment and vehicle airlock (King City, ON).

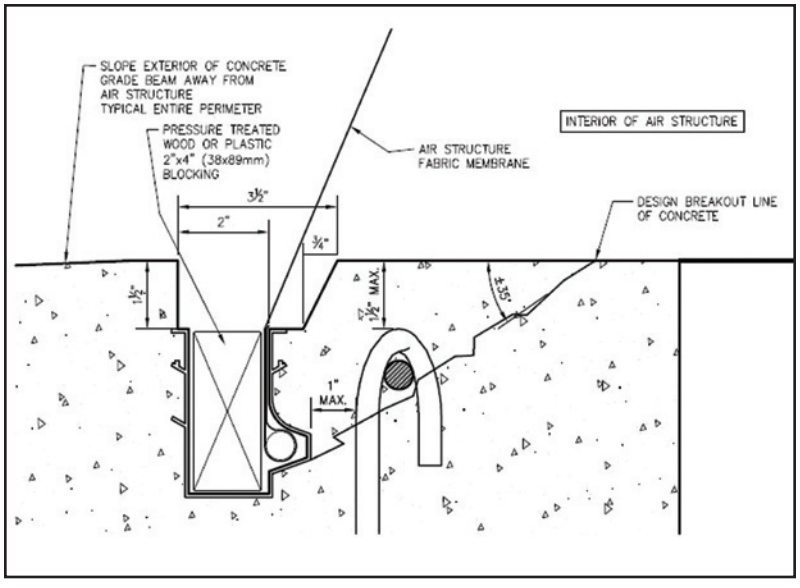


Figure 1

The shape of the dome's membrane adheres to certain design parameters, taking into consideration the wind loads and other climatic data of the site, and creating a curvature that promotes snow shedding off the sides and ends of the structure. If an air structure's height to width ratio is too low the top of the structure becomes too flat, allowing snow to accumulate and putting too much weight on the fabric membrane. To achieve the proper curvature, a dome's height at the peak typically needs to be 30% of the width of the structure, i.e., a dome that is 200 feet wide would be a minimum of 60 feet high at the curvature's apex.

Because this fabric membrane is supported by pressurizing the interior air space, a significant uplift load needs to be offset, which is accomplished by anchoring the membrane to a concrete grade beam around the perimeter of the dome. Soil friction and the weight of the concrete resist the uplift pressure that's created by inflating the dome. An aluminum channel is cast into the top of the grade beam, creating a profile that accepts the fabric membrane—that has a rope edge manufactured into it at the anchor point—and pressure treated lumber fits into the channel around the entire perimeter of the structure, locking the fabric membrane into the grade beam (Figure 1).

In order to maintain the internal air pressure, specially designed airlocks are installed to allow for easy access into the dome, including revolving doors, pedestrian airlocks for barrier free access, and vehicle airlocks for maintenance and lift equipment. Emergency exit doors are located around the perimeter of the structure in compliance with occupancy codes, and are only to be used during an emergency situation as they will allow the internal air pressure of the dome to escape.

CONSTRUCTION REQUIREMENTS

While overall project costs are indeed significantly less than a traditional building, site infrastructure costs, such as excavation and site preparation, parking lot requirements, storm water management, and the supply and distribution of electrical and natural gas utilities are required for an air structure just as they would be for any other type of building. Professional services required for site planning, such as architectural and engineering drawings and stamps, as well as the applications and approvals required with your local building department also need to be considered when planning your dome project.

One difference with the site infrastructure required for an air-supported structure is the installation of a concrete grade beam to hold the dome down, rather than a traditional foundation that supports the weight of the building on top of it. The design and engineering of the grade beam depends on the size of the dome and the wind loads of the site's location, as well as the soil conditions of the site. Once these factors are determined, the air structure manufacturer will design the anchoring system accordingly, including requirements for equipment pads for mechanical units and entrance and exit components, and will provide a set of construction drawings stamped by a qualified structural engineer.

With new projects, the concrete grade beam and other infrastructure required for the dome, including electrical and natural gas service and distribution are planned and constructed in conjunction with the rest of the site development. Whether or not the dome will be seasonal or year round will need to be considered during the planning stages of the project. There are some subtle changes to the design of the dome and its anchoring system between seasonal and permanent structures. Outside of the scope of the air structure and its related construction, however, is the requirement for field drain-

John Mascaro's Photo Quiz

Answers from page 25

John Mascaro is President of Turf-Tec International

The reason why this tent is on this college stadium turf is not for an event as you may have guessed; it is actually for logo painting. In this part of the country, rain is a natural way of life so sports turf managers and specialized athletic field maintenance companies have to come up with innovative ways to paint logos, even in inclement weather. At Oregon State University, this new infill field was installed with no center logo as the college was about to change the team logo and they did not have the final design when the field was delivered. The solution was to paint the center logo with temporary paint for a season until the final design was approved and could be ordered and inlaid into the carpet. In order to facilitate the paint drying process during the rain, they placed a portable tent over the area and used several large volume diesel fuel/electric indirect fired heaters to dry the paint. Careful monitoring of humidity was also key to allow the paint to dry quickly. Once the area was dry enough, they pick up the tent, move to a new location, and continue the painting process.

Photo submitted by Mike Hebrard, owner of Athletic Field Design in Oregon. Al Kirk is Sports Turf Manager at the Oregon State University in Corvallis.

If you would like to submit a photograph for John Mascaro's Photo Quiz please send it to John Mascaro, 1471 Capital Circle NW, Ste # 13, Tallahassee, FL 32303 call (850) 580-4026 or email to john@turf-tec.com. If your photograph is selected, you will receive full credit. All photos submitted will become property of SportsTurf magazine and the Sports Turf Managers Association.

▲ **Fabric membrane** being locked into anchoring system (Greenville, PA).

▲ **Dome spread out** and connected to the grade beam, beginning inflation (Greenville, PA).

age. Simply put, if the dome is going to be seasonal, field drainage will be required because the field will be open to the elements for part of the year; if the dome is going to stay up year round the field won't require this drainage infrastructure. When the dome and field are being constructed together in new developments, the final installation of the synthetic turf is typically completed after the air structure has been installed. The installation process with for the dome typically involves driving around the interior with heavy lift equipment, potentially damaging the brand new field. Of course, plywood can be laid down for the lift equipment to drive on if the field is installed first, or in the case of installing a dome on an existing field.

For existing fields, where the grade beam is installed around the outside of the field, the turf typically needs to be disturbed around the perimeter of the field to install the grade beam. Once the grade beam is completed, the turf is repaired and shored up to the edge of the new concrete, which is flush to grade for seasonal domes, leaving little evidence of it being installed, or it can be raised for permanently installed domes to create a curb on the outside that can be useful for a guideline when clearing snow in the winter time. The grade beam can also be installed across an existing turf field if the plan is to have a seasonal dome cover a portion of the field. Turf fill-in pieces can then be created to cover up the grade beam and allow for regular use when the dome is taken down for the summer.

INSTALLATION

Once the grade beam construction and all other site work is complete, the air-supported structure and its related components are ready to be installed. Depending on the size of the dome, the fabric membrane will be manufactured in as few as two to three or as many as eight to ten sections, which are folded and rolled up into bundles for shipping and ease of handling on site. These sections are unfolded, spread into place and connected to one another using aluminum joint plates.

The fabric membrane is then connected to the grade beam around the perimeter and locked into the anchoring channel. If applicable, the structural cables are laid in place and connected to

their anchors in the grade beam. The furnace and inflation equipment are connected to the duct work for the dome, which is either a fabric connection through the side of the dome or underground ducts from the equipment pad to floor grates inside the dome. Flip the switch to the inflation equipment and 1 to 2 hours later the dome is fully inflated.

The rest of the installation process includes placing and connecting all of the entrance and exit components to their fabric curtains on the dome, and installing the insulation material, interior lighting system, and divider netting or curtains. All in all, the initial installation process usually takes anywhere from 1 to 3 weeks, depending on the size and complexity of the air structure package.

Seasonal domes that are taken down in the spring and reinstalled in the fall basically go through the reverse of the process outlined above every spring and then repeat the process every fall. Of course, the seasonal ups and downs are more efficient than the initial installation, taking about a third of the time. The furnace and inflation equipment typically stays in place while the dome sections and the other attached components are stored away for the summer months. The cost associated with these seasonal take downs and reinstallations can add up for large full-field structures, given the man power and rental equipment required to accomplish the task.

OPERATING AND MAINTENANCE

Operating costs for an air-supported structure include electrical costs for the inflation equipment and the interior lighting system, and heat fuel costs for the furnace. Although air structures have a lower capital cost than traditional buildings and have the unique ability to be removed and reinstalled seasonally, they do require a slightly higher operating budget for utilities than other buildings that can be better insulated and don't require an electric fan for inflation. That being said, significant improvements have been made in the way of insulating the fabric membrane of an air structure with further innovations to this technology on the horizon.

A very important maintenance consideration is snow clearance around the perimeter of the dome. Because an air-supported structure is designed to shed the snow off the fabric membrane, the snow accumulates around the perimeter once it does. It's extremely important that the snow gets cleared away from the fabric membrane so it doesn't jeopardize the structural integrity of the dome.

Other maintenance required includes regular checks on the backup inflation equipment to ensure a seamless transition in the event of a power failure, as well as regular maintenance for all mechanical equipment associated with the air structure. ■

CELEBRATING 100 YEARS:

Lessons in Building a *Company That Lasts*

Tough times never last, but tough companies do. That's evident from the challenges Toro faced from the start. In Toro's first 30 years, the company's leaders navigated through the Great Depression and two world wars by staying true to the company's core ethics and values—and those principles have driven the company's longevity and success ever since. Here are some of the surprisingly simple strategies that have worked for Toro over its first 100 years:

Intense focus on solving customer problems, first and foremost.

Hard-sell tactics have never been part of Toro's culture; it has always been about finding out what the customer needs, meeting those needs and providing exemplary service. In fact, Toro got its start in the golf industry by listening and solving problems. Our first two prototypes (a fairway roller in 1918 and a fairway mower in 1919) came out of requests from golf clubs in Minneapolis. The staff at each club collaborated with Toro on a number of early products, offering input and helping to test equipment.

Taking care of the customer after the sale.

Toro co-founder and first president John Samuel Clapper thought that any manufacturer of a complicated piece of machinery should care more about that product*after* the sale than before. For the last century, Toro has done that in three key ways:

• Standing behind the product.

Toro assigned its first manufacturer service representative in the golf business in 1926. Mungo "Scotty" Reid McLaren was charged with traveling the country to visit every golf course that had purchased Toro equipment at least once a year. At each stop, he inspected the equipment with the crew, helped them fix any problems and provided much appreciated training.

That tradition of customer service continues today. In the words of a superintendent at a Country Club in Scotland, PA, "I can tell anyone considering purchasing Toro equipment, you won't go wrong. When I had a problem with my fairway unit, Toro took the high road, stood behind its product, and made me a loyal customer."

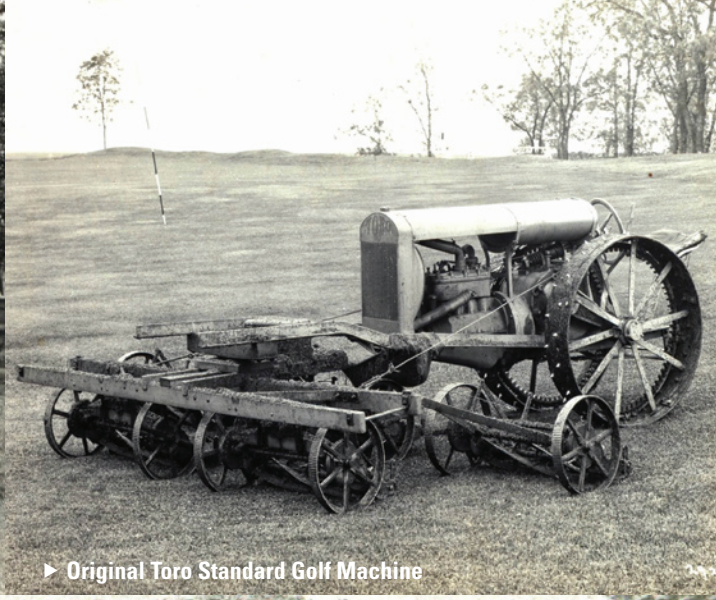
• Standing behind our distributor partners.

Scotty McLaren not only supported our customers, he also visited all of our distributors and trained them. To this day, we stand behind all of our distributors with ongoing training, exceptional parts fill rates, sales and technical support, warranty coverage and many other tools to help them provide the level of service our customers have come to know and trust.

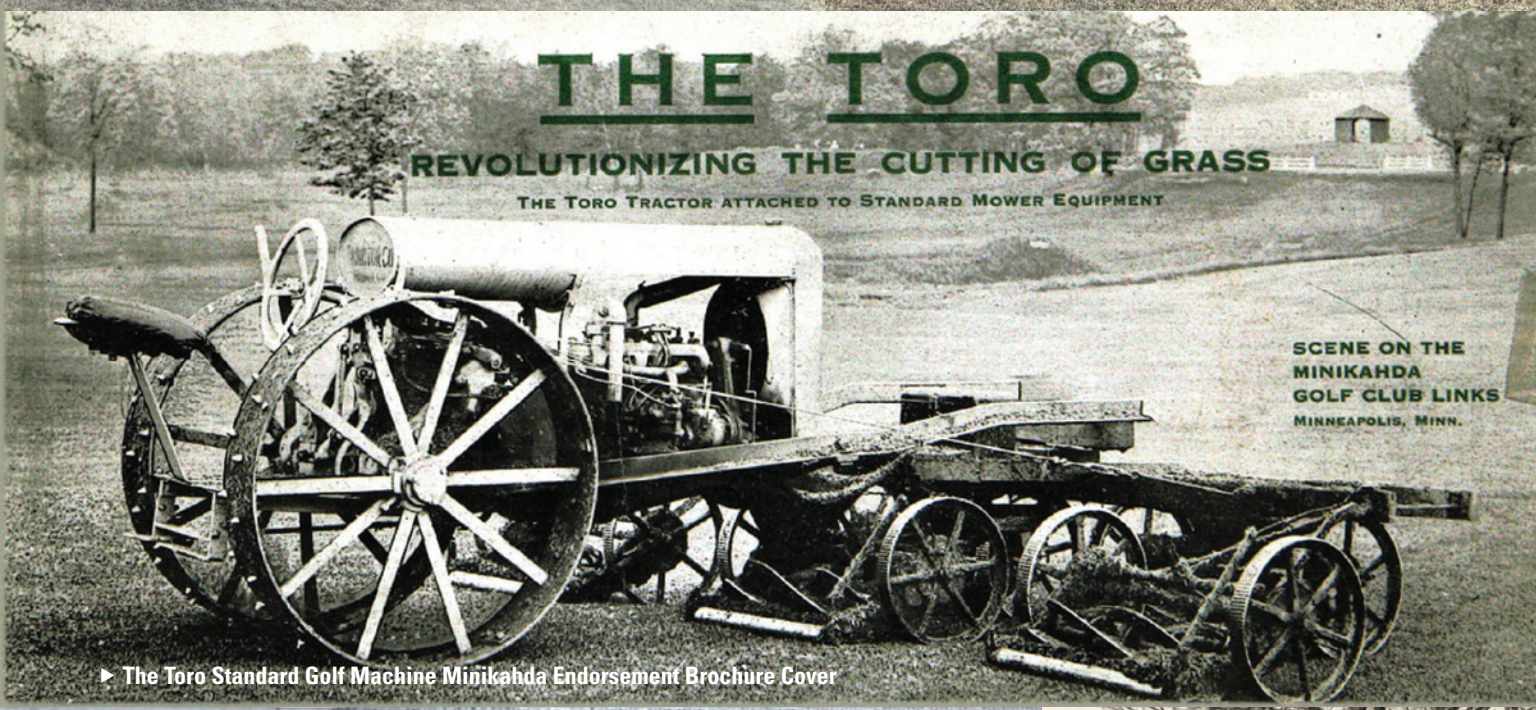
As another loyal Toro customer in Boone, NC stated, "It's truly a blessing to have dependable equipment in combination with exemplary service."

- John Clapper, Toro's first president, holds 16 patents for Toro innovations.
- In January 1929, just 10 months prior to the stock market collapse, Toro offered its first common stock to the public at $1.40 per share.
- During the war in 1942, the company made plans for additional manufacturing space and new products to prepare for the anticipated post-war boom of suburbia and demand for homeowner products.
- In 1951, Toro opened a new manufacturing plant in Windom, MN, to serve as a primary consumer products production facility.
- Agronomist James R. Watson, Ph.D., (1920-2013) joined Toro in 1952. Dr. Watson led a team of 25 scientists at Toro's R&D facility, conducting cutting-edge agronomic studies that significantly advanced turf care knowledge and helped revolutionize the industry. Dr. Watson became a living legend in the turf industry.
- In 1966, Toro helped prepare the field for Super Bowl I, forming a partnership that continues to this day.
- Toro traded stocks on the New York Stock Exchange for the first time in 1978.
- Building on the legacy of Dr. James Watson, Toro's Center for Advanced Turf Technology (CATT) was formed in 1998.

▶ 1921 model with new, flexible frame



▶ Original Toro Standard Golf Machine

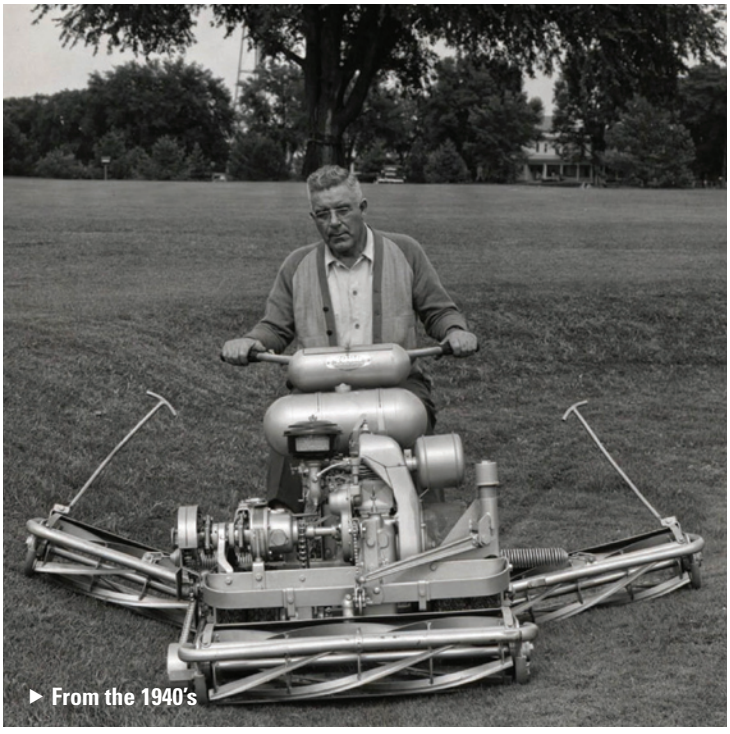


▶ The Toro Standard Golf Machine Minikahda Endorsement Brochure Cover

▶ 1929 distributor meeting

▶ From the 1930's


▶ From the 1940's


▶ From the 1940's

• Staying close to what's important to the customer.

Toro's third president, Ken Goit, once said, "The success of this company is no secret. It has been due to two simple things: building a good product and treating customers honestly and fairly." This fundamental approach has allowed Toro to reach our 100th year, and it's also how the company hopes to approach the future.

Every new product, feature and improvement we develop is driven by the need to make life easier and more productive for the people we serve. That attitude is reflected in comments from another superintendent at a country club in Warren, PA, as posted on the Toro Leaderboard: "It is obvious that Toro has listened to customer wishes and needs, and delivered us into a new era of precision mowing with 'all the fixins'!"

Providing exemplary expertise in sales and service and unparalleled local support.

Another loyal customer at a golf club in Mendham, NJ states that, "The expert sales staff at my Toro distributor gives me product support whenever I need it. That's why I love my Toro!"

The importance of local support permeates the fabric of The Toro Company and can be traced back to Clapper's foresight and belief that Toro should have a network to provide the local, expert service golf courses needed. The Toro Company set up their first distributor in 1922 and had 17 distributors by the end of 1925, providing a big competitive advantage as it relates to serving golf courses around the country. Our distributor network, to this day, continues to play a vital role in our business, delivering local support our customers depend on. Some of these distributorships are in their fourth generation with Toro.

Taking care of your employees.

Toro's focus on taking care of customers extends to their long history of taking care of employees. As Ken Melrose, Toro's eighth president, said, "We believe the single most important factor that influences our success as a company is the Toro employee."

Several of Toro's presidents were known for walking the plant to talk with workers regularly. They knew their employees' names and their families. An interesting example of how Toro stood out in support of their employees is that during the Great Depression, while many companies simply let go of employees, The Toro Company opted to cut back hours instead of jobs to keep people earning paychecks. Even in those early years, company leaders knew and acted upon the belief that people were our greatest asset.

Thanks to our customers for putting their trust in Toro!

Any company that lasts for a century must inevitably endure challenges, turning points and difficult economic times and learn from those experiences. The Toro Company has been able to overcome these trials and tribulations to achieve lasting success by focusing on, and not losing sight of, our core people and performance values and the true needs of our customers.

As we celebrate our centennial, we're not only looking back but also forward at new ways to take care of our customers honestly, fairly and ethically in the years to come. That means both our valued channel partners as well as end-user customers. For us, it's not just *what* we do, but *how* we do it that counts.

At the end of the day, it is our foundational values that extend from Toro through our Distributor Partners that have helped our company weather the test of time. And of course, it is only proper that we conclude by expressing our sincere thanks to all of our end-user customers for putting their trust in Toro.

TIMELINE

■ **1919:** Toro revolutionized the turf maintenance industry by mounting five mowers to the front of a farm tractor.

■ **1922:** Toro changed the way the industry serves customers with the first national golf distributor network.

■ **1928:** Toro developed the first electric-powered walk greensmower.

■ **1940:** The 76" Professional revolutionized mowing with cutting units on each side, often referred to as "wings," that adjusted to undulations in the turf and could be raised and lowered when transporting.

■ **1948:** Toro designed safer rotary mowers for homeowners after market studies discovered that many homeowners were afraid to use them.

■ **1952:** Toro invested in turf maintenance and agronomic research with the addition of James "Doc" Watson, and opening the world's first research and development center specializing in turfgrass science.

■ **1959:** Toro made bagging possible for the first time with wind tunnel technology that harnessed the airflow beneath the rotary mower.

■ **1964:** Toro pioneered the use of plastics in golf irrigation with the first valve-in-head sprinkler.

■ **1968:** First electric key start residential mower.

■ **1972:** Toro incorporated the use of hydraulics with reel and rotary mowers.

■ **1990:** Recycler mowers made bagging a thing of the past with mulching capabilities.

■ **1999:** Personal Pace system was developed – a self-propelled system that adjusts to the operator's desired speed.

■ **2010:** Toro eFlex was the first greensmower to run on Lithium-Ion battery technology.

■ **2013:** Reelmaster 3550-D was developed; the lightest fairway mower on the market

■ **2014 and beyond:** Toro promises more innovations to come in the next century with a continued passion for helping customers enrich the beauty, productivity and sustainability of the land.

FIELD PAINTING TIPS & DISASTER STORIES

What 3-4 factors do you consider most important for efficient and successful field and logo painting? What is the worst painting disaster you've ever been involved with or seen happen?

TODD TRIBBLE, Athletic Field Superintendent
Oklahoma State

I think using high quality paint, that is mixed correctly, has to be the most important step in having successful logos and lines. We use a national brand and dilute our white to a 50/50 ratio of water to concentrate which allows us to achieve 10 gallons of paint per 5 gallons purchased. I have found on our orange that it needs to be mixed with a bit more concentrate than a 50/50 or our logos come out a bit muted. We stir our paint using a cordless drill along with a paint paddle (~10$) available at most home improvement stores.

Strings and meticulous operators can really make your paint stand out for the right reasons. We string out every line we paint regardless of its visibility; this helps us ensure that our dimensions are not changing. I make sure our strings are pulled tight before a line is painted which helps prevent strings from "walking" or bowing on us. We generally have the same operators paint the soccer field and football fields as they know where any undulations are and can account for those areas as the painter is being pushed during the painting process. We always have a water source being either a 5-gallon bucket of water or a hose and coupler nearby in case of a spill, wind drift, or a poorly painted area.

As far as painting actual logos I feel like you are going to need two coats for the initial painting before fans see it. We will paint the first coat on a Thursday if we play on Friday at soccer and the second coat on game day. I have always felt like an initial coat of white as a base helps our orange appear brighter vs. using back to back coats of orange. If we play at home the following week we can usually get away with one paint application instead of two as a base coat is already down. When the team goes out of town we always paint the outline of the logo in white (using strings since our logo has straight edges) just to keep our edges crisp and dimensions where they were intended to be.

Lastly, we always make sure we are looking at the weather forecast 48 hours in advance if we know there is painting that needs to be done. Stillwater tends to be a very windy place so if we know our game is Friday and the wind will be blowing 20-30 mph we will avoid those types of days and paint the day before. We have the same outlook obviously with rain that may be in the area. We have used plywood to block the wind on days we have to paint foul lines and coaches boxes at baseball.

I think if you plan beforehand and have a routine in place before you set up your painters most problems can be avoided. The final process in field preparation is lining and logos and will most often be what your fans, coaches, and administrators notice before anything else. Paint applications are really the finishing touches on your field so we try and nail this portion of the set-up each and every time.

KEVIN MALONE, CSFM
The LandTek Group

I've only done a small amount of line painting and logos. But I can say that these would be most important to me:

■ Using a quality sprayer