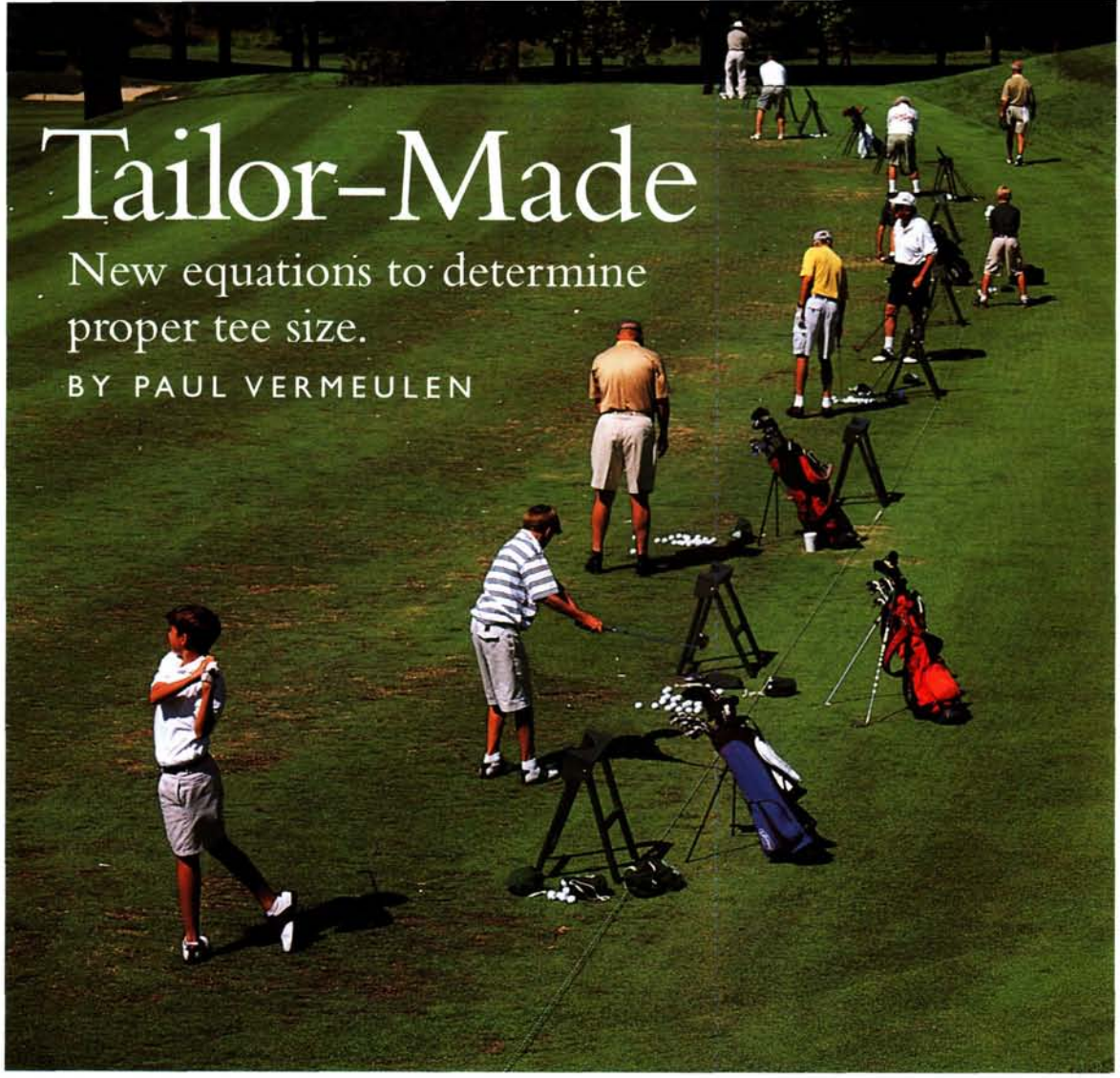
Tailor-Made

New equations to determine proper tee size.

BY PAUL VERMEULEN



The correct size of a driving range tee can be calculated using the stall dimensions, ratio of stall area damaged over total stall area, weekly rotation frequency, divot recovery rate, and needed number of stalls during the peak golfing season.

Standing on the first tee of your favorite course without grass underfoot would be a disappointment, to say the least. There was a time, however, when that was exactly how the game commonly was played. Before the development of improved turfgrasses, golfers used to step onto a bare teeing area, reach into a large box (appropriately called a teebox), and grab a handful of sand to build a small mound on which to tee up their ball.

With the care of these old tees being relatively straightforward (i.e., the only routine maintenance was to refill the teeboxes every few days), why is it then that green committees all over the globe chose to switch to turf? Although the exact reason may never be known, it is probably safe to assume that golfers complained about the bare tees being unplayable after a heavy rain because the ground turned to mud. (Or perhaps it was that superintendents got tired of golfers complaining about their tee shots going off-line because the sand in the tee boxes was inconsistent!) In any event, today's golfer is much more sophisticated, or pampered, depending on how you look at the situation, than those of yesteryear.

As a result of watching endless hours of made-for-TV golf, most golfers would feel cheated if they had to swing their $500 metal drivers on a turfless tee. The lopsided educational experience of TV golf typically shows well-dressed touring professionals playing on large, perfectly groomed teeing surfaces surrounded by cheering fans from all walks of life. After exposure to such idyllic scenery, who among us would not lose their sense of reality?

In defense of golfers, however, one must concede that the opportunity to play on 18 well-manicured tees is not an unreasonable expectation. Given the right circumstances, a superintendent should have little difficulty maintaining a good stand of turf throughout the golfing season. The problem is that most golfers cannot tell the difference between the right circumstances and circumstances beyond the superintendent's control when it comes to bare ground showing up in the middle of the tees.

The cold truth is that the circumstances involving televised golf are rarely identical to the circumstances of golf at the local course. Here, one can find superintendents having difficulty maintaining turf on the tees because they are too small to support the number of rounds being played. More specifically, the usable square footage of the tees is inadequate, thus dictating the reuse of a teeing area battered by concentrated divot removal before it has had time to fully recover. As the golfing season progresses, the turf gets thinner and thinner from continual reuse and, at some point, golfers suddenly start complaining about poor maintenance.

When faced with the problem of tattered tees resulting from limited area, the real question at hand is not what is wrong with the maintenance program, but rather how much larger does each tee need to be so that it can be maintained successfully. A search of articles written on the topic of proper tee sizing reveals a general rule of thumb in *Golf Course Design and Construction*, available from the National Golf Foundation (NGF). This rule states that tees should have 100 to 200 square feet of usable space for every 1,000 rounds of golf played annually. Applying this rule to a course that hosts an average of 40,000 rounds per year suggests that the tees should range in size from 4,000 to 8,000 square feet.

While at first glance this rule of thumb seems both straightforward and practical, close examination exposes several serious flaws. First, the rule of thumb does not specifically take into consideration the par value and number of each hole.

The difference in par value is very significant, as golfers commonly use an iron on a par-3 hole and a driver or fairway wood on both par-4 and 5 holes. When golfers swing irons, they tend to remove a divot that grows in size as the loft of the club increases. Thus, more area is required to maintain a par-3 tee in good condition than a par-4 or 5 tee. The number of the hole is also significant, as golfers tend to take numerous practice swings and/or the occasional mulligan on the first and tenth holes, dictating the need for more square footage.

Second, the rule of thumb underestimates the square footage for golf courses that host a moderate number of rounds during a three- to four-month season and overestimates the square

The installation of an artificial surface is necessary when the lack of real estate prevents tee expansion.

footage for those that host a large number of rounds throughout the entire year. For example, the rule simply suggests that a course hosting 14,000 rounds per year should have tees that range in size from 1,400 to 2,800 square feet. If this same course were to divide the square footage into three multiple tees on each hole and host the majority of its annual rounds during the summer, i.e., 100 rounds per day, then many of the small individual tees would end up being severely worn halfway through the golfing season. To make matters worse, many of the individual tees would be too small to maintain with a riding mower.

In another example, the rule suggests that a course hosting 90,000 rounds per year should have tees that range in size from 9,000 to 18,000 square feet, a very broad range indeed. Dividing the large square footage into three or even five multiple tees would not be a problem, but maintaining somewhere in the neighborhood of six acres of teeing ground on a heavily played course would certainly be time consuming. Furthermore, since the only regions where 90,000-plus rounds can be played in a 12-month period are where warm-season species grow vigorously most of the time, the excessive square footage would not be needed because the teeing surfaces would heal relatively quickly.

Lastly, the rule of thumb offers no guidance for the proper sizing of driving range tees. In the absence of such information, most courses across the United States have grossly undersized driving range tees that are a constant source of aggravation for golfers, the golf course superintendent, and governing course officials. In most cases, the greatest source of aggravation is the fact that the size of a small range tee cannot be increased due to an absence of available real estate.

After identifying the weaknesses of the rule of thumb published by NGF, the task at hand is to develop a set of equations that accurately accounts for the many different circumstances across the United States. To do this, the best place to start is to establish a minimum size requirement for golf courses that host a very small number of rounds, either seasonally or annually. This minimum size requirement must take into consideration two basic design criteria to be applicable across a broad range of circumstances.

First, nearly all courses are now designed with three or more multiple tees on each hole to accommodate golfers of all skill levels by varying

As a result of watching endless hours of made-for-TV golf, most golfers would feel cheated if they had to swing their $500 metal drivers on a teeing surface composed of bare soil and weeds. Without adequate square footage, however, such unpleasant circumstances cannot be avoided.

Maintaining good turf on tees is impossible when the usable square footage is inadequate. The real question at hand is not what's wrong with the maintenance program, but rather how much larger does the tee need to be so that it can be maintained successfully.

the total length of the course. Second, to maintain courses in an efficient manner, each individual tee should be at least 800 square feet so that they can be easily mowed with a riding mower. Based on these basic design criteria and the fact that par-3 tees and the first and tenth tees require additional square footage, minimum tee sizes can be intuitively set as follows:

Hole	Forward Tee	Middle Tee	Back Tee	Total
Par 3	800 ft^2	2,000 ft^2	800 ft^2	3,600 ft^2
Par 4 & 5	800 ft^2	1,400 ft^2	800 ft^2	3,000 ft^2
Nos. 1 & 10	800 ft^2	1,800 ft^2	800 ft^2	3,400 ft^2

Next, a multiplier must be established that determines the necessary increase in square footage based on play volume. This multiplier must take into account several factors. First, the total size of the tees must increase in proportion to the volume of daily play during the peak golfing season. By using daily play figures during the peak golfing season rather than annual play figures, as is done in the NGF publication, the multiplier will yield more accurate results by taking into account the specific time frame when problems on the tees are most likely to occur. Second, the area of turf damaged by both divot removal and the scuffing of golfers' feet during the normal act of swinging a club conservatively equals 0.6 square feet for par-3 holes and 0.4 square feet for par-4 and 5 holes and tees Nos. 1 and 10.

By taking into consideration basic design criteria and the need for a multiplier that increases square footage based on daily play, the following equation for determining tee size can be written:

$$y = (z)(m)(x) + (b)$$

Variable	Definition	Units
y	needed square footage for a tee	ft^2
z	area damaged per round	ft^2/round
m	days to full divot recovery	days
x	average number of rounds per day	rounds
b	minimum square footage value	ft^2

As an example, this equation can be used to determine the needed square footage for a typical course that hosts 200 rounds per day during the peak golfing season and promotes full divot recovery in 30 days using standard maintenance procedures. These values are calculated as follows:

Par-3 Tees

$$7{,}200\ ft^2 = \frac{0.6\ ft^2}{1\ round} \times 30\ days \times \frac{200\ rounds}{1\ day} + 3{,}600\ ft^2$$

Par-4 & 5 Tees

$$5{,}400\ ft^2 = \frac{0.4\ ft^2}{1\ round} \times 30\ days \times \frac{200\ rounds}{1\ day} + 3{,}000\ ft^2$$

Tees Nos. 1 & 10

$$5{,}800\ ft^2 = \frac{0.4\ ft^2}{1\ round} \times 30\ days \times \frac{200\ rounds}{1\ day} + 3{,}400\ ft^2$$

As a quick reference, a summary of tee sizes based on an area of damaged turf per round of 0.6 ft^2 for par-3 holes and 0.4 ft^2 for par-4 and 5 holes and tees Nos. 1 and 10, a 30-day divot recovery period, and minimum square footage values is presented in Table 1.

Once the square footage needed to successfully maintain the tees is determined, the final step is to subdivide and determine the value for each

individual multiple tee on each hole. As a guideline, the percentage of golfers playing from each set of tee markers should be used. Using the previous example, if 13% of the golfers play from the back tees, 69% play from the middle tees, and 18% play from the forward tees, then the square footage for each tee on a given hole should be divided as follows:

Hole	Total Square Footage	Back Tee	Middle Tee	Forward Tee
Par 3	7,200	936 (7,200 × 13%)	4,968 (7,200 × 69%)	1,296 (7,200 × 18%)
Par 4 & 5	5,400	702* (5,400 × 13%)	3,726 (5,400 × 69%)	972 (5,400 × 18%)
Nos. 1 & 10	5,800	754* (5,800 × 13%)	4,002 (5,800 × 69%)	1,044 (5,800 × 18%)

**For ease of maintenance, the square footage of an individual tee should be increased to a minimum of 800 ft² without reducing the needed square footage of other tees on the same hole.*

DRIVING RANGE TEES

Having established a set of equations for determining the proper size of the tees on the course, the only remaining task is to do the same for the driving range tee. The circumstances are a little bit different, but the basic approach to the problem should be the same. In short, the equation should take into account the area of turf damaged on a daily basis during the peak golfing season and the general rate of divot recovery.

The dimensions of the area of turf damaged on a daily basis can be determined given that golfers typically concentrate their use in the forward three-quarters of each stall to avoid hitting other golfers practicing in neighboring stalls. For example, if the dimensions of a driving range stall are 10 feet wide by 8 feet deep and golfers typically concentrate their use in the forward three-quarters, then the area of damaged turf is equal to 60 ft² (10 ft × 8 ft × ¾ = 60 ft²).

The rate of divot recovery on a driving range tee is appreciably slower than for the tees located on the course. The difference between the two is due to the severity of turf damage on driving range tees. When golfers practice within the confines of a stall, they remove divots from an area until the turf has been all but completely harvested. With so little vegetation left behind, recovery from underground portions of the remaining plant material or from seed takes much longer.

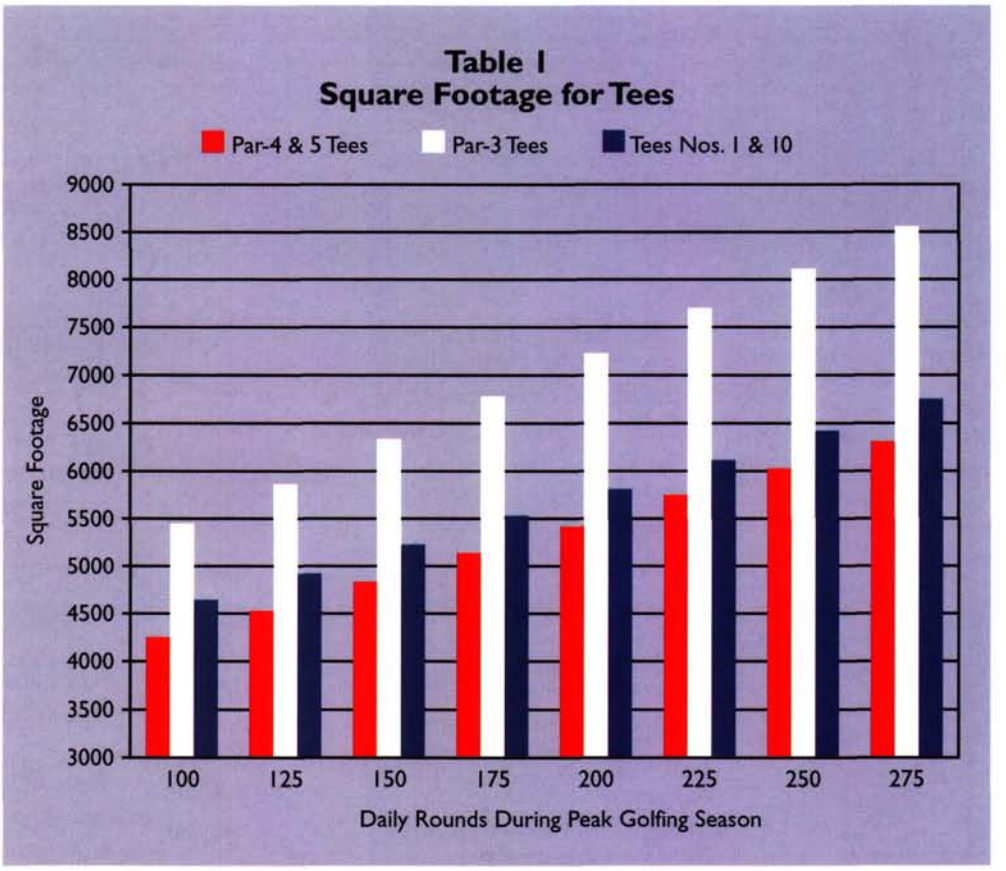
By knowing the area of turf damaged on a daily basis during the peak golfing season and the general rate of divot recovery, the following equation for determining the size of a driving range tee can be written:

$$y = (z)(d)(q)(m)(x)$$

Variable	Definition	Units
y	square footage of driving range tee	ft²
z	square footage of individual driving range stalls	ft²
d	ratio of stall area damaged over total stall area	ft²/ft²
q	weekly rotation frequency	days/7 days
m	days to full divot recovery	days
x	number of stalls needed per day during peak golfing season	stalls/day

As an example, the above equation can be used to determine the needed square footage for a typical driving range tee where 14 stalls measuring 10 ft by 8 ft are needed, the ratio of stall area

A summary of tee sizes based on the area of damaged turf per round, a 30-day divot recovery period, and minimum square footage values.



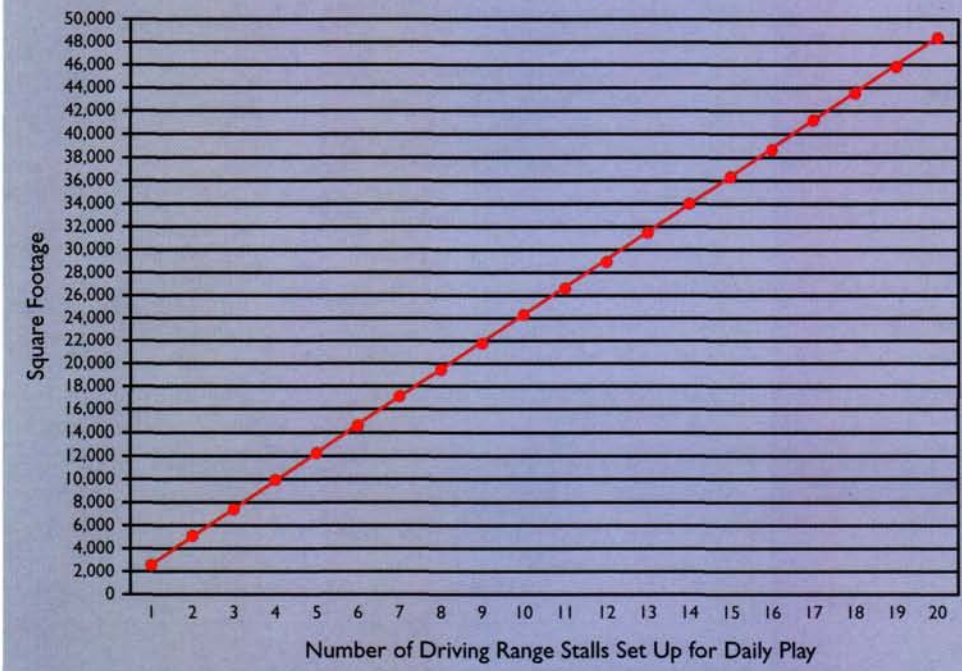
damaged over total stall area is 3 ft^2 over 4 ft^2, the stalls are rotated daily, and full divot recovery is promoted in 40 days. This value is calculated as follows:

Driving Range Tee

$$33{,}600\ ft^2 = \frac{(10\ ft \times 8\ ft)}{1\ stall} \times \frac{3\ ft^2}{4\ ft^2} \times \frac{7\ days}{7\ days} \times 40\ days \times \frac{14\ stalls}{1\ day}$$

As a quick reference, a summary of driving range tee sizes based on a standard 10 ft by 8 ft stall size, a ratio of 3 ft^2 of damaged area per 4 ft^2 of available space, daily stall rotation, and a 40-day recovery period is presented in Table 2.

Table 2
Square Footage for Driving Range Tee



A summary of driving range tee sizes based on a standard 10 ft by 8 ft stall size, a ratio of 3 ft^2 of damaged area per 4 ft^2 of available space, daily stall rotation, and a 40-day divot recovery period.

In addition to calculating driving range tee size, the equation can also be used to document the need for an artificial surface by solving for days available for full divot recovery and then subtracting this value from the actual number of days needed for full divot recovery as determined by on-site testing. For example, a course with the following circumstances:

Area of driving range tee	15,000 ft^2
Dimensions of individual driving range stall	12 ft × 8 ft
Ratio of stall area damaged by divot removal	3 ft^2 / 4 ft^2
Weekly rotation frequency	4 days / 7 days
Number of stalls needed per day during peak golfing season	14 stalls / day

The value for days available for full divot recovery is calculated as follows:

$$\frac{15{,}000\ ft^2}{\frac{(12\ ft \times 8\ ft)}{1\ stall} \times \frac{3\ ft^2}{4\ ft^2} \times \frac{4\ days}{7\ days} \times \frac{14\ stalls}{1\ day}} = \text{approx. } 26\ days$$

Taking this value and subtracting it from the actual number of days needed for full divot recovery as determined by on-site testing, e.g. 40 days, equals a shortfall of 14 days. In other words, the turf on the driving range tee will be harvested 14 days before full divot recovery can be promoted by routine maintenance procedures. This being the case, it can be documented that an artificial surface must be used 14 days out of every 40 days during the peak golfing season to successfully maintain the driving range tee.

If the equation is not used to document the need for an artificial surface, then, at a minimum, it can be used to calculate the maximum number of stalls that can be set up during the peak golfing season without causing the premature harvest of turf. This can be done by using the actual divot recovery period determined by on-site testing and solving for the number of driving range stalls needed on a daily basis. Using the same information as in the last example, the number of driving range stalls needed on a daily basis is calculated as follows:

$$\frac{15{,}000\ ft^2}{\frac{(12\ ft \times 8\ ft)}{1\ stall} \times \frac{3\ ft^2}{4\ ft^2} \times \frac{4\ days}{7\ days} \times 40\ days} = \text{approx. } 9\ stalls$$

In conclusion, since the very first day golf was played on grass tees, many superintendents have had to explain repeatedly why the centers tend to go bald during the peak golfing season. When faced with such unpleasant duties, try using new math to solve an old problem.

REFERENCE

Georgiady, P. 1997. In the Beginning. *Golf Journal*. L(8):20-23.

PAUL VERMEULEN *is the Director of the Mid-Continent Region and concentrates his Turf Advisory Service visits in Illinois, Kansas, and Missouri.*