CHAPTER 1

Evolution of the Golf Green

ORIGINS OF GOLF

The exact origin of the game of golf is unknown, but it is generally accepted that the game has been evolving for more than 600 years. Early evolution was a process of adopting elements of other related activities or games until golf was similar but unique.

By the fifteenth century, the Dutch were playing a game on ice with implements and techniques that closely resemble early golf clubs and golf swings (see Figure 1-1). However, the object was to strike a pole in the ice with the ball in the fewest strokes, and not to put the ball into a hole. It is reasoned that this ice game was also played on dry land and introduced in Scotland by Dutch seamen and merchants who were actively trading with Scotland, and who had time to kill while in harbor waiting for their ships to be refitted. The Scottish linksland was close by, and it was covered by pioneer grasses that were often stunted by the wind, salt air, and heat, or grazed short by wild or domestic animals (see Figure 1-2).

It is not known when the transition was made from striking an object post to putting the ball into an object hole, but it was some time before the first rules of golf were written in 1741. The very first rule of the first rules states: "1. The ball shall be teed no more than one club's length from the hole" (see Figure 1-3). Later the rules were revised to read two club lengths, then four, then ten. Finally, someone somewhere began the profession of golf course architecture by simply separating the teeing ground completely from the area around the object

Figure 1-1: Origins of golf can be traced back to a fifteenth century Dutch game played on the ice, with the target being an upright stake, not a hole. (Painting by Bareno Avercamp, circa 1650)

Figure 1-2: When golf became established in Scotland in the 1600s, it was played on the unimproved and unmaintained linksland, so greens were not distinct from the rest of the golf course, and everything together was called a "fair-green." (Painting by Allan Stewart, 1919)

hole. Some historians believe that this was Allan Robertson or Old Tom Morris in the mid-1800s at the Old Course at St. Andrews. Precisely when and how the teeing ground became distinct from the putting ground is unknown, but it was a critical step in the evolution of the game, as well as in the process of allowing the area we now call greens to begin its own distinct evolution.

In 1857, there were 18 known and established places to play golf in Scotland, which increased to 59 by 1880. While the Dutch game on ice has faded into oblivion, golf had taken root on the earth and is still prospering.


The Original Rules of Golf ™
1745

Articles & Laws in Playing at Golf

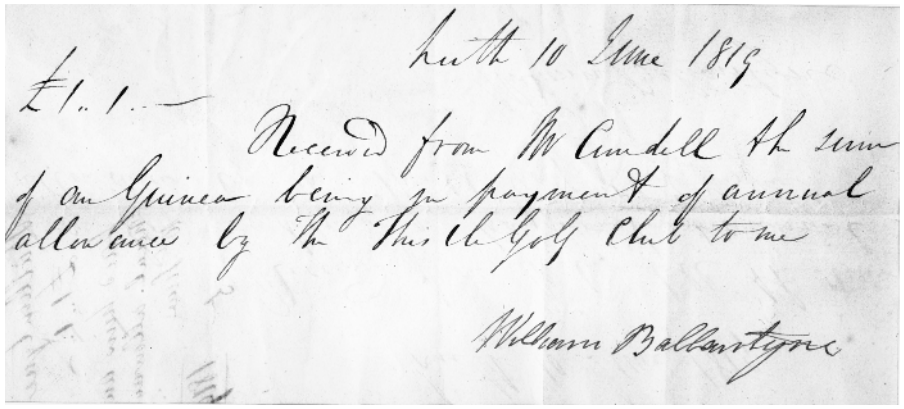
1. You must Tee your Ball, within a Clubs length of the Hole
2. Your Tee must be upon the Ground
3. You are not to change the Ball which you Stroke off the Tee
4. You are not to remove Stones, Bones or any Break Club, for the sake of playing your Ball, Except upon the fair Green, within a Club's length of your Ball. (that only)
5. If your Ball come among Water or any wattery filth, you are at liberty to take out your Ball & bringing it behinds the hazard and Teeing it, you

Figure 1-3: The first rule of the first rules dealt with how close together were the object hole and the teeing ground for the next hole, so already greens were becoming the most important golf course feature.

The next 120 years saw rapid changes in all aspects of the game, including demographics, personalities, techniques, rules, equipment, hazards, sites, conditions, golf courses, and not least of all, golf greens. The area around the hole or cup came to be treated with more care and concern than other parts of the golf course and slowly evolved into modern-day putting greens. From then until now, there have been a succession of approaches to constructing and maintaining golf greens, with each having the goal of raising the standard of putting green quality. Many of those old ways are being rediscovered because of today's concern for environment, while others simply formed the foundation from which the art and science of greenkeeping has evolved. Therefore, it seems worthwhile to review this rich history and identify significant advances or discoveries, all the while keeping in perspective the impact of social influences that were prevailing during each of these periods.

FIRST GREENKEEPERS

The earliest verified record of a person being employed to care for a golfing green, or "fairgreen" as golf courses were once called, seems to be a receipt of payment in 1744 to an unnamed boy who was retained as "greenkeeper and caddy" for the sum of 24 shillings per year and a change of clothes by the Royal Burgess Golfing Society. Later, in 1819, a William Ballantyne was paid one


£1.. 1..—

Leith 10 June 1819

Received from W Cundell the sum of one Guinea being in payment of annual allowance by the Thistle Golf Club to me

William Ballantyne

Figure 1-4: An 1819 original receipt for an annual payment to William Ballantyne by the Thistle Golf Club, presumably to perform some greenkeeping duties.

Figure 1-5: Greenkeeping was firmly established as a profession by the mid- to late 1800s, but the crews were small and their equipment was simple.

guinea for the care of grounds for the Thistle Golf Club (see Figure 1-4). What those duties entailed is not clear, but this does show that by this point golfers no longer wanted to simply play the linkslands as they found them, and were willing to pay out some money to preserve or improve them. It is reasonable to assume these early greenkeepers (see Figure 1-5) were not much more than farmhands, employed to be jack-of-all-trades repairmen, whose main golf course duties were to repair minor damage caused by animals, especially burrowing rabbits, and occasionally to change holes and tee markers; they were not necessarily involved with grooming the turf.

THE INFLUENCE OF OLD TOM MORRIS

It is also evident that greenkeeping was not a highly paid or esteemed profession, and hence those early pioneers labored in anonymity, until a person of extraordinary abilities became publicly recognized and respected. That person was Old Tom Morris (see Figure 1-6). In H. S. C. Everard's *A History of the Royal and Ancient Golf Club, St. Andrews 1754–1900* (London: William Blackwood & Sons, 1907), he writes that in 1863, when Old Tom Morris was hired back to St. Andrews from Prestwick after Allan Robertson's death, Tom's duties were listed as follows:

> His duties were explained to him: to keep the putting greens in good order, to repair, where necessary, and to make the holes. For heavy work, carting, &c., he was to be allowed assistance at the rate of one man's labour for two days in the week, and it was understood that he was to work under the Green Committee. Emblems of office were then handed over to him—to wit, a barrow, a spade, and a shovel—in prophetic instinct, belike, that "saund," and ever "mair saund, Honeyman," would be in future ages the watchword of the newly-appointed Chief of the Links. The sum of £50 per annum was voted by the Union Club for payment of the custodian's salary, and £20 for the upkeep of the Links.

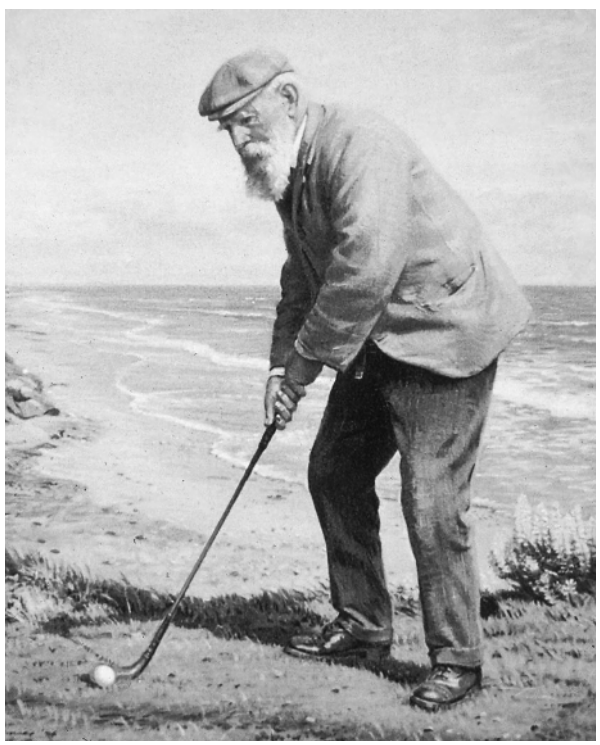


Figure 1-6: Although not the first greenkeeper, Old Tom Morris established himself as a leader in the profession as well as in the game of golf, and is still universally known a century after his death.

In the delightful book by G. Witteveen and B. Labbance, titled *Keepers of the Green: A History of Golf Course Management* (Chelsea, MI: Ann Arbor Press, 2002), there is much more detail about the demands and skills of early greenkeepers, and the book is recommended to students of golf course history.

However, the reasons for Old Tom's fame were not only his agronomic skills, but also his proven expertise as a player, club maker, ball maker, teacher, innovator, spokesman, father, and pious man. Every aspect of his personal and professional life earned the respect and endearment of folks in and outside the game of golf. Therefore, he first emerged as a leader and then as a senior practitioner whom colleagues and employers followed because he got favorable results.

Imagine a golf course superintendent of today convincing golfers to reduce their course by four holes, from 22 to 18, as Old Tom did at St. Andrews. Or his closing the course on Sundays to give the golf course a rest. Or alternating the direction the course was played to reduce wear, or building and filling in bunkers as he pleased (see Figure 1-7). Whether legend or fact, Old Tom's role in every one of these decisions seems to have been central. But just as important in establishing Old Tom's stature were the playing conditions at St. Andrews, especially the greens, which became the standard against which every other golf course and all other greens were judged.

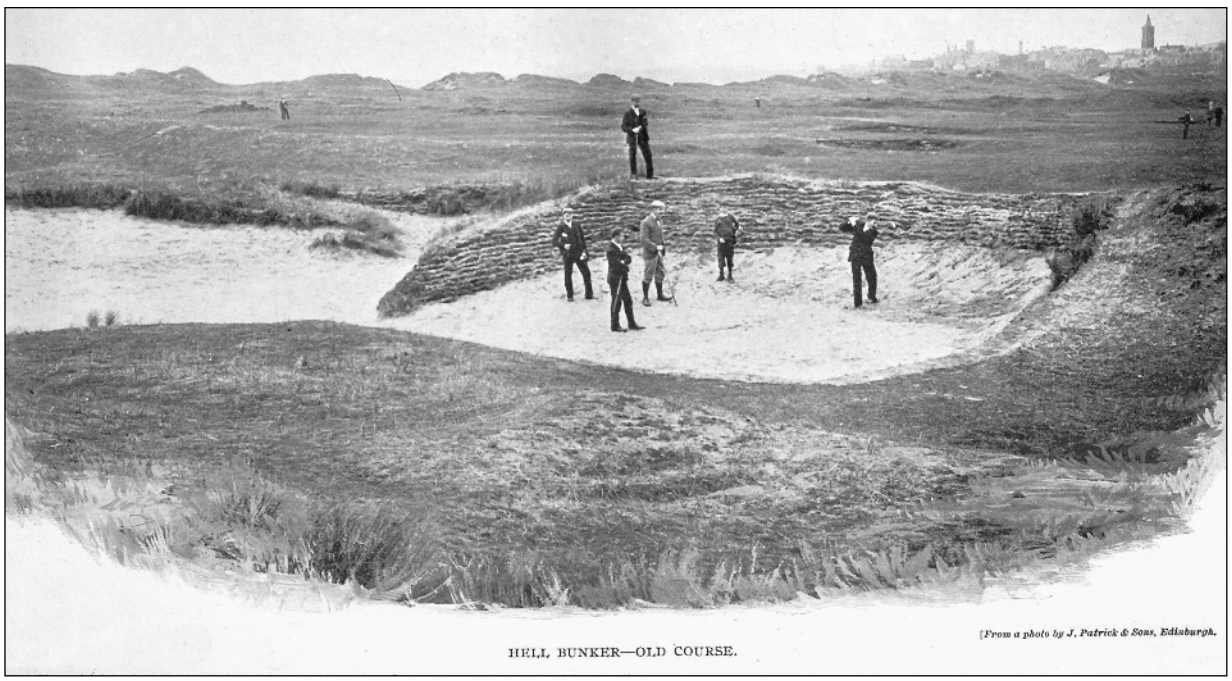


Figure 1-7: This late 1800s photograph of Hell Bunker on the Old Course at St. Andrews shows the sod wall ravetment to stabilize the face against wind and water erosion.

One should not forget that the social climate of Old Tom's era also helped him become even more influential. First, as a result of the Industrial Revolution in northern Europe in the nineteenth century, more people had more time for leisure activities, including golf. Golf equipment also became less expensive because of mass production. Hence there was greater interest in places to play golf, like the vacation town of St. Andrews. Newspaper accounts and golf books were becoming more widely available, and thus making public figures of golf celebrities. Telegraph, then telephone, communications allowed news and sporting results to be reported in a more timely fashion, and exhibition matches were widely promoted and hence of greater public interest. This new interest resulted in town governments acquiring or protecting public land for the growth and playing of golf, and thereby seeking the advice of golf professionals like Morris. Inevitably there developed competition between towns for the recognition of the finest links, and this in turn spawned the collecting and spending of money to improve their links or golfing grounds. This was important, because without money and resources, the greatest greenkeeper in the world could not produce notable results, and that is as true today as then. So in the late nineteenth century, the greenkeepers, course designers, and constructors had some money available with which to advance their crafts and creations. Finally, there developed the social dynamic of forming a committee of concerned golfers to justify and monitor the work and expenditures of the greenkeeping staff, and to advise them on matters of concern to golfers. The Green Committee was born and thus began an even faster upward spiral to obtain and maintain the very best golfing turf, particularly putting surfaces.

Old Tom Morris is credited with accidentally discovering the virtues of routine sand topdressing to improve the density and uniformity of putting turf when he accidentally spilled a wheelbarrow of sand on a green, and the turf thrived. While the benefits of fertilization, lime, sulfates, and compost were well known in other forms of agriculture, it was not until Tom's time that money would be used for such materials to improve the growth of turfgrasses on golf courses. Likewise, the basics of drainage and the advantage of irrigation had long been known in agriculture, but not until Old Tom's era would they be justified to improve linksland golf courses. Old Tom was credited with digging shallow wells at each green for irrigation and with making minor drainage improvements in bunkers. So during the period from about 1850 to 1890, there was the making of "the perfect storm": golfers paying to use golfing grounds; competition between golf courses for income and prestige; formation of green committees whose mission it was to improve the playing conditions; Old Tom Morris gaining recognition as an industry leader and turfgrass innovator; an incredible growth spurt in terms of the number of golfers and golf courses; and recognition of putting greens as being of primary importance to golfers and as a mark of distinction between courses. Golf had money, incentive, and leadership, but limited know-how.

GOLF GREENS AND GREENKEEPING EVOLVE

An excellent glimpse of the state of greenkeeping at the turn of the twentieth century is given in an 1897 letter to the editor of *Golf Magazine* (British), written by an A. H. Pearson of the Notts Golf Club (see Figure 1-8). For purposes of this text, I will summarize a few of his main points, ideas that will become important in shaping the next 100 years of knowledge about golf greens and their evolution.

According to Pearson, earthworms were a major pest. Worms produced casts or small earthen mounds that, unless removed before mowing, would streak and smother the turf beneath them, leaving an imperfect putting surface. Since this was a time before sophisticated pesticides, suggested earthworm control measures included a drench of lime dissolved in water and a topdressing of fine charcoal dust. However, Pearson also recognized the value of earthworms as natural aerifiers, so he further suggested using topdressing of coarse sand broomed into the turf and wormholes to help keep them open for the turfgrass. Rolling of greens was a common practice in the late nineteenth century, but some greenkeepers were beginning to recognize the negative impact of rolling in causing soil compaction on some sites.

Pearson stressed the value of using good clean seed for overseeding and that some grasses are better adapted to some situations than others, but he acknowledged that producing a mature putting surface takes time. Sodding of greens with established turf was not uncommon, so care in cutting and laying the sod was already known to be important in establishment. Amending rootzones with ashes, sand, or other porous material was a practice that was encouraged to gain the benefit of deep rooting by the turf, and improved soil capillarity.

By the 1890s mowing of greens had evolved from using the sickles and scythes of the mid-1800s to using push-type reel mowers (see Figure 1-9). These remained in sporadic use well into the 1930s. However, frequent mowing was thought to impoverish the soil, encourage weeds and mosses, and stress the turf. Fertilization was usually confined to spring with a light application, and Pearson warned of negative effects that can come from either too heavy an application or selecting the wrong nutrient source. And lastly, he conceded that even "Under the best conditions it [putting green turf] cannot withstand the trampling of feet, which it has to endure on anything like a crowded course, unless it has an occasional rest, and where there are a number of daily players, duplicate greens should be provided."

Meanwhile, golf in the United States did not become permanently established until 1888 (see Figure 1-10), and there is no reference basis for greenkeeping in this country until almost 1900. This 10- or 12-year period of golf's infancy in the United States created opportunity for many young Scotsmen who knew something about maintaining a golf course to come to America and work within this now rapidly growing pastime. However, most were experienced on

THE MAINTENANCE OF GOOD PUTTING GREENS.

To the Editor of GOLF.

SIR,—I see in last week's "Tee-Shots" a note on the destruction of worms upon putting-greens. The destruction of worms is a very simple matter. A few lumps of unslaked lime placed in a cask of water, and allowed to remain until the lime has settled, will make lime water, which can be poured off, and if the greens are watered with this inexpensive liquid the worms will all come up to the surface and die; or, again, a dressing of fine charcoal dust will have the effect of destroying the worms. But I would ask the question, "Does one want to destroy the worms?" I dare say the average green-committeeman will think me mad to ask such a question. Well, sir, I am comparatively young (as a golfer), but I have seen and heard of so many foolish things being done upon Golf greens that, even if I be mad, I should find plenty of good company upon green-committees. To return to the worms. These are chiefly found upon the heavier soils, and I think they play a most important part in draining and aerating the soil, and if you destroy them you will find the greens become sodden, dead to play upon; the soil will become sour, and the grass coarse and rank. I would deal with such greens by sanding them well from time to time, and have them well brushed over with a birch broom, lightly applied, to distribute the worm casts. In course of time, as the applications of sand take effect, the grass will become finer and the greens keener, also the worms will be greatly reduced in number, and when the sand acts to keep the soil porous, their services can be dispensed with.

My experience of inland links is that they are not half enough sanded, rarely brushed, and twice too much rolled. I have heard a green-committeeman advocate daily rolling. This would ruin *any* green in the winter, and, with anything like heavy soil, it would be disastrous in any weather. I believe nearly all greens would be better with less rolling and more brushing.

With regard to seaside links, one generally finds the sanding very much overdone and moss rampant, calling in unmistakable tones for manure. I am not going to mention the names of any links, and if you publish my remarks I shall take my niblick to protect myself from the indignation of my own green-committeemen; so I will continue my criticisms. Some committees sow grass seeds upon their greens; *cui bono?* They do not grow, and if they did they would ruin the greens, being quite unsuitable. I have seen what are called "hay-seeds," *i.e.*, sweepings from a hay chamber, containing cocksfoot (*Dactylis glomerata*), rye-grass (*Lolium*), and other coarse grasses [illegible] with the ordinary soil ashes, sand, or some other material to make it more porous, and on poor, sandy soil by mixing some better soil with the sand to encourage the roots of the grass. On some sandy links I have seen the turf laid with only an inch or two of poor soil between the roots and a bed of sandstone, with the result that the grass was baked up by a few weeks of hot weather. Again, I have seen such relaid greens beautifully prepared, but raked and rolled as level as a billiard-table, which takes away half the charm of putting upon them. Undoubtedly, natural greens are the best, but if one has to re-lay them a certain amount of roll and inequality of contour should be preserved. I have heard of greens being concreted underneath to prevent their burning up, but this seems to me quite a wrong course, as it altogether prevents the action of capillary attraction which is the action by which Nature keeps sandy soils moist during dry weather, so that unless the concrete is placed so low beneath the surface as to form a reservoir it would be worse than useless, and the cost must be something serious to contemplate. Turf cut for relaying greens is, so far as my observation goes, generally far too thin. Of course thin turf is easy to lay, but if half the roots are cut off it has a poor chance of withstanding dry weather. The turf should be cut at least two inches thick. On established putting-greens, especially on sandy links, constant and continued mowing impoverishes the soil, and the grass becomes poor, weedy, and half smothered with moss. The greens should then be dressed during the early spring with some good chemical manure, properly prepared so that it will not burn the grass; soluble so that the first shower puts it out of sight and carefully balanced in its ingredients so as to manure the grass without causing a coarse growth. Bones encourage clover, and although I have seen clover sown I cannot imagine anything more undesirable on a putting-green than a carpet of white clover. It bruises to a pulp when much walked upon, and in damp or dew it holds the moisture so that a ball will scarcely travel over it. Basic slag is open to the same objection. Nitrate of soda makes a rank growth of grass, and is far too quickly washed away. What one wants is a perfect, plant food, with the lime element kept as low as possible. May I say, in closing, a word on behalf of the poor turf. Even if of the best quality, and under the best conditions it cannot withstand the trampling of feet, which it has to endure on anything like a crowded course, unless it has an occasional rest, and where there are a number of daily players, duplicate greens should be provided. This is done on many links, but on others it is not, and the poor turf comes in for an unmerited amount of abuse.

I am, Sir, &c.,

Notts Golf Club. A. H. PEARSON.

ANSWERS TO CORRESPONDENTS.

HON. SEC.—The usual practice is to give him a warning, and tell him that next time you will expect a medical certificate; otherwise he will only be paid for the number of days he has been at work. We should recommend you to pay the full wages this time.

MANCHESTER GOLF CLUB.

The annual dinner of the Manchester Golf Club took place on January 30th, at the Grand Hotel, Manchester, the captain, Mr. A. C. Knight, in the chair. It had been arranged that the captain's prize should be played for in the afternoon, but the heavy fall of snow made Golf impossible, and the competition was unavoidably postponed. The disappointment did not prevent a considerable number of members appearing at the dinner, which was in every way a great success. The

Figure 1-8: Early golf magazines like *Golf* (British) often had editorial or question-and-answer columns, which today can give insights into problems and solutions of early golf courses, especially putting greens.

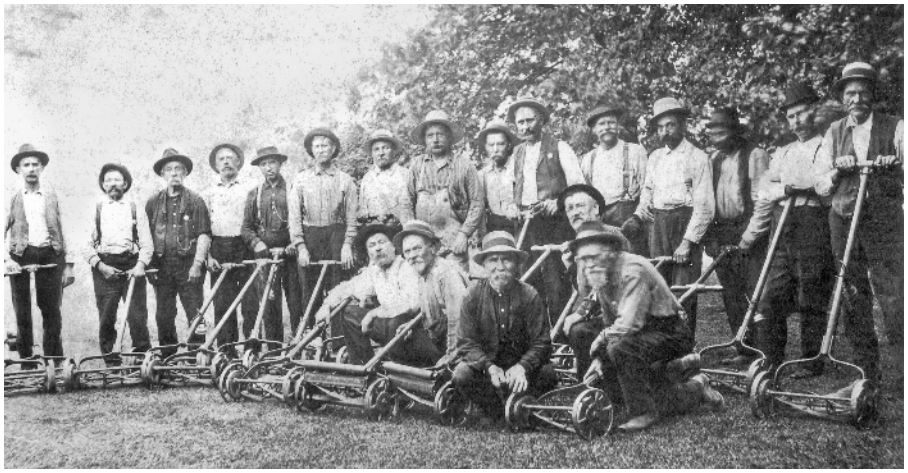


Figure 1-9: By the 1920s in the United States, greenkeeping was a recognized profession and golf courses had fairly large staffs because wages were low, maintenance equipment was crude, and maintenance expectations were rising. Notice the large number of push mowers.

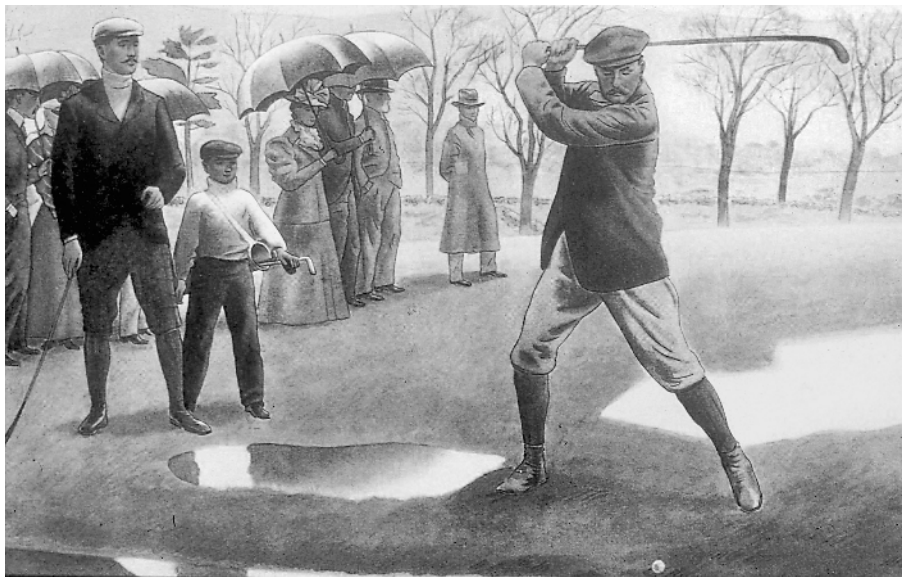


Figure 1-10: Just as when golf was introduced into Scotland and was played on unimproved and unmaintained open areas, so, too, was it in 1888 when golf was permanently introduced to the United States. (Lithograph after drawing by Everett Howry, 1931)

sandy linksland golf courses that experienced a climate of fairly moderate and predictable weather. Thus, when employed on U.S. golf courses with conditions similar to those in Europe, such as on sandy soils found along the New England coasts or Long Island, they did well, and many of their golf courses became legendary for the quality of their turf and playing conditions. However, when given a golf course site with conditions uncharacteristic of linksland, they struggled and experimented to find management techniques that were better suited. This need for new and better understanding of how to grow turfgrass comparable in quality to those grown on sandy coastal sites ushered in a whole new emphasis in agriculture, loosely called grassland science or agrostology.

EARLY SOURCES OF INFORMATION ABOUT GOLF GREENS

The very early information sources were seed suppliers such as Sutton's (see Figure 1-11) or Carter's (see Figure 1-12) out of the United Kingdom, or later the O. M. Scott & Company in the United States (see Figure 1-13). Companies selling supplies to the horticulture and agriculture industry made attempts to

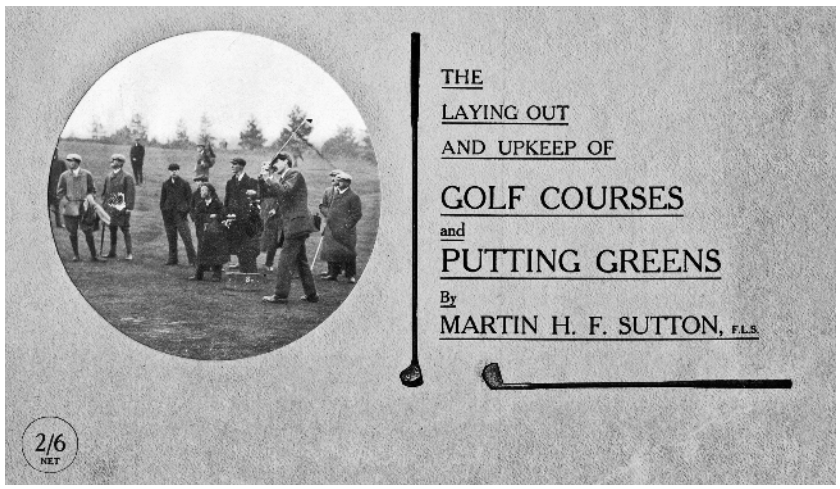


Figure 1-11: Early 1900s catalog from Sutton Seed Company of the United Kingdom was a source for information on construction and management of golf greens.

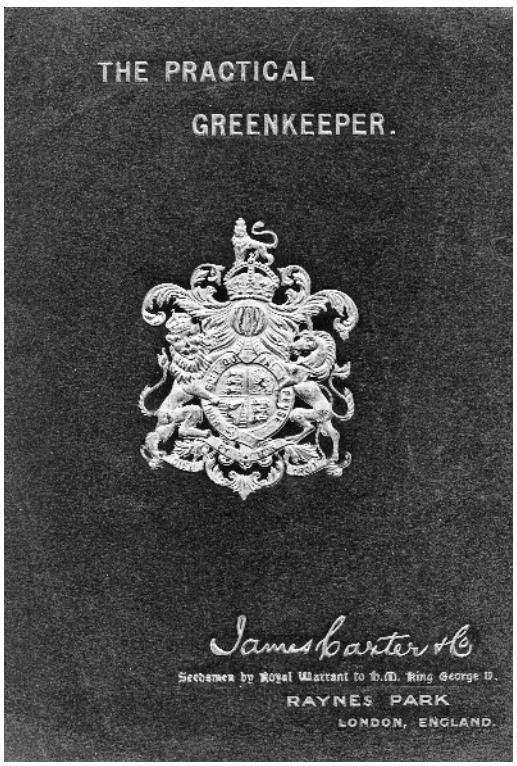


Figure 1-12: One issue of a series of supply catalogs and helpful hints for greenkeepers published by the Carter Seed Company of England.

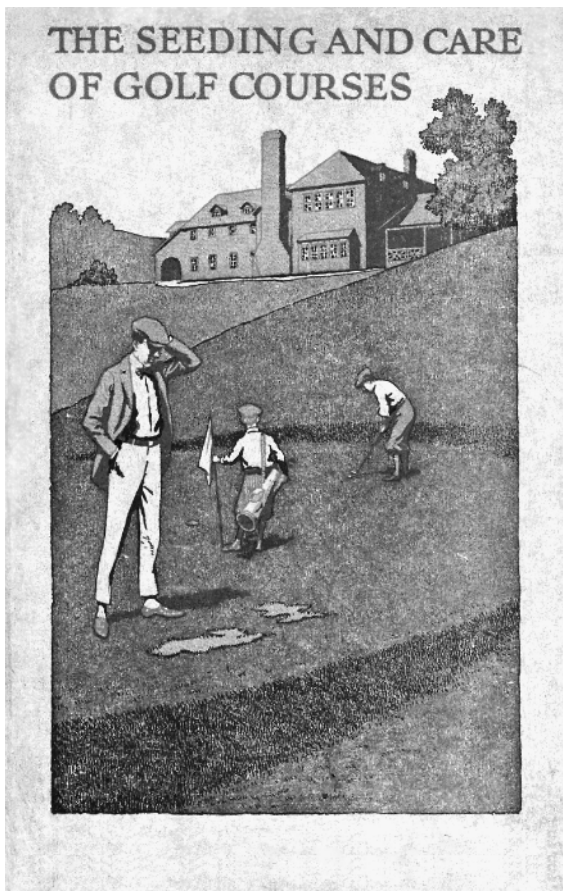


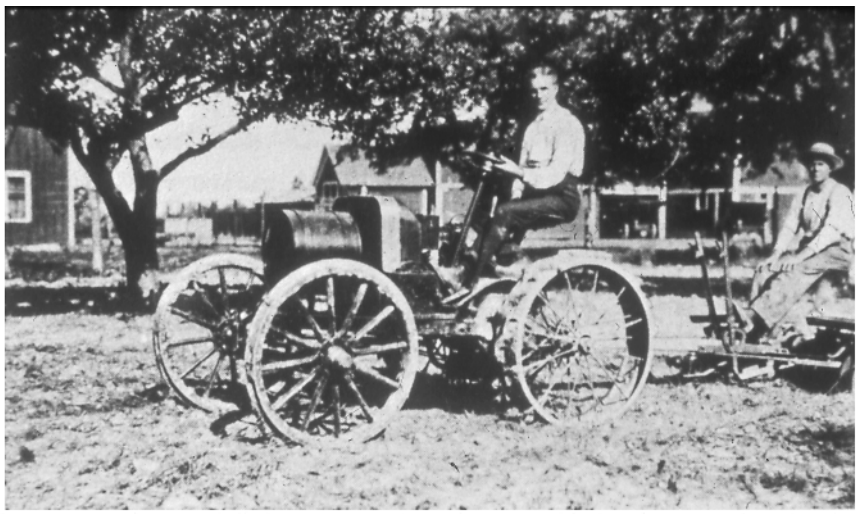
Figure 1-13: A 1920 booklet published by O. M. Scott & Company to assist greenkeepers in building and establishing golf courses. (Courtesy of O. M. Scott & Co.)

expand their markets by offering products that they believed would benefit turfgrass culture. University research on pastures and/or grasslands was often cited as information sources, and the earliest turf consultants were university professors. Taken together these company publications were important contributors to the body of information that greenkeepers needed, but it was mostly recycled information that had been gathered for other purposes, and it was not based upon research or investigations that were golf course specific. As a result, there was a need for a new science and engineering devoted to golf courses, athletic fields, and lawns. Thus in the early 1900s, Drs. C. V. Piper and Russell A. Oakley were hired by the United States Department of Agriculture (USDA) to begin studying turfgrasses, and their contributions are examined in detail later in this chapter.

By the early twentieth century, the American Industrial Revolution had produced enormous wealth and opportunity for some people. Immigration to America was active and fueled by not only the freedom and potential that our expanding country offered, but also by some severe and oppressive living conditions in other parts of the world. The new immigrants to America brought new energy, skills, and ideas that could blossom and grow and help fuel all aspects of our culture, businesses, and industries, including golf. Donald Ross was one such example (see Figure 1-14).

America in 1900 was still in the mode of the "gay nineties" (1890s, that is), and technology was rapidly changing American lifestyles. One example was the production of the internal combustion engine, which when installed in a chas-

Figure 1-14: A photo of Donald Ross playing golf at Royal Dornoch in his childhood home in Scotland, where he learned all aspects of the golf business before coming to America in 1898.



The late Henry Ford (left) built many experimental tractors before putting one into mass production. This experimental model, which he called an "automobile plow", was built in 1907.

Figure 1-15: 1907 news item showing the state of development of internal combustion engine powered tractors, and why horses and men would remain the primary power source in golf course maintenance for another 20 years.

sis produced the "horseless carriage" or automobile and tractor (see Figure 1-15). This meant a greater freedom of movement, and at a faster pace, so time and space begin to shrink. In 1908, Henry Ford would mass-produce the $800 Model "T," which would make the automobile affordable to the average folks. This, when coupled with high national prosperity and industrial automation that lowered the costs of goods and services, allowed even the common man free time for luxuries such as golf. Although golf in the early 1900s was still somewhat a rich man's sport, mass production began lowering the cost of clubs and balls, and allowed people of more modest means to take up the game. This in turn created a need for new golf courses, and on sites further from towns and cities than previously conventional means of travel, such as walking, bicycles, trains, coaches, and so on, would allow. As golf spread across America, the sites, climates, and problems of producing acceptable golfing turf became even more important and complex, intensifying the need for turf science.

The internal combustion engine soon found all other sorts of applications beyond people movers, such as lawn mowers, tractors, and then bulldozers. This process took another 20 years or so, but without question this mechanical power affected golf courses, and ultimately golf greens (see Figure 1-16).

A documented starting point in the evolution of printed materials on greens and greenkeeping in America is the 1897 book of H. J. Whigham. He was an accomplished player who published one of the first golf books in America, titled *How to Play Golf* (Chicago: Herberts, Stone & Company, 1897). He also

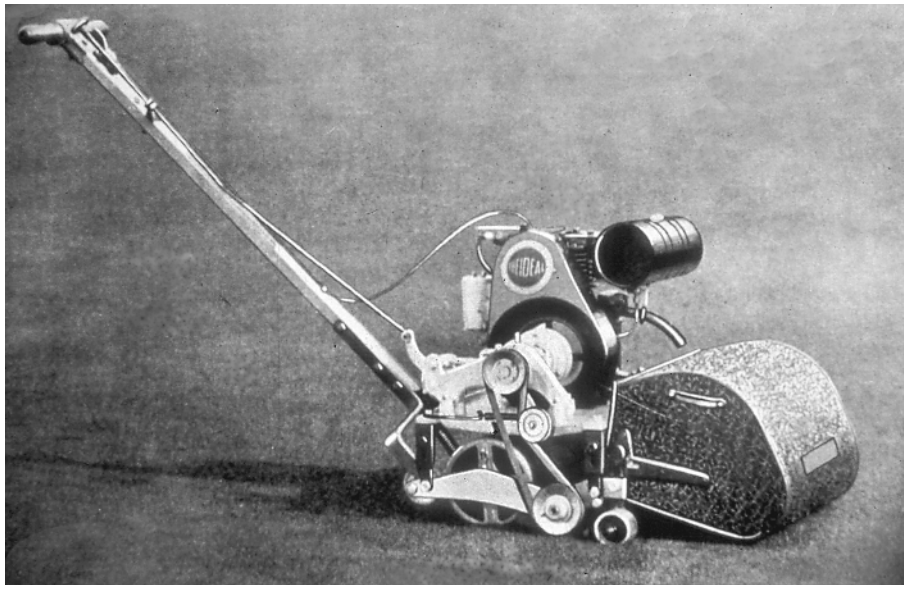


Figure 1-16: By the 1920s, green mowers had become specialized pieces of equipment.

offered many opinions and insights on golf courses and golf greens during these early formative years of 1888 to 1897, and his writing set the standard for much of what would come later. He wrote, "…must your putting greens be flawless," and to obtain that condition he further advised:

> …[t]hat were neither absolutely flat or square. In size they should vary, but they should never have a radius of less than 40 feet [sic, 5,000 square feet].
>
> The excellence of your putting green depends, to a large extent, upon the kind of mowing machine you possess. The ordinary Philadelphia lawn mower of common use does not cut the grass close enough for golfing purposes, and so it is necessary to have a special machine made, with the same width of blade, but with smaller wheels, so that the knife may be brought closer to the ground. This slight change in the implement will make all the difference between good and bad greens.
>
> Finally, you must have a water supply available at each green. The actual amount of water to be used varies, of course, with the difference in climate.

He advocated sodding greens and suggested that one inch of water per week is adequate in most climates, but could be inadequate in extreme ones. Whigham also stressed that sandy loam soils are preferred throughout the golf course, and that a springtime rolling with a three- to five-ton steamroller would help smooth out the turf (see Figure 1-17). So with golf less than a decade old in America, influential golfers were already setting standards for green maintenance.

Some help came from Europe in 1899, when Horace Hutchinson wrote *The Book of Golf and Golfers* (London: Longmans, Green, & Co., 1899), with a chapter on "Laying-out and Up-keep of Greens," written by Messrs. Sutton & Sons, of Reading (see Figure 1-18). Since the Suttons were in the seed business, they naturally recommended more specialized varieties called "golf grasses," consisting of fine fescues, meadow grass, and dwarf perennial rye grass on sandy or chalk soils. Heavy soils, they suggested, require *Poa trivialis* and *Agrostis.*

Prior to planting, the Suttons recommended that greens be given:

> …a heavy dressing of well-rotted farmyard or stable manure…or on sandy soils, dressing of marl, applied at the time the greens are made, will obviate interminable work in later years, and produce a verdant spot in droughty seasons when surrounding herbage has given up.

Figure 1-17: Rolling of greens with heavy rollers was espoused as a method of producing smooth putting surfaces.

Figure 1-18: During the end of the nineteenth century and the first quarter of the twentieth, many books were published on golf course and green design, construction, and upkeep.

Later they write: "[T]he principal constituents of plant-food required by grasses, and of which most soils are liable to run short, are nitrogen, phosphoric acid, potash and lime." Of course, they offer to sell some excellent products to answer these needs.

Since the profession of golf course architecture was well established in England, the Suttons remained politically correct and avoided any reference to how to design or build golf greens, or the need for irrigation, again reflecting a philosophical difference between the United States and Europe regarding watering turf.

However, the most authoritative voices on turfgrass management seem to be found in a 1906 book, *Golf Greens and Green-keeping,* also edited by Horace Hutchinson for *Country Life Library of Sport* (London: Country Life, Ltd., 1906) (see Figure 1-18). Fourteen experts contributed their expertise, six or seven of whom were active golf course architects. The book covered a wide range of experiences and observations on various soil types that, taken together, formed some bedrock principles for building and maintaining golf greens, principles that established a baseline for turf science in America.

GOLF GREENS AND GREENKEEPING BECOME MORE SOPHISTICATED

To summarize these experts, they generally agreed that seed should be sown in the fall; thereafter, it takes six to nine months to produce a mature turf strong enough for regular play, and using sod or "turves" works well, but the sod should come from a known and clean seed source. Rootzones were only mod-

Figure 1-19: Topdressing with sand and compost mixes was a popular greenkeeping technique. One person spread the topdressing with a shovel, another brushed it into the turf, and the third person "poled" the green prior to mowing. Note how these golf course workers of the early 1900s are dressed.

Figure 1-20: Horses were a common source of power for constructing and mowing before tractors were developed for golf course use.

ified by working up the soil to a depth of 6 to 12 inches, incorporating in some proven quality organic matter and some natural occurring mineral (chemical manure) or organic fertilizers. Topdressing with light soil or sand was important (see Figure 1-19). Greens were mowed with a scythe for the first couple of mowings, and until "…sufficiently strong to be able to resist the slight snatching movement of a (mowing) machine, which can then be used with safety." Light frequent rolling was encouraged, along with frequent use of "…an iron-toothed rake." Drainage by installed tile lines or gravel filled sumps is done as needed. Irrigation should be light and frequent when the grass is young and tender and infrequent and deep when the green is mature. All simple but good advice.

Back in America, the most common maintenance problems on greens still remains weeds, worms, mosses, worn out or compacted areas, and being able to sufficiently water turf during dry conditions. As in Europe, tools available to greenkeepers were organic fertilizers and a few chemical manures (ammonium nitrate, nitrate of soda, sulfate of ammonia, potash, phosphoric acid, etc.), sulfur, lime, and charcoal along with rakes, shovels, brooms, and wheelbarrows, and sifting screens for compost and topdressing. Greenkeepers might have man- or horse-drawn mowers (see Figure 1-20), carts for hauling, perhaps a water wagon, and a variety of harrows, drags, and farm implements. A crew might consist of the greenkeeper and one or two laborers, supplemented with caddies when needed. Despite these limitations, the golf courses seem quite playable as shown in pictures from that period.

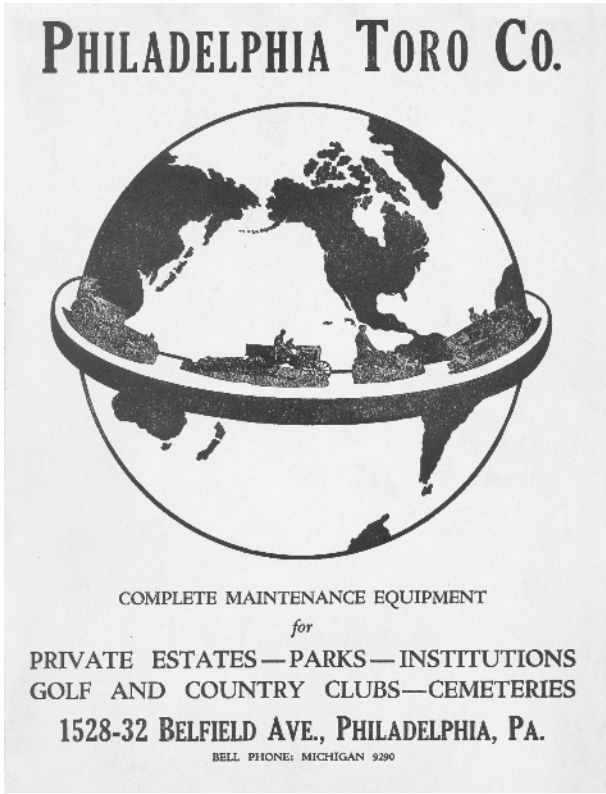


Figure 1-21: Cover of a 1935 catalog for greenkeeping equipment. Studying such catalogs gives insights into the materials and methods used during that period.

Just a few years later, in 1912, Martin H. F. Sutton, F.L.S., edited a book titled *The Book of The Links: A Symposium on Golf* (London: W. H. Smith, 1912) (see Figure 1-18). Here eight different authors, four of whom were golf course designers, offered views on course maintenance and specifically greenkeeping. Drainage was beginning to be emphasized, along with the importance of an irrigation source. Worms remain a big problem but worm killers are available (from Suttons, of course). By now heavy rolling has gone out of fashion and given way to light topdressing and light rolling. Specially selected and blended seeds were advised, along with some weed control materials (both from Suttons, of course), and numerous other tips and insights were offered. But by far the most illuminating feature of the book, for those interested in the history of greenkeeping, is the appendix of tables and useful information. By browsing these pages one can form an appreciation of the state of greenkeeping at the turn of the century. A 1935 catalog of greenkeeping equipment provides similar insights (see Figure 1-21). A comparison of these sources would provide insights into putting green maintenance in the United Kingdom up to the time of World War II.

Although electricity was known about even before Ben Franklin and his famous key and kite episode, and Thomas Edison introduced his electric light bulb in 1880, electricity was never harnessed and made commercially available

until almost the 1890s in America, and then only in larger cities closer to the generation source. There were as many different types of electricity with regard to voltage, cycles, and amperages as there were electricity producers and suppliers, with dozens of different types in large cities. Only through President Roosevelt's 1934 Rural Electrification Act did electric power become more standardized as producers figured out how to share transmission lines. But even so, electricity wasn't universally available in the United States until the 1950s. Until then, only 10 percent of the nation's farms had electricity, compared to 70 percent of city dwellers. Therefore, during the early part of the 1900s, power sources available to golf courses located away from metropolitan areas were confined to horses, crude internal combustion engines, and wind or water mills. This lack of a power source and crudeness of electric motors and pumps meant irrigation for most golf courses was impractical. A few places like National Golf Links, Pine Valley, and other wealthier clubs could erect windmills (see Figure 1-22) and water towers, but irrigation was still rare.

Figure 1-22: Electrical service was not available to many golf courses until the early 1950s, leaving wind as the best source of power to pump irrigation water. Consequently, irrigation of golf greens was inconsistent, and volume and pressure were usually low.

GOLF GREENS WITHOUT IRRIGATION

Golf courses without irrigation would simply plant the most drought-tolerant grasses practical, and hope for reasonable rainfall during the golf season. A 1921 USGA *Green Section Bulletin* (see Figure 1-23) stated:

> Eleven years ago there were three grass putting greens in this locality (Southern California) and all of them were failures in every respect.... These three greens disappeared ten years ago and during the next six years no attempt was made to get anything better than oiled sand greens.

Without any irrigation water or power source to pump it, the alternative was to not bother with planting grass on golf greens and instead make putting surfaces of bare soil or oiled sand. Oiled sand greens were developed by simply excavating a green cavity perhaps six to eight inches deep, filling it with a medium to fine sand, then drenching it with used motor oil. The oil kept out the weeds and burrowing insects, as well as helped to bind the sand particles together to resist wind erosion. If the United States Environmental Protection Agency (EPA) had existed back then, it probably would have had strong negative opinions of oiled sand greens. Nonetheless, this was a popular way to build greens in parts of North America, and many still persist today. In the plains states of the United States and prairie provinces of Canada, oiled sand greens still exist, and sand green golf championships are still held. In fact, in Charlottesville, VA, there is still a sand green course.

Since approach shots to sand greens don't hold or check up very well, the technique for playing on a sand green is a bump and run style. Once a golf ball is on the putting surface, it is marked, and the area between the ball mark and the hole is smoothed down of footprints, ball marks, and so on. Smoothing is done with a toothless rake, called a "smoother," or a broom, a piece of carpet, or a drag mat. Then the ball is replaced and putted.

But even without irrigation and turf surfaces, golfers and greenkeepers were trying to find ways to improve playing conditions of greens. Below is a 1923 article from the USGA describing some additional techniques:

Sand Greens on a Sawdust Base

> About two years ago it was reported to the Green Section that a sand green made on sawdust base would provide a resiliency so that balls could pitch to the green. The plan included a base of sawdust, six or eight inches deep, well tamped, then covered with soil, and finally covered with sand. The first sand green of this kind was built on the course of the Ridgewood Country Club, Columbia, S.C., and a second one at Pinehurst, N.C. Mr. Richard S. Tufts reports on his results at Pinehurst as follows:

Bulletin *of the* Green Section *of the* U. S. Golf Association

Vol. 1 **Washington, D. C., June 20, 1921** **No. 6**

A MONTHLY PERIODICAL TO PROMOTE THE BETTERMENT OF GOLF COURSES

ISSUED BY THE GREEN COMMITTEE OF THE UNITED STATES GOLF ASSOCIATION

CONTENTS

Address all communications to W. B. Lydenberg, Executive Acting Secretary, P. O. Box 476, Eleventh Street Station, Washington, D. C.

Figure 1-23: In 1921, the USGA began publishing the *Green Section Bulletin,* which was a timely and science based source of information on greenkeeping. (Courtesy of United States Golf Association)

> "I have just returned from Columbia and am glad to submit a report on the experience they have had there with their sawdust greens, and also on our own experience.
>
> "I do not believe that these greens have worked out satisfactorily in either case. The main objection to them seems to be excessive maintenance. At Columbia they have been using too much sand and too little soil on top of the sawdust, with the result that the sawdust works up through the sand making the putting very uneven. They have used from one-half inch to one inch of sand, which is too much, as heel-marks are always left in such an amount of sand.
>
> "Our own experience with these greens has been a little more satisfactory. We used about two inches of loam as top-dressing on top of the eight inches of sawdust on one-half of the green, and about three inches on the other half of the green. The half with the thicker top-dressing became too stiff and a ball landing on the green did not receive the deadening effect of the sawdust beneath. The other half of the green has worked out satisfactorily, although we find that the maintenance is about twice what it is with the sand-clay greens.
>
> "The main objection to these greens is that it is impossible to get the surface flat, as it is always slightly rolling and therefore not quite true to putt on. Furthermore, in order to use the greens it would be necessary for us to double the maintenance force that we have in use on the courses, and even then they would not putt as true as our sand greens. We therefore do not consider that it is advisable to replace our sand greens with the sawdust, even though their action can be made satisfactory."

Another problem with any variety of oiled sand green is that, by necessity, they had to be flat, for if they had any slope to them they would erode when they received any significant precipitation. They were usually 20 to 30 feet across with the hole cut right in the middle (see Figure 1-24), so they became a bit monotonous to play. However, to quote the old cliché, "They were better than nothing," and having played on them personally, I believe they are a lot of fun.

Where water for golf greens was sufficient, either as precipitation or through irrigation, fine grass putting surfaces were preferred over oiled sand or greens covered with rough vegetation such as common Bermuda grass or tall fescue. Donald Ross's beloved Pinehurst resort operated for almost 35 years with oiled sand greens, until 1934, when the greens were converted to Bermuda grass. Modern-day information on sand greens can be found on the website for Pasture Golf (www.pasturegolf.com) under the topic of questions and answers about "sand greens."

As an interesting side note, Pete Dye tells the story of meeting Donald Ross often in the mid to late 1940s, when Dye, who was stationed at nearby Fort Bragg, would play golf at Pinehurst. Dye claims the mounded greens on Pinehurst Number Two came about because Ross topdressed the common

A PROFESSIONAL FOUR-BALL MATCH UNDER WAY ON THE LINKS AT CAMDEN, SOUTH CAROLINA Photo by Kirk

Figure 1-24: Where no irrigation for greens was available, a common method of green construction was to use oil-drenched sand.

Bermuda grass on the greens with about a quarter inch of sand each week. Dye says Ross often talked about rebuilding those greens to get rid of the crowned effect but died before he could. So then everyone started to believe that was the way Ross wanted them. Now many think those are great greens, but Dye isn't so sure that Donald Ross would think so.

NATIVE SOIL GREENS

Some attempts were made by early golf course builders to make the greens rootzones that would support finer turf, but restricted budgets of time or money forced compromises that often were less than ideal. It would be instructive to remember how golf courses were built before the advent of bulldozers and earthmovers in the late 1930s or after World War II.

The best description of how horses and slip scrapers or pans (see Figure 1-25) were used to build golf greens was written by an L. W. Sporlein in about 1920.

> Since golf courses are made in all kinds of soils, the methods of construction will vary somewhat in accordance with their locality. However, there are three principal methods in general use for constructing greens. In this article I shall endeavor to show in a brief manner, from my own experience, how economy in green construction can be attained. The major problem always being to move soil in such a way as to eliminate hand labor as much as possible.
>
> Where the soil is not of a heavy nature one of the most generally used methods is that of employing the five-foot fresnos or dump scrapers. The equipment units required consist of three fresnos each, drawn by four

(*a*)

(*b*)

Figure 1-25: (*a*) and (*b*) Until after World War II, the most common sources of power for constructing golf courses was men and horses. As a result, golf greens were generally low profile and built from native soil.

horses, one "railroad" or a sturdy plow with a good team to draw it, four drivers, a loader, a dumper, a plow "shaker" or holder, all under the direction of a superintendent.

In cases where it is desirable or necessary to save the top soil at the green site for replacement on the green after it has been roughly shaped up, the surface soil only is removed, and piled up as near as possible to the green. It is placed either directly in front of, or to the side most convenient for hauling to the green surface, after roughing in with the less fertile soils obtained while building the traps.

After the topsoil has been removed from the green site, the traps are marked off with the plow, and two furrows are plowed along the side nearest the green. The fresnos are now loaded by keeping one runner in the groove left by the plow making the second furrow. A sharp turn towards the green takes a full load of earth directly to the point where needed. The man dumping the fresnos always designates where each load is to be placed and is ready when the load reaches that point. Keeping the trip from the trap to the green and back as short as possible, will enable one to handle much more direct in a day's time. The tendency is for the team drivers to take a much longer route back to the trap after their fresno is emptied than is necessary.

When one plow depth has determined the size and shape of a trap, as many more are removed as is necessary to give the depth required, and by making each succeeding plow depth a foot or two narrower in perimeter gives slope to the sides. Where two or more traps are required, alternate plowing first in one and then in another keeps the fresnos moving and eliminates their waiting for the plow, and the drivers soon learn to switch from one trap to another without loss of time.

In constructing the green, it is best to first build up the entire surface to a more or less uniform height and to place the high slopes or rolls in afterwards, when the approximate shape is obtained. By a single adjustment of the spreader bar on the fresnos, so as to cause the load to spread out to a uniform thickness instead of dumping in one spot, the top soil when ready for replacement can be evenly distributed over the green surface. After the surface has been disced and dragged with a spike tooth harrow, the hand work of raking into final shape is very much simplified.

The second method, making use of the ordinary two horse slip scraper, is practically a repetition of the one just described with the exception of the kind of equipment used. In this procedure the plow is not so essential. I have also found in my experience that it is not as satisfactory or as economical except under some unusual conditions where four horse equipment is not available.

The third method is that in which the greens are rough-stacked with a universal spader or regulation steam or gasoline shovel of one and one-half

> to two yards capacity, such as is used in excavating the cellar of a small house. One that moves about on its own caterpillar track and can make a complete circle with the shovel is best. This method is most economical in heavy clay or stony soils, or in the fall when an inch or two of frost will stop or handicap other methods.
>
> Three or four horse-drawn dump wagons, depending on the capacity of the shovel, convey the soil taken from the traps to the spot on the green designated by the superintendent. By placing pieces of paper weighted down by a stone or lump of earth at the points where loads are required as many as twenty or thirty can be spotted at one time. The rich surface soils can be first removed and piled conveniently for replacement on the green surface later, in much the same manner as described in the other methods.
>
> The dump-wagons will not give as even a soil distribution as fresnos but if a tractor-driven disc is used before hauling on the top soil as well as afterward, this deficiency is easily overcome. The green is now ready to be loosened up with a spike tooth harrow and the final raking into shape by hand, the sides seeded and stolons planted."

From this description, several things about green construction before 1920 should be clear. Most of it was done by horses using native soil close to the particular green site; no mention of tile drainage is made; and usually the soils deepest in the excavation site ended up in the top layers of the green. Once topsoil was respread, it may have had some organic amendment, but it, too, was as variable as the site. It often took many years of topdressing with good sandy soils to build up a functioning rootzone, just as Donald Ross had done at Pinehurst.

ALTERNATIVE PUTTING SURFACES

In a 1924 *Golf Illustrated* article, Dr. R. A. Oakley quoted one writer as saying, "Good [grass, sic] greens without money, like bricks without straw, are impossible in the absence of miracles." Oakley further observes, "Lack of funds, after all, is largely the cause for the acceptance of sand greens or other substitutes for turf." This would include lack of funds to develop a water source and distribution system as well as the cost of maintaining grass versus alternative putting surfaces. One alternative used in the west for sand greens was magnetic iron sands; these were industrial by-products that would pack tightly together to resist weeds and erosion, without oiling. Another alternative, which seemed to catch Oakley's attention in 1924, was cottonseed hulls, particularly in the south, and specifically at El Paso Country Club. Apparently, when compacted by a wooden roller with a spiked surface, the oily cottonseed hulls would resist being eroded by the hot, high, and dry winds of El Paso. The idea originated in north-

ern Mexico, where total rainfalls of six inches or less per year made oiled sand greens susceptible to wind erosion. But laying down layers of cottonseed hulls and rolling them until the entire mat was about one inch thick worked well, and no weeds would grow in them. Using cottonseed hulls also allowed slight undulations in the putting surface, which were impossible on oiled sand greens.

All design, including golf course design, is a reflection of the technology, knowledge, materials, prosperity, and social values of any given period, as well as the skill of the designers. This holds true even when the discussion is isolated to the narrow focus of golf greens. By now it should be obvious that golf green design and development was limited by several individual factors, including the availability of irrigation water, budget for construction and maintenance, sites, and the available pool of scientific and common knowledge about golf greens. If there was no irrigation water, then oiled sand, bare soil, sawdust, crushed shells, cottonseed hulls, or a myriad of other nonvegetative surfaces were used. Since these could be eroded by wind or water, they had to be dead flat and were usually round so they were easy to drag or smooth down. The hole was cut in the center, and so cupset space was not a factor; neither was any other maintenance consideration. Clearly such greens offered no opportunity for design expression for none was needed, but they permitted the growth of golf where it otherwise could never exist, and at a low cost (see Figure 1-26).

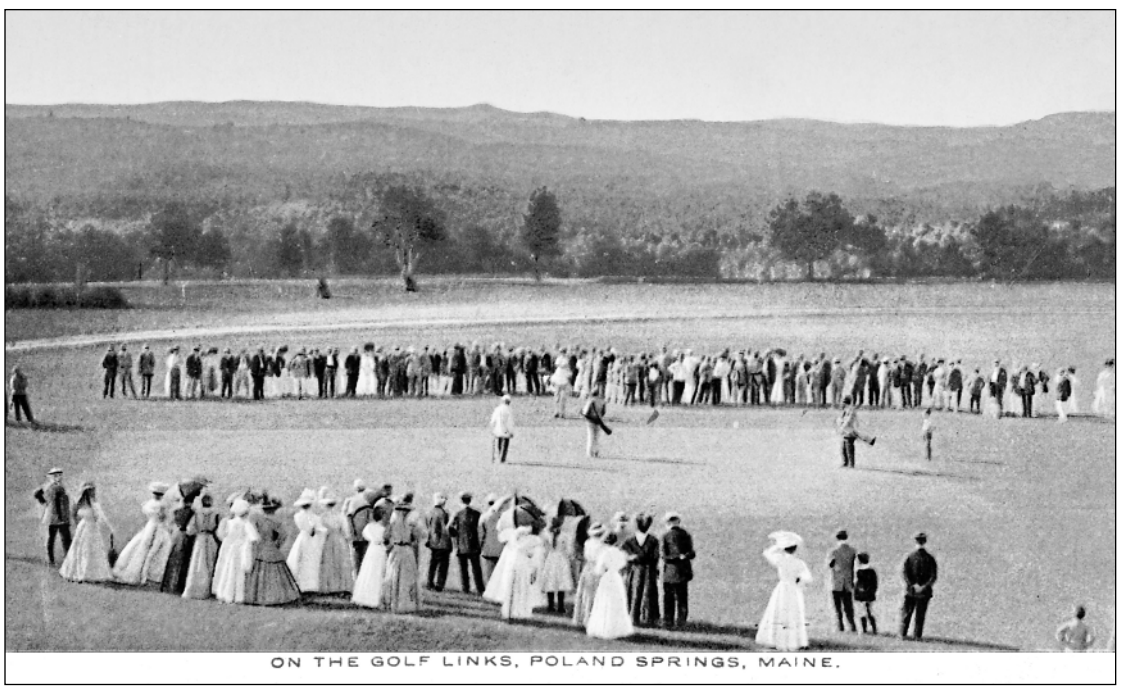


Figure 1-26: As shown in this early twentieth century postcard, golf greens made of oiled sand were small, flat, and featureless. However, these golfers appear to be enjoying themselves.

FORMS OF EARLY GREENS

The earliest and naturally occurring golf greens on linksland courses were in hollows or depressions where the finest grasses were found, because this landform would not only collect surface water, but it also sheltered the greens surface from drying winds (see Figure 1-27). This was also where rabbits and other animals would feel most secure, and they would keep the grass nibbled down short. Occasionally a plateau green was chosen, but it usually had a higher backdrop to protect it from prevailing winds, or it had a readily available and plentiful irrigation source to sustain it. Although sand topdressing seemed to stimulate the fine grasses on such greens, it would also make them droughty unless very fine sand was used, and/or it was mixed with a moisture-holding compost. So with an emphasis on conserving rootzone moisture, the punchbowl or modified punchbowl green became a popular green style, often with the bottom of the "bowl" within the putting surface. Now the greenkeeper could move the hole to take advantage of the natural health of the turf during any given season. Dry hole locations in wet weather, sunny ones in winter, moist ones during drought, and so on.

Perhaps the most dramatic and famous punchbowl green in America, and one of the most fun to play, is the 16th green at National Golf Links (see Figure 1-28). This green epitomizes the concept of surface harvesting water. Oddly

Figure 1-27: Early golf greens on European linksland were generally in hollows or areas of naturally occurring fine-textured grasses. After years of topdressing and close cutting, these greens became well defined but not separated from their natural surroundings.

Figure 1-28: The National Golf Links on the eastern end of Long Island were considered linksland comparable to famous European coastal areas. Not only did the naturally sandy soils support fine-textured golf turf, but also the abundant wind permitted construction of windmills to pump and store water for the golf courses. (Courtesy of Clocktower Press)

enough, right next to it is a windmill that was used to draw water from a well, pump it up to a water tank high in the structure, and then let gravity pressurize it for piping. This tower primarily served the clubhouse needs first, but anything extra could go for irrigation.

So during this pre-1920 period, in both Europe and America, the emphasis on constructing for grass greens was on storing soil water, even to the point of working silts and clays into sandy rootzones, and less thought was given to drainage, other than surface drainage, which, again, limited design expression.

If irrigation water was available, then greens could be planted to turf, and although the designer could now build in strategy and interest with undulation, he or she was still limited by budgets of time and money, so most of the greens were push-up types, which meant the physical and chemical properties of the rootzone usually took on the characteristics of the soil conditions within a few yards of the green. Where irrigation was possible and soils were tight, architects also had to consider drainage issues, and to work at the highest levels of design sophistication and expenditure meant specifying modification of the rootzone, principally with organics or composts, fertilizers and mineral amendments. Even if a water source was available, the methods to pressurize and distribute the water were usually limited to water towers and water wagons. This objective of moisture conservation strongly influenced golf course routings designed by knowledgeable architects as it relates to green site locations and chances of

Figure 1-29: The form of early golf green design attempted to conserve water on the putting surface as well as reduce wind-induced evaporation. However, greens depending on only natural rainfall for moisture often severely dried out in the summer.

maintaining quality turf. The point is that, even with a water source, it behooved the golf course architect to take all available steps to conserve that precious water by developing tight rootzones, for burned-out grass greens were considered worse to play on than oiled sand greens (see Figure 1-29). Design and maintenance were totally integrated.

GOLF GREENS IN THE ROARING TWENTIES

Before looking at golf course construction in the 1920s, it is worth remembering what America was like in the Roaring Twenties. The world had just defeated the Germans in the "war to end all wars," prosperity was at an all-time high, there were many people becoming wealthy in all sorts of industries. Golf was becoming America's game, and no one could imagine that this situation would ever end. There was lots of mass transportation, even as America was becoming a nation of personally owned automobiles, so no place was really remote. This meant suburban communities could develop, elegant resorts were springing up, and country club development was everywhere. As a result, golf courses escalated their competition with one another for egoistical as well as financial reasons. One easy way to distinguish a golf course from its competition was to irrigate it, and with irrigation came new, higher standards of turf care, especially for greens. Power mowers were still in their infancy but were more common, a few pesticides were available, and budgets for manpower were steadily increasing. This period was called the "golden era of golf and of

golf course architecture," because it was a time of enormous wealth and a great host of golf course designers and greenkeepers determined to show off their skills by spending it. In addition, there were many sources of mass communications, such as radio, daily newspapers, golf magazines, newsreels, and movies, to sell the message and virtues of golf and golf courses. Golfing celebrities, such as Walter Hagen, Bobby Jones, and Walter Travis, also contributed to the game's popularity.

The 1920s saw increasing use of irrigation for greens, which had a profound but still limiting effect on design concepts. Certainly, being able to have a stable, yearlong turf surface allowed the designer greater freedom of design expression, but the capacity of the irrigation source still set the size of the green that could be irrigated on a frequent basis. Another compounding factor was that, if infiltration rates into the rootzone soils were slow, that fact dictated a gentler slope to avoid runoff waste. Of course, then, as today, designers often ignored these agronomic considerations and left it up to the greenkeeper to figure out how to grow grass on the designer's "masterpiece." Invariably, greens that were too difficult to maintain were ultimately rebuilt to a more manageable and commonsense concept—a practice that has not changed much in the past 80 years. This goes back to the tried and true premise that "form must follow function," and the concept is elaborated upon in Chapter 3, on design.

IRRIGATING GOLF GREENS

The first sprinklers were not much more than rotating nozzles, held up in the air by a stand and supplied by a garden-type hose (see Figure 1-30). There was little or no way to control pressures, and so the precipitation pattern would vary with the rise and fall of available water pressure. Sprinklers had to be set and moved by a workman who, one only hoped, understood how to compensate for wind, variable soil requirements, and pressure fluctuations to get a uniform watering. As a result, most greenkeepers preferred hand watering over sprinklers because it was easier for workmen to see or visualize a uniform water application. Dr. Alister MacKenzie wrote in the June 1931 issue of *Golfdom,* "[T]he greenkeeper at one eastern club recently told me that at times they required as many as 18 men to water the course. This obviously is exceptional. The average would require six men."

This problem of trying to achieve uniform application of water to greens led several researchers to see the value in subirrigation, or applying water at the bottom of the rootzone and allowing upward capillarity to result in a uniform wetting front. This system worked well in small, intensive forms of agriculture and horticulture, and it was reasoned it should work well in golf greens. In fact, it did work well in small, flat test plots, but as soon as the rootzone surface was varied, differential wetting resulted.

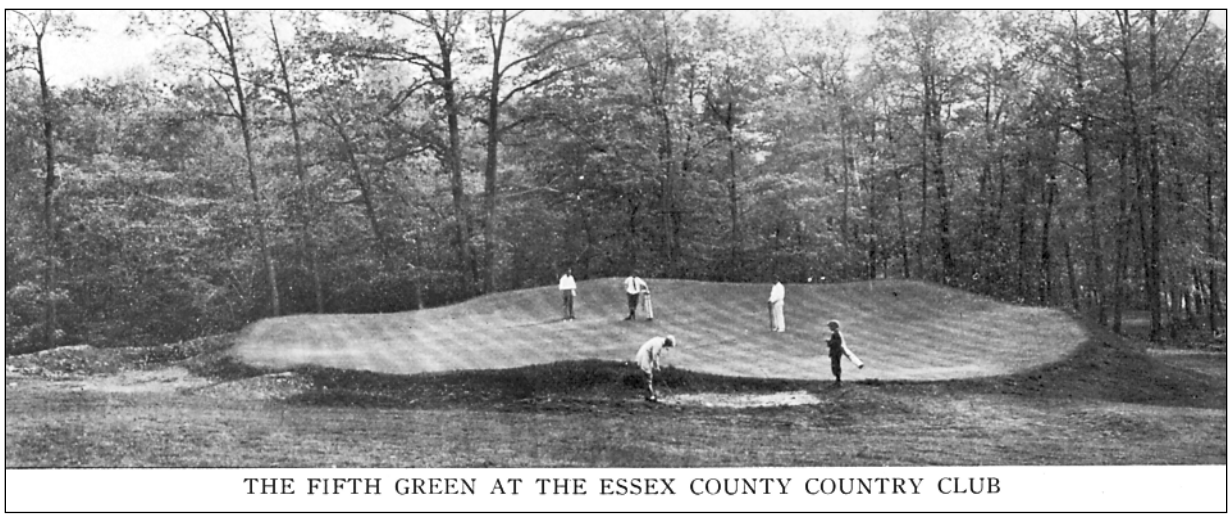
(*a*)

(*b*) The Turbo-Irrigator in Operation on a Private Lawn—Price Complete $12.00

Figure 1-30: (*a*) and (*b*) 1915 advertisements for golf course sprinklers show that, even if a golf course had a dependable and pressurized source of irrigation water, the means to apply it were crude at best.

Parenthetically, subirrigation still makes good sense, and it is only a matter of time until it becomes a water-conserving approach in the future. Several golf courses are now attempting it, but most are in areas of adequate rainfall where salt accumulation that occurs with subirrigation will be purged by natural drenching precipitation. Where irrigation water is high in salts, or in microclimates where low rainfall is normal, subirrigation may have only limited applicability, if any, unless combined with turfgrasses that have high salt tolerances.

Just as irrigation practices and equipment were being refined, so too was mowing. Early techniques involved skilled workmen with very sharp scythes, who might be able to work within three-quarters of an inch of the soil surface. These workers were supplanted by improved mechanical mowers, which might mow down to just below one-half inch or so. This meant greens putted slow by today's standards, and rolled like a closely cut fairway turf would today. Putters from that era commonly had three to five degrees of loft and were rarely straight-faced, because putts had to be forcibly stroked and would be played as much through the air as rolling on these early grass greens. Slow rolling speeds for golf balls, combined with the need for surface drainage water, meant that slopes on grass greens could and should be accentuated, and so slopes of seven to ten percent were common. As mowing heights began to come down with sophistication in mowers in the 1920s (see Figures 1-31 and 1-32), so did the requirement for slope until now, with ultrafast greens of today resulting from mowing at one-tenth of an inch or less, only one to two percent pitch is usually used. This is barely enough to drain surface water and, again, has limited the designer's ability to build character into putting surfaces. This will be discussed more in later chapters.



THE FIFTH GREEN AT THE ESSEX COUNTY COUNTRY CLUB

Figure 1-31: During the first half of the twentieth century, golf greens were often designed with a good degree of surface slope for drainage, as can be seen in this 1930s advertisement.

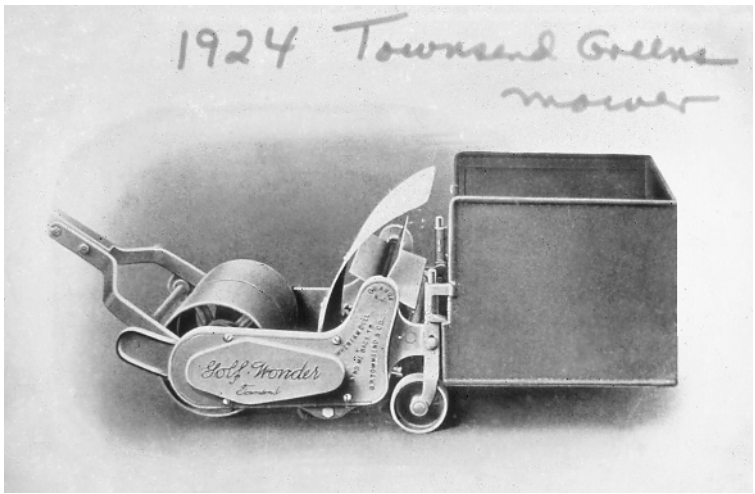


Figure 1-32: Through the 1920s and well into the 1930s, green mowers became more refined, capable of mowing to a quarter of an inch or less, but were hand pushed.

While Europe stayed with the old traditional techniques, America after the First World War was not tied to these frugal European approaches. In fact, Reginald Beale, F.L.S., in the 1924 book, *Lawns for Sports: Their Construction and Upkeep* (London: Simpkin, Marshall, Hamilton, Kent & Co., 1924), wrote:

> [N]either the Americans nor the French work on this principle [of economy]; nothing daunts them, they want the best that money can buy, and they see that they get it in spite of their climate, which is thought to cramp any greenkeeper's style, varying as it does from artic to tropical temperatures, so far as America is concerned. If the ground is poor, it is made rich; if it is wet, it is drained; if rocks and stumps stand in the way, steam drills and dynamite soon settle them; water is laid on as a matter of course; the clubhouses are the acme of luxury, and the whole organization goes with a click.

PIPER AND OAKLEY

Beale's view was quite correct and based upon the enormous amount of theoretical and applied research on golf greens in America, which began in 1902 when Dr. Charles Piper was hired by the USDA to work with golf courses and lawn grasses as an agrostologist. Shortly thereafter, Dr. Russell Oakley joined him at USDA as an agronomist, and together (see Figure 1-33) they pioneered noncommercial turfgrass science, not just in America, but also throughout the world. Their work resulted in their classic 1917 book, *Turf for Golf Courses* (New York: The Macmillan Company, 1917), which became the bible for greenkeepers. However, their interests were more on the total scope of golf course maintenance challenges rather than narrowly focused on golf green construc-

tion, although they did offer some insights in their book in a section subtitled "Soils for Putting Greens." They wrote:

> For putting greens every effort should be made to secure as nearly perfect soil conditions as possible before seeding the green." . . . The texture of an ideal turf soil is a loam, which may vary from a sandy loam to a clayey loam . . . sandy soils are bettered by the addition of silt or clay, or both, so as to obtain in the surface foot about one-third of these materials. Where clay is used, it should be dry and pulverized, as otherwise a good mixture is not secured. Humus forming materials should be added in large quantity, preferably enough to cover the green to a depth of three to four inches. The thorough mixing of these elements will form a satisfactory sandy loam soil.
>
> In some cases it may be cheaper to carry good soil to cover the proposed green to a depth of at least six inches, but good soil for turf is usually scarce when the prevailing soil is either very clayey or very sandy.

Other suggestions from Piper and Oakley included seeding with a blend of creeping bent and red fescue, having a rootzone depth of 8 to 12 inches, tiling if subsoil is not porous, and using organic fertilizers or well-rotted animal manure. They stressed that irrigation is important and suggested that the moisture-holding capacity of the soil should be higher. They concluded this section by writing:

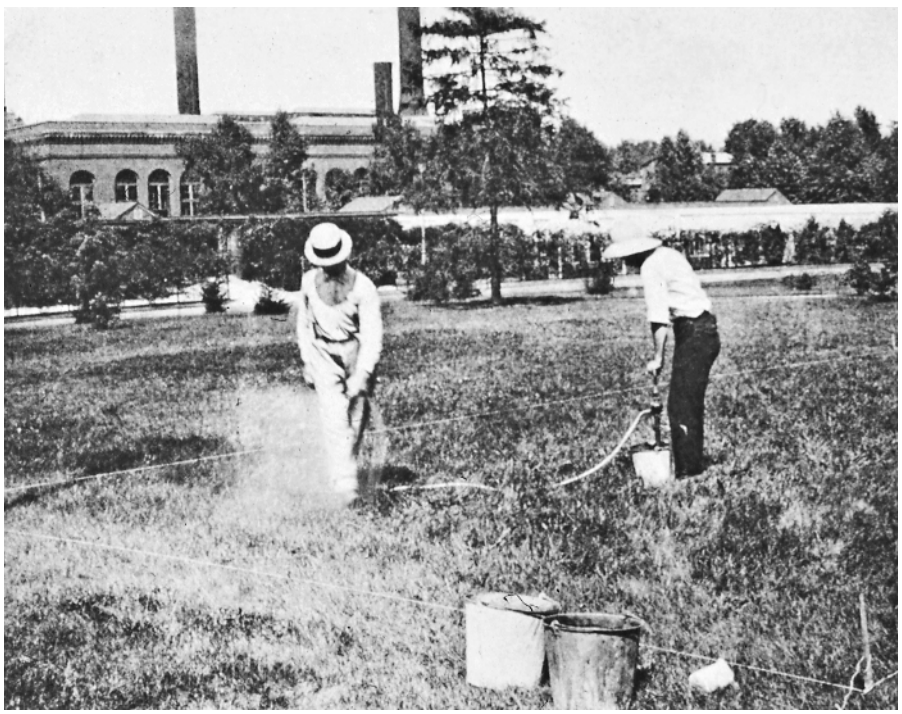


Figure 1-33: A rare picture from a *USGA Green Section Bulletin* showing Drs. Oakley and Piper, who were hired by the USDA to advance the turfgrass sciences. (Courtesy of United States Golf Association)

> . . . No hard and fast rules can be laid down that will insure the securing of good turf under any conditions, as the factors involved are numerous and far from being thoroughly understood. So far as our knowledge goes, however, all of the factors emphasized are of prime importance, and it is rare that any one of them can be neglected and good results be achieved.

Perhaps the most fascinating chapter of Piper and Oakley's book dealt with "Experimental Work on Golf Courses." Until the work of Piper and Oakley, greenkeepers learned by trial and error, but never really made any bold deviations from the norm because it might cost them their precious job. Piper and Oakley wrote:

> The experience in golf course management has not resulted in much increase of accurate knowledge so far as turf-growing is concerned. Every putting green on a golf course has in most cases been subjected to so many kinds of treatment that it is impossible for any one to determine which factors were good and which were bad.

So true exploratory science was left to researchers in government, universities, or industry, using scientific methods involving check plots, replications, statistics, null hypothesis, and so on. But such investigations take lots of time, money, and energy with no guarantee of any return on investment, or assurance that what is discovered has any utility. However, such searching for truth and principle is what advances a profession. It has been said, "Science is the description of the world as it really is, and proof of that is universally reproducible. Science without proof is philosophy, while art is the creative expression of an idea." Accepting this notion allows one to see that greenkeeping has been and will perhaps always be philosophically both art and science.

Piper and Oakley did set up simple experiments of their own to find "universally reproducible" results, as well as evaluated the work of others as a sort of peer review. One notable investigation they cite was done by J. B. Olcott of South Manchester, CT, at the Connecticut Experiment Station from 1885 until his death in 1910 (see Figure 1-34). Olcott searched localities throughout America, Europe, Hawaii, New Zealand, and Australia for samples of turf that he could propagate and evaluate for superior utilitarian qualities. From among thousands of isolates, he selected over 500 strains of grasses and after many years concluded that, in New England, creeping bent and red fescue were best.

F. W. TAYLOR

When Olcott died, a Philadelphia engineer, F. W. Taylor, purchased the finest turves developed by Olcott and moved them to his home test plots in Highland, PA. Taylor's work was described by Piper and Oakley as follows:

Figure 1-34: One of the earliest turf gardens to develop improved strains of grasses was Olcott Gardens, started in 1885 as a hobby for an amateur botanist. The garden had as many as 500 different strains of grass and provided valuable information to early turfgrass scientists. (Courtesy of United States Golf Association)

> In many ways the most extensive and remarkable series of turf experiments undertaken were conducted by Fred W. Taylor on his home grounds near Philadelphia. These experiments began in 1904 and were continued until Taylor's death in 1915. . . . Purely from the love of the sport, he undertook his experiments with the firm belief that greens could be made in much the same way that an article is manufactured in a machine shop or factory. He believed that careful study would reveal the specific requirements of fine turf, and that these requirements could be met by the use of standardized materials.

Taylor's objectives were to design a standardized rootzone that was a good medium for germination of the seed and the development of the seedlings, and whose fertile soil would have a high water-holding capacity while at the same time providing perfect drainage. Taylor received three patents in 1916, a year after his death, for his method of building golf greens, which are the basis for

the USGA recommended method, the PURR-Wick™ system, the California green, and yet to be refined methods of subirrigation for golf greens. Taylor was not so much a genius with profound vision as a keen observer of fundamental principles applied to golf green construction. He recognized and understood capillarity, maintaining proper soil, air, and moisture balance, and site specificity in selecting grasses.

A good description of F. W.'s methodical approach was from Piper and Oakley when they wrote:

> With these conclusions fairly in mind, Taylor sought to construct the ideal green by selecting his grasses and actually building a medium upon which they were to be grown.

What makes this interesting is that the process that Taylor used is precisely the one that we should use today, although with the additional step of factoring in the quality of the irrigation water. It should be a three-step process.

Step 1: Carefully analyze the quality and quantity of any and all irrigation sources.
Step 2: Based upon the water analysis and observed or measured microclimatic factors, select the best adapted putting green turfgrass.
Step 3: Then determine the best method of rootzone and composition architecture for each green site based upon steps 1 and 2.

Although this decision-making process is almost a century old, few have learned to trust it, for most golf course superintendents and turf consultants resist it in favor of some "one size fits all" method. One goal of this book is to help serious students understand the importance of Taylor's approach, so that work is extensively reviewed in Chapter 2 on Golf Green Theories.

From F. W. Taylor's time until now there is nothing really new except *products* (genetic material, soil amendments, fertilizers, pesticides, etc.), but the thought process behind their application remains a constant search for the best balance and control of physical, chemical, and biological factors that influence the health of putting green turf. From this point on, nearly all the history of golf greens is a merger of turfgrass science trying to understand and improve on what is observed on golf courses, and the techniques being used. There is no single best approach, and to optimize performance requires intelligent application, for each particular situation or green site, of proven and evolving science-based knowledge and commonsense.

Currently, there has been a shift in thinking away from emphasizing the conservation of water in the rootzone of greens, as it has been the goal for 150 years or so, to complete and thorough drainage of excess soil moisture, and to directly managing the soil air in the rootzone of greens with vacuums and air pumps.