long and persistent search, involving much correspondence and many expeditions. When the desired material was found, it was likely to be in unsuitable condition, and then came a search for machinery to bring it to condition. Eventually regular agricultural machines were found that served for mixing, for cutting, for grinding, and for shredding at relatively low costs. Gasoline engines of from ten to twenty horsepower were needed for this work.

Every material had to be tested to show its physical characteristics, much in the way sand is tested for use in concrete and filtration work. Nothing was taken for granted about these materials; positive knowledge was sought and obtained as to the size of their particles, their voids [air spaces], and water-lifting capacity.

A novel plan for study was carried out in the fall of 1909. This consisted of a concrete basin about fourteen feet square and sixteen inches deep. The basin was built with small reservoirs for water, and with drain outlets at different heights to control the depth of the water in the soil.

Referring in a letter to the grass grown in this concrete basin, Taylor said:

A rather spectacular part of my experiment is that I have succeeded in growing a grass which was planted in the month of November, and which went from the first of June till the first of September without having a drop of rain or other moisture come to it from above. A glass cover was put over it to keep the rain off, and it received its water supply from the reservoir below, through the lifting sands which soaked the water up from the reservoir and passed it on up to the roots.

We experimented with lifting sands from all parts of the country, and finally succeeded in finding sand of a particular grain composition which will lift water as high as 48 inches from a reservoir below, and hand it over to the grass roots. Some ordinary sands will only lift water half an inch, some not at all, others all the way between this and 48 inches, depending upon the grain composition of the sands.

Turning again to Van du Zee's paper, we read:

It was impossible to avoid the feeling that, in carrying on these extensive experiments, Dr. Taylor took joy in putting shop management into the work. There was the precise classification of materials, precisely measured proportions of the various materials that entered into the synthetic soils, precise percentages of water to be supplied, etc. It seemed as if Dr. Taylor had in mind a routing plan for the roots and for the water. In arranging soils of different kinds in layers at various levels, he made provision for the young roots, the maturing roots, and the fully-matured roots.

We learn also from Van du Zee that Taylor's failures, as they enabled him to eliminate certain combinations, were as satisfactory to him as his successes. He often expressed a joy in failure. "If it weren't for our failures," he said, "we would learn so little!"

While he was conducting his experiments he never lost an opportunity to investigate any promising turf that had been formed in the ordinary way. Turf samples were brought to Boxly from many different regions, replanted there, and carefully treated and watched. The results obtained from this work were practically all negative.

Now, as to the outcome of all this experimenting. In his *Country Life* article, Taylor set forth his conclusions and the reasons for them at length. It must suffice here to say that the grasses he selected as standard were red fescue and creeping bent (the former to be used where summers are cool and the latter where summers are hot), and for the growing of these grasses developed three types of synthetic soil. His first type was his costliest and best. His second type he recommended to those who might not wish to go to the expense of the first type; while not so good as the first, he considered it far better than any natural soil. His third type was a cheaper soil designed for sections where clay is difficult to procure and bar sand is available.

The best type of Taylor soil is constructed as follows: At the bottom is a drainage layer of broken stone from three to four inches thick. Above this are two layers of different soils, one three inches thick and the other an inch and a half; these layers being not horizontal but placed one on top of the other at an angle of 45 degrees. Then above these oblique layers are two horizontal layers of different soils, each about an inch thick; and finally a very thin "seed germinating" layer of a still different soil. The materials that enter into these layers in different combinations and proportions are shredded peat moss, powdered bone, cracked bone, powdered limestone, cow manure, clay, and "fibrous peat from the surface of forest soil."

As was indicated by Van du Zee, these various layers are designed to make provision for the grass roots at the various stages of their development. So masterly was the knowledge gained by Taylor of their development that he was able to tell what, at each stage, they would need in the way of space, air, food, and water.

In a note introducing Taylor's putting-green article, the editor of *Country Life* said:

On November 2, 1914, I went to Philadelphia and examined scores of experimental grass plots, together with three putting greens on the new Sunnybrook Golf Club's course. These last had been sown only five and a half weeks before—and in a late season for sowing grass. The grass was so well developed that the greens could have been played upon even then, and, owing to the peculiar quality of the soil, without the least danger to the tender young blades. On the same course were other greens, sown at the same time in the old way, bearing eloquent testimony to the superior grass, conformation, and surface texture of Mr. Taylor's greens.

Bender tells us that the best of the ordinary greens cost, in those days before the World War, from $600 to $700 each. The best Taylor green (10,000 sq. ft.) cost $2,500. But whereas the ordinary green costs from $100 to $200 a year for upkeep (feeding and seeding), the Taylor green practically abolishes the cost of upkeep; constant feeding and seeding being done away with, and the green needing only to be mowed and watered. The ordinary green, again, has to be watered

every few days, whereas the Taylor green has to be watered only once in two or three weeks.

Nearly a year, we are told, is required to bring the ordinary green to a condition where it can be played on; and then, if the desire is to have a green anywhere near first class, several more years must elapse. A Taylor green, on the other hand, not only is ready to play on in about two months, but in less than a year develops into a practically ideal green, owing to the fact that its synthetic soil makes it unnecessary at the start to grow more than one kind of grass, and the single grass which in it can be brought quickly to usable condition is of the best type for putting. In making the greens for the Pine Valley course, Bender began the work on April 4, and the greens actually were used on the following June 10. A Taylor green can be played on after a heavy rain and throughout the winter; in freezing and thawing, the turf rises and falls, not in sections, but as a mass. It is a green of extraordinary flexibility; dig your heel into it, and immediately it springs back. "The more you walk on it," says Bender, "the better." Moreover, it is a green which, consisting of a single kind of grass, favors scientific putting by offering a uniform resistance to the ball.

After pointing out in his article that the object of his experiments became "to suit the soil to the grass, not the grass to the soil," Taylor went on to say:

The practice of using the soil as it happens to exist where the putting green is to be located, and of adding manure and fertilizer to improve it, has been so universal, however, that most grass growers will look upon as an extravagance the cost of transporting from a distance materials for making a putting green, and will question whether the members of the club would be willing to pay the cost. The writer is convinced, however, that this objection will not long prevail. The success of a golf course and the pleasure of its members depend more upon the condition of its greens than upon any other single element, and where large sums are spent in purchasing land, building a club house, and making roads leading to the club, the money will be forthcoming for making greens which will be perfect within a year rather than to wait for several years while greens are being gradually improved, frequently at great annual expense by adding properly prepared soil on top of the grass, and resowing, so that in the end the green planted on the natural soil costs far more than the artificial green.

Thus here once more we see exemplified the Taylor principle of prudential spending, of royal economy. And now let us consider the thing that inspired these grass-growing experiments of his; namely, his work at golf—and as here used, work certainly is the word.

CONTROL is the central factor in reasoning. It is regulation and control that makes the difference between guessing and thinking. We may draw an analogy from the mechanical sciences. Science can not create energy, it can only guide and direct it. Science did not create the Mississippi River; what it does it to build levees to direct and control its course. The progress of engineering is a constructive process in which instruments are devised as means of regulating natural energies. In this way we control and use the powers of nature which, left to themselves, threaten to overwhelm us. After the same fashion we may say that progress in thinking is an engineering process in which invention and construction, devising and planning, ordering and adjusting, are the main factors. We cannot create the stream of thought any more than the engineer can create the Mississippi. What he can do is to guide the stream. To do this is to think. In emphasizing the factor of control, we define and locate the problem of reasoning. The difference between clear and confused thinking, between guessing and inquiring, is a difference describable in terms of the amount of conscious control we exercise over the flow of our ideas. Do they just flow along following the lines of least resistance, or is there an effort made to order and arrange them with reference to some need or purpose?

In the tide of human affairs there are to be found two kinds of people: Those who float and those who swim. The floater, carried by the current, drifts aimlessly. The swimmer directs his movements toward an end and organizes his energies with reference to a purpose. To think is to swim, not to float; it is to dominate, not to drift. (McClure: *How to Think in Business*, p. 73-74.)