ASSESSMENT OF TESTING METHODS FOR ESTABLISHING GOLF COURSE ACCESSIBILITY GUIDELINES

Progress Report to the United States Golf Association

November 1, 1996

J.A. MURPHY AND G. GENTILUCCI
NEW JERSEY AGRICULTURAL EXPERIMENT STATION
RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
COOK COLLEGE, NEW BRUNSWICK, NJ 08903-0231

ASSESSMENT OF TESTING METHODS FOR ESTABLISHING GOLF COURSE ACCESSIBILITY GUIDELINES

Executive Summary

The Americans with Disabilities Act of 1990 was passed to eliminate barriers which limit accessibility to the disabled. This has heightened the awareness of the play of disabled golfers, especially regarding the use of assistive devices for the playing of golf. Of particular concern is the impact that non-conventional forms of traffic have on playing surface quality, particularly putting greens. Work during 1995 focused on developing quantitative tests to i) assess the surface characteristics of putting greens and ii) quantify the disruption of playing surfaces. Tests were conducted on golf course putting greens with a range of soil moisture content, soil texture, and turfgrass species to evaluate a number of techniques for the ability to characterize surface hardness and soil strength. Both 'push-up' and high-sand root zone greens were used in these tests. Two relatively inexpensive devices were found that adequately characterized surface hardness and soil strength. A number of techniques were evaluated for the ability to measure the extremely subtle rutting caused by traffic with golf shoes and assistive devices. A depth gauge micrometer was adapted to measure the micro-relief of putting greens surfaces. Techniques to measure the effects of traffic on ball roll are still under development, however, we have made progress. Current methodology utilizes a stimpmeter to create a repeatable ball roll. Before traffic, the path of ball travel for an average (8- to 10-ft stimpmeter roll) putt is determined, and the final resting point of the ball is recorded by measuring the forward (x) and lateral (y) positions relative to the line of travel and end of the stimpmeter. After traffic, ball roll is measured again to determine any deviation from the non-trafficked path of travel. Work during 1996 focused on utilizing the quantitative tests described above to describe the relationships between putting green surface characteristics and the ability to bear traffic. Considerable data has been gathered from putting greens on eleven different golf courses located throughout New Jersey and is currently being summarized. Traffic was applied to greens using wheelchairs, a single rider cart, and the heel of a golf shoe. Each type of traffic was evaluated for the amount of surface depression remaining after 30 seconds of static (stationary) pressure on the putting green. Stationary pressure was applied because this was considered the form of traffic that would result in the most obvious damage and the 30 second time would be representative of the approximate time of putting and waiting for fellow competitors to play out a putt. Preliminary data indicates that relationships between soil strength and the depth of rutting, and soil strength and depth of rutting are beginning to emerge. Edaphic features of each putting green including the soil texture of the root zone, soil moisture content, thatch depth, organic matter content of the thatch, and particle size distribution of topdressing are being determined and will be related to the ability to bear traffic. Data collection and analysis will continue through 1996 to further develop the relationships discussed above. Percentage of time devoted to the project by University personnel include Gary Gentilucci (graduate student, 50%) and James A. Murphy (20%).

ASSESSMENT OF TESTING METHODS FOR ESTABLISHING GOLF COURSE ACCESSIBILITY GUIDELINES

Progress Report to the
United States Golf Association, Green Section Research

The Americans with Disabilities Act of 1990 was passed to eliminate barriers which limit accessibility to the disabled. This has heightened the awareness of the play of disabled golfers, especially regarding the use of assistive devices for the playing of golf. Of particular concern is the impact that non-conventional forms of traffic have on playing surface quality, particularly putting greens.

Problems associated with traffic are classified into four types: soil compaction, wear, rutting or soil displacement, and divoting. These four types of damage frequently occur in combination, however, at a given time, one type of stress usually represents the primary problem on the turfgrass playing surface. Rutting is potentially the most acute and troublesome form of damage associated with traffic from assistive devices. Wear is also a potential acute form of damage associated with assistive devices; this, however, can be minimized by proper operation of devices (etiquette). Considering the current level of traffic from assistive devices, soil compaction will likely be a minor issue, however, compaction will become an important chronic stress as the level of traffic from assistive devices increases.

RESEARCH OBJECTIVES

Work during 1995 focused on developing quantitative tests to i) assess the surface characteristics of putting greens and ii) quantify the disruption of playing surfaces.

RESEARCH METHODOLOGY

Evaluation of putting green surface hardness and soil strength.

Our research evaluated a number of techniques for the ability to characterize surface hardness and soil strength. The tests were conducted on golf course putting greens with a range of soil moisture content, soil texture, and turfgrass species. Both 'push-up' and high-sand root zone greens were used in these tests. After many trials we chose two relatively inexpensive devices to characterize surface hardness and soil strength.

- Surface hardness is measured with the Clegg Impact Soil Tester. A five-pound weight (hammer) is dropped from the height of 18 inches (45 cm) down a guide tube. The deceleration or loss of velocity of the hammer is measured as it impacts the turf and is measured in gravities. The hammer's deceleration (rate at

00611

which it stops) is a measure of the surface hardness. A rapid deceleration (high value) indicates a hard surface; lower deceleration of the hammer during impact indicates a softer surface.

- Soil strength is measured with an Eijkelkamp 6.06 type IB hand penetrometer. A penetrometer measures the force required to push a cone shaped probe into the soil. The penetrometer is pushed to a one-inch depth from the surface and the penetration force is varied by the compression of a spring. The force exerted is registered by a sliding ring on the outside of the piston barrel of the penetrometer.

Quantifying disruption of a playing surface.

We evaluated a number of techniques for the ability to characterize disruption of a putting surface (i.e., rutting and alteration of ball roll). Initial tests were conducted primarily on native soil putting greens at the Rutgers turfgrass research facility. A number of prototype designs and refinements of those designs were required to achieve a reliable measurement of the extremely subtle rutting caused by traffic with shoes and assistive devices. Techniques to the effects of traffic on ball roll are still under development, however, we have made progress.

- The disruption of a putting surface is quantified through measurements of micro-relief, which maps the changes in contour of a surface. Micro-relief measurements utilize a depth dial gauge micrometer to evaluate the depth of rutting (depression in the putting surface) caused by traffic. The measurement system is comprised of a depth dial micrometer mounted on an aluminum bracket which rests on reference stands affixed to the putting surface. To determine surface contour, depth (distance) measurements are made from the aluminum bracket to the playing surface along a transit that crosses the path of traffic. Measurement of the surface contour is taken before and after traffic; since the bracket position is stationary any change in contour can be attributed to disruption from traffic over the surface.

- We are attempting to quantify ball roll deflection, or interference to ball travel, caused by traffic. Our current methodology utilizes a stimpmeter to create a repeatable ball roll. Before traffic, the path of ball travel for an average (8- to 10-ft stimpmeter roll) putt is determined, and the final resting point of the ball is recorded by measuring the forward (x) and lateral (y) positions relative to the line of travel and end of the stimpmeter. After traffic, ball roll is measured again to determine any deviation from the non-trafficked path of travel.

RESEARCH OBJECTIVES

Work during 1996 focused on utilizing the quantitative tests described above to describe the relationships between putting green surface characteristics and the ability to bear traffic. Considerable data has been gathered and is currently being summarized. The preliminary results described below were developed from data collected in 1995 through early summer 1996.

RESEARCH METHODOLOGY

Putting greens on eleven different golf courses located throughout New Jersey have been used as testing sites for this research during the spring and summer of 1996 (Table 1). Traffic was applied to greens using a wheelchair equipped with 1-inch wide hard rubber tires, wheelchair equipped with $1^{3}/_{8}$-inch pneumatic tires, single rider cart with 4-inch wide pneumatic tires, and the heel of a shoe. Each type of traffic was evaluated for the amount of surface depression remaining after 30 seconds of static (stationary) pressure on the putting green. Stationary pressure was applied because this was considered the form of traffic that would result in the most obvious damage and the 30 second time would be representative of the approximate time of putting and waiting for fellow competitors to play out a putt. The depth of depression was also evaluated for types of traffic as they moved across the green.

Table 1. Golf course putting greens being monitored through the 1996 growing season for surface characteristics and the ability to bear traffic.

Location of Course	Green	Age of Green	Turfgrass Species Present
Plainfield Country Club	5th	45	Bent/Poa
Canoe Brook Country Club	11th	2	Bentgrass
	13th	75	Bent/Poa
Fiddler's Elbow Golf & Country Club	12th	23	Bent/Poa
	Practice	8	Bent/Poa
Montclair Golf Club	5th	3	Bentgrass
	18th	60	Bent/Poa
Springdale Golf Club	12th	75	Bent/Poa
Metedeconk National Golf Club	19th	10	Bentgrass
Tavistock Country Club	4th	75	Bent/Poa
Woodbury Country Club	1st	4	Bent/Poa
	10th	4	Bent/Poa
Ramblewood Country Club	1st	25	Bent/Poa
Galloway National Golf Club	17th	2	Bentgrass
	18th	2	Bentgrass
Blue Heron Pines Golf Course	1st	4	Bentgrass

PRELIMINARY RESULTS

Surface hardness and soil strength.

Figures 1 and 2 present the relationships between soil strength of a putting green and the depth of deformation due to traffic, and between surface hardness and the depth of deformation, respectively. Because data analysis and summarization are

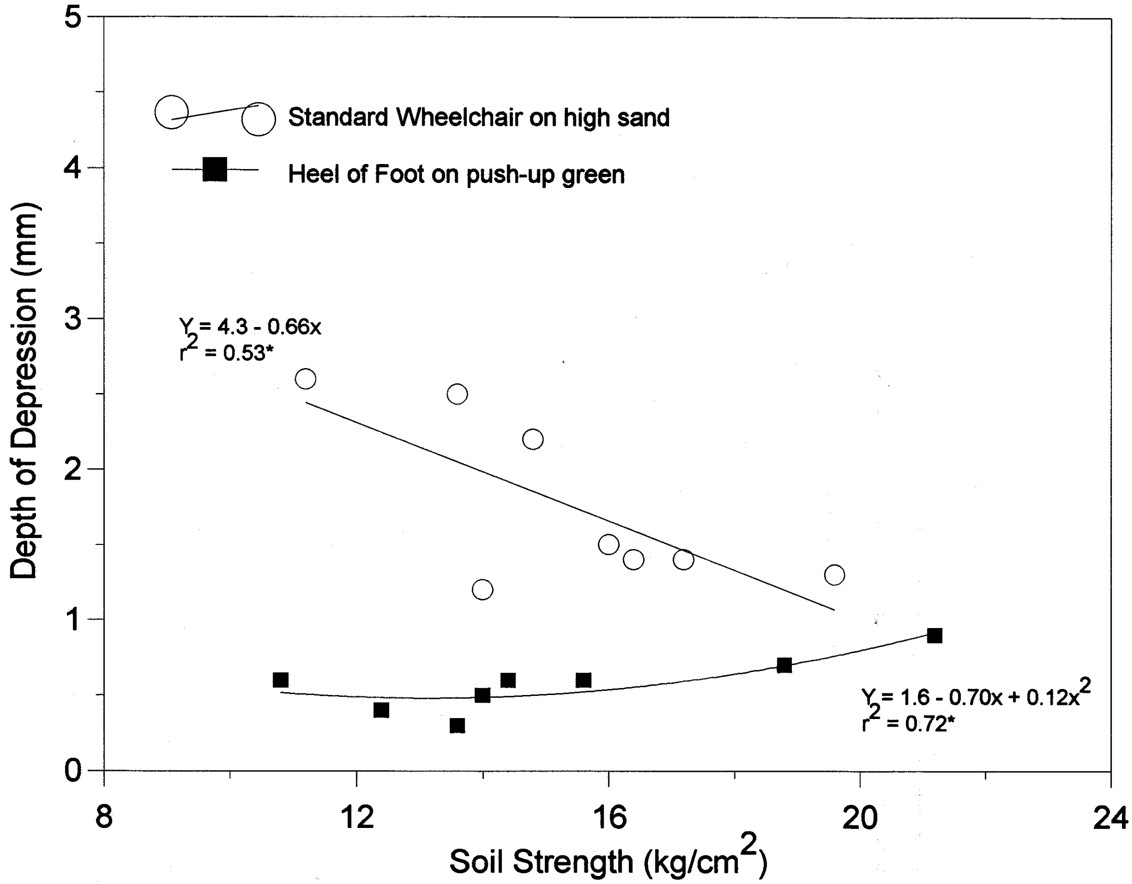

Figure 2. Average depth of depression across trafficked path of a hard tire wheelchair and heel of a shoe on a putting green (30 seconds of static pressure). * denotes significance at 0.05 probability level.

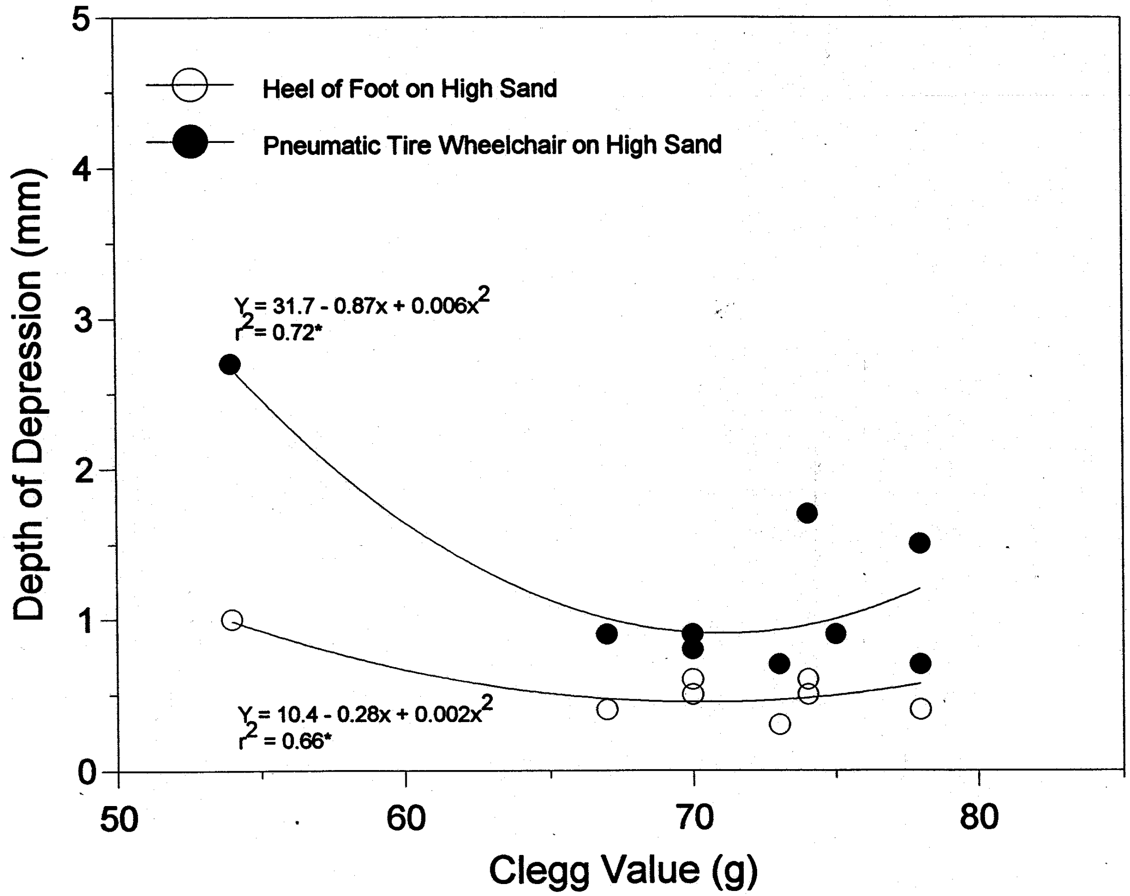

Figure 1. Average depth of depression across trafficked path of a wheelchair and heel of a shoe on high sand putting green (30 seconds of static pressure). * denotes significance at 0.05 probability level.

00615

currently underway, not all types of traffic and putting green conditions are represented in these figures; however, relationships are emerging as illustrated in these two figures.

Figure 1 presents the depth of depression caused by the heel of a shoe and a wheelchair equipped with $1^3/_8$-inch wide pneumatic tires after 30 seconds of static pressure. For these depression data, the values of the Clegg Impact Tester ranged from 50-gravities (a soft putting surface) to 80-gravities (a hard putting surface). The depth of rutting caused by the shoe heel and the pneumatic wheel was similar at high Clegg readings (hard surfaces); whereas rutting depth was greater for wheelchair traffic compared to the shoe heel when surface hardness was low.

Measurements of soil strength and the depth of rutting caused by two types of traffic on two different putting greens is illustrated in Figure 2. The depth of the depression caused by the heel of a shoe on a "push-up" green appeared to be similar across all measured levels of soil strength. On a high sand green, the depth of surface depression caused by a wheelchair equipped with 1-inch wide hard rubber tires decreased as soil strength increased (harder surface).

Data such at those presented in Figures 1 and 2 will help to identify which types of traffic, if any, are likely to produce excessive rutting, as well as which types of putting greens have greater tendency to have rutting problems. Edaphic features of each putting green including the soil texture of the root zone, soil moisture content, thatch depth, organic matter content of the thatch, and particle size distribution of topdressing are being determined and will be related to the ability to bear traffic.

Interference with ball roll.

Ball roll deflection due to traffic over the line of a "putt" is extremely difficult to quantify; however, we are continuing our attempts to measure deflection. Figure 3 presents the amount of deflection measured at one location in 1996. Ball roll did not appear to be significantly deflected by one pass of traffic (Fig. 3a), whereas ball roll was deflected to the right after 3 (Fig. 3b) and 6 (Fig. 3c) passes of traffic. Also note in Figure 3 that the final distance in the ball rolls after traffic had a greater range. As illustrated in Figure 3, our techniques to measure interference with ball have become refined enough to detected interference. As more data is analyzed we should be able to determine if there is a 'threshold' value for depth of deformation that will cause interference with ball roll. Any such 'threshold' value would likely vary according to the type of traffic.

PLAN OF WORK

Data collection and analysis will continue through 1996 to further develop the relationships discussed above. It is anticipated that Mr. Gary Gentilucci, the graduate student working on this project, will graduate with his Master's degree in Spring or Summer 1997.

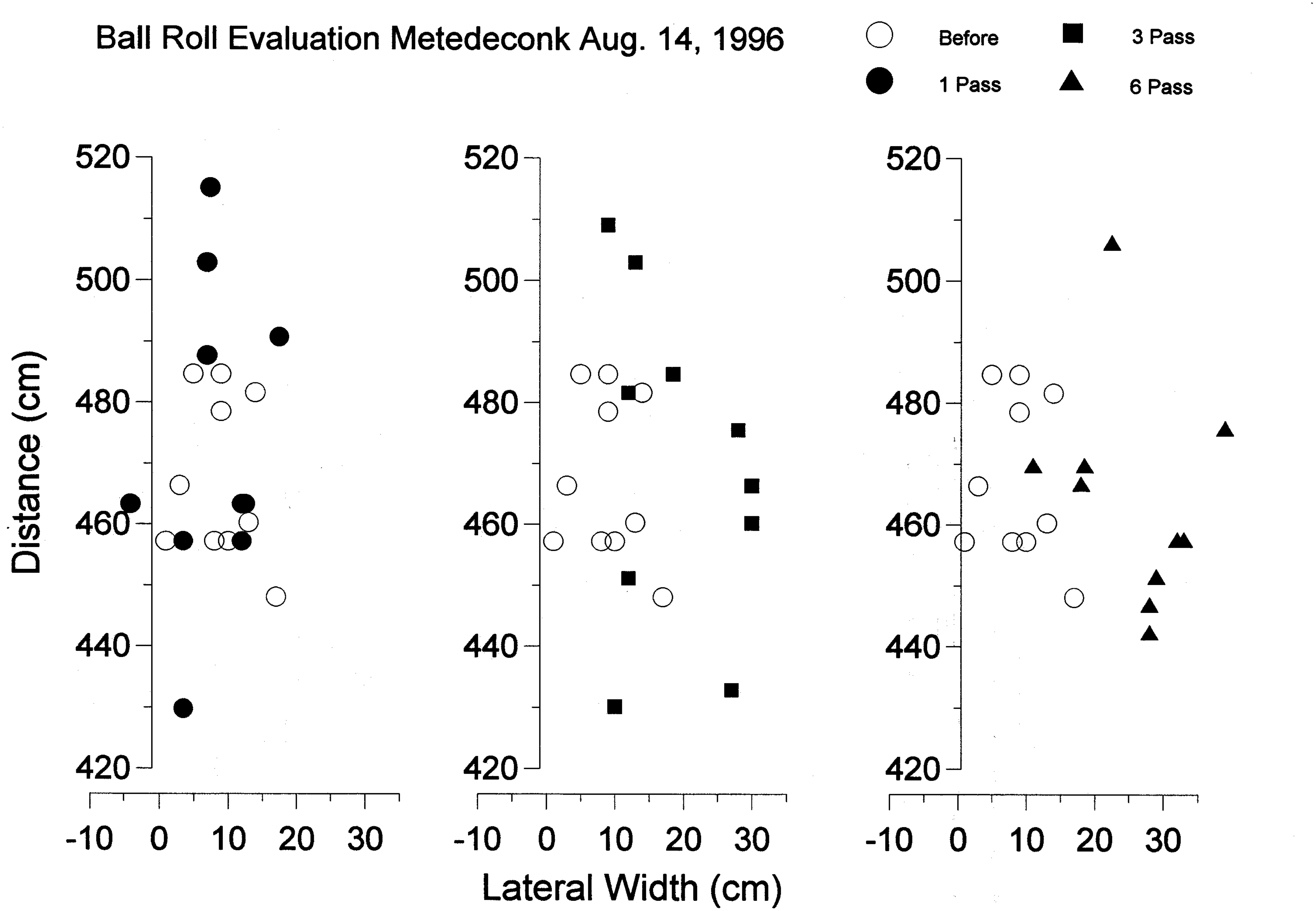

Figure 3. Ball roll deflection across the path of a hard tire wheelchair; increasing pass number is across the same tire path and increased the depression depth and width.