

1998 TRAVELING GOLF SPIKE STUDY
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Introduction

Golf is a game that has undergone tremendous technological changes in the 1990's. One of these dramatic changes has been the banning of the 8mm metal golf spike on shoes at numerous golf courses. In 1995 there were less than 100 golf courses worldwide (1) that had banned the traditional 8mm metal spike. At this time Michigan State University (MSU) began its involvement in alternative spike research (2). Our scientific commitment to concerns brought forth with changes in golfers footwear has been cautious and calculated. Through literature reviews we uncovered a conflict in opinions between turf-researchers and golf course managers and superintendents in 1959(3,4). There have been numerous changes in turf management since that time including: standards for green root-zone construction, thinner bedknives allowing tighter mowing heights, light frequent sand-topdressing, and the banning of insecticides that killed soil microorganisms that alleviated the development of thatch. Each of these probably had some bearing on the acceptance of today's alternative spike/sole. MSU was cognizant of the fact that rating wear caused by the 8mm spike (uplifting of the turf plant) and alternative spike designs (indentations on the putting surface) was similar to comparing apples and oranges. Not wanting to release results that might differ from public opinion led MSU to conduct a golf sole/spike traffic survey in 1997(5). Prior to this survey, MSU never attributed a qualitative rating to any of the alternative spike research it conducted. Among the 1997 survey results was the fact that, regardless of the occupation of the surveyor, the uplifting of turf caused by 8mm spikes was perceived more damaging to a research putting green than indentations made by any of the alternative spikes. However, concerns and doubts persisted regarding the plethora of alternative soles and spikes available in today's market. These doubts led to MSU conducting the 1998 Traveling Golf Spike Study.

Materials and Methods

In winter and early spring 1998, various non-metal golf shoe spike manufacturers were asked to submit entries for the study. The different contributions from each company and their respective codes used in this data reporting are represented in Table 1.

The experiment was a randomized block design with 27 shoe/spike entries and 3 replications. It was conducted at 6 different locations (golf courses) thus providing an ability to evaluate and analyze a spike by location interaction. The golf courses were chosen to represent the various types of putting greens that are managed on Midwestern golf courses. Each course is currently under a ban of metal spikes or under pressure to do so soon. Details of each golf course and its management characteristics are shown in Table 2. This study was conducted between 6 July and 30 July 1998. Each golf course was visited one day during this period. The weather on each day that the golf courses were visited was very similar. Temperatures averaged 80°F and rain was not a factor before or during data collection.

Table 1. 1998 Traveling Golf Spike Study Treatment List- Michigan State University.

Treatment	Code	Shoe	Spike
1	DJ8mm	DryJoys	8mm
2	DJ6mm	DryJoys	6mm
3	DJds	DryJoys	Duraspikes
4	DJgk	DryJoys	GreenKeepers
5	DJgs	DryJoys	Greenspike
6	DJfs	DryJoys	Flatspikes
7	DJfg	DryJoys	FlexiGrip
8	DJgpr	DryJoys	Gripper
9	DJssxp	DryJoys	Softspike XP
10	FJCssxp	Foot-Joy Classics	Softspike XP
11	FJC	Foot-Joy Classics	_____
12	DJGXssxp	DryJoysGX	Softspike XP
13	DJSSssxp	DryJoys(studded sole)	Softspike XP
14	DJS	DryJoys	_____
15	TMssxp	Turfmaster	Softspike XP
16	SJTssxp	Soft-Joy Terrain	Softspike XP
17	GJssxp	Green-Joy	Softspike XP
18	U2tg	Ultimate 2000	TurfGrips
19	DTtg	Difference Tour	TurfGrips
20	Dtg	Difference	Turfgrrips
21	AP	All-Performance	_____
22	STGtg	Stabilite TurfGrips	TurfGrips
23	SS	Stabilite Softspikes	_____
24	NAtg	Nike Air Zoom	TurfGrips
25	NAZws	Nike Air Zoom	Waffle Spike
26	NAA	Nike Air Access II	_____
27	Control	_____	_____

Table 2. Participating golf courses and specific putting green information for 1998 Traveling Golf Spike Study- Michigan State University.

Golf Course	Forest Akers	CC Detroit	Oakland Hills	Red Run	Pine View	Inverness
Location	E. Lansing, MI	Grosse Pointe, MI	Bloomfield Hills, MI	Royal Oak, MI	Ypsilanti, MI	Toledo, OH
Test Green	Pract./Putt	Pract./Chip	Pract./Putt	Pract./Putt	18 th	Pract./Putt
Date of visit	6 July	13 July	15 July	16 July	27 July	30 July
Supt.	Ron Foote	Mark Jackson	Steve Cook	Gary Thommes	Charles Gaige	Tom Walker
Mowing Ht. (inch)	0.157	0.130	0.130	0.095	.145	.130
Turf Species	Penncross	Penn A-4	<i>Poa/Agrostis</i>	<i>Poa annua</i>	Penncross	Pennlinks
Construction (Sand/Peat)	85/15	90/10	Push up	Push up	80/20	Push up
Age of Green	2 years	2 years	70 years	90 years	9 years	11 years
Topdressing depth (inch)	0.25	0.19	3.0	4.9	0.5	2.0
Topdressing frequency	3 weeks	2-3 weeks	3 weeks	2 weeks	6 weeks	1-2 weeks
Topdressing material	100 % sand	100 % sand	100 % sand	100 % sand	100 % sand	100 % sand
Days since last topdressing at time of visit	14	10	8	7	30	10
Thatch Characteristics	minimal	< 0.25 inch	minimal	minimal	0.5 inch	0.25 inch

Traffic was applied to each treatment to represent 200 foot steps around the cupping area of a putting green. 6-10 people (all wore approximately size 11 shoe) were responsible for applying traffic at each course. Each person applying traffic treatments wore every pair of shoes in the study and applied the same number of footsteps in the same pattern for each plot.

At the end of the traffic period the plots were rated using the scale found in the Survey Data Analysis section of this report. Ratings were done by MSU staff, golf course superintendents, and golfers at the golf course.

Survey Data Analysis

Plots were rated using a turf damage severity scale (1 = *Severe*, 2 = *Significant*, 3 = *Moderate*, 4 = *Minimal*, and 5 = *None*) immediately following 200 simulated rounds of golf. For this study, a plot is one replication of a single spike/shoe traffic treatment and an observation is a single rating for one plot. The product of the number of spike/shoe treatments, spike/shoe replications, and raters is the number of observations taken from each golf course. Table 3 summarizes the number of plots and rating observations taken at each golf course.

Table 3. Summary of rating observations at each golf course.

	C. C. Detroit	Forest Akers	Inverness	Oakland Hills	Pine View	Red Run
Spikes/Soles	26	26	27	27	27	27
Replications	3	3	3	3	3	3
Plots	78	78	81	81	81	81
Raters	13	20	8	14	6	11
Observations	1014	1560	648	1134	486	891

The survey categories imply a ranking of turf damage severity, but not quantifiable differences among plots. These data, called ordinal data, arise when a continuous characteristic (turf damage) is measured on a discrete scale with a finite, countable number of categories (severe, significant, moderate, minimal, and none). The assigned scores, 1 = *Severe*, 2 = *Significant*, 3 = *Moderate*, 4 = *Minimal*, and 5 = *None* to the categories for purpose of analysis is arbitrary. Assigning other scores to the categories that preserve their ranking order are equally appropriate, e.g. 1 = *Severe*, 10 = *Significant*, 100 = *Moderate*, 1000 = *Minimal*, and 10000 = *None* or a = *Severe*, b = *Significant*, c = *Moderate*, d = *Minimal*, and e = *None*. It is apparent that a proper analysis of ordered outcomes must not depend on the labeling system for categories.

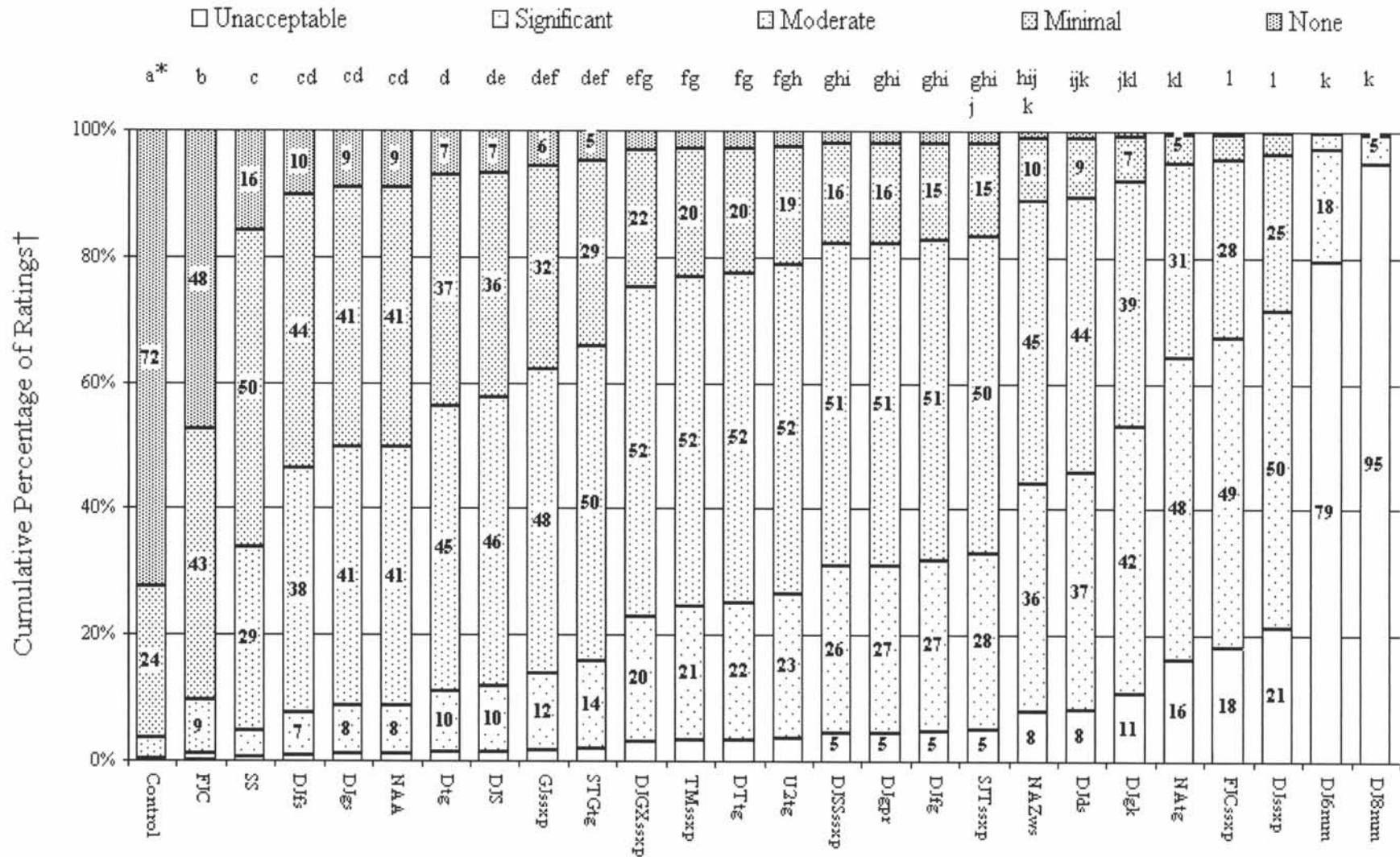
Ordinal data are discrete multivariate and follow the multinomial distribution law. Appropriate hypotheses for comparing treatments with an ordinal response are phrased in terms of equality of the category probabilities. Representing ordinal data should **never** include mean rating scores, but rather probabilities to observe a particular category. Recently, statistical techniques have been developed for ordinal data that permit treatment comparisons, statistical tests, and results similar to analysis of variance but take into account the distributional properties of ordinal data. These analyses are independent of category labeling or numbering, adding an element of objectivity. Parameters of ordinal data models are statistically estimated by maximum likelihood techniques. Reliability of estimates increases with increasing sample size.

A proportional odds model with the logit transform was used to analyze the turf damage rating data and to test for shoe/spike effects, golf course effects, and their interaction. Results are given in terms of probability distributions rather than mean rating scores. Calculating a chi-square value for pairwise comparisons of parameter estimates separates treatment probability distributions.

Results and Discussion

The results from our work and surveys reflect a strong spike x location interaction. The results can be viewed by examining spikes among different locations (Figures 1-6) or spikes across different locations (Table 4). The six figures allow easy examination of various spikes within a specific golf course putting surface. Table 4 provides a format to evaluate individual spikes and their response across all putting surfaces. Both the figures and the tables provide the same information, the presentation formats are diametrically oriented.

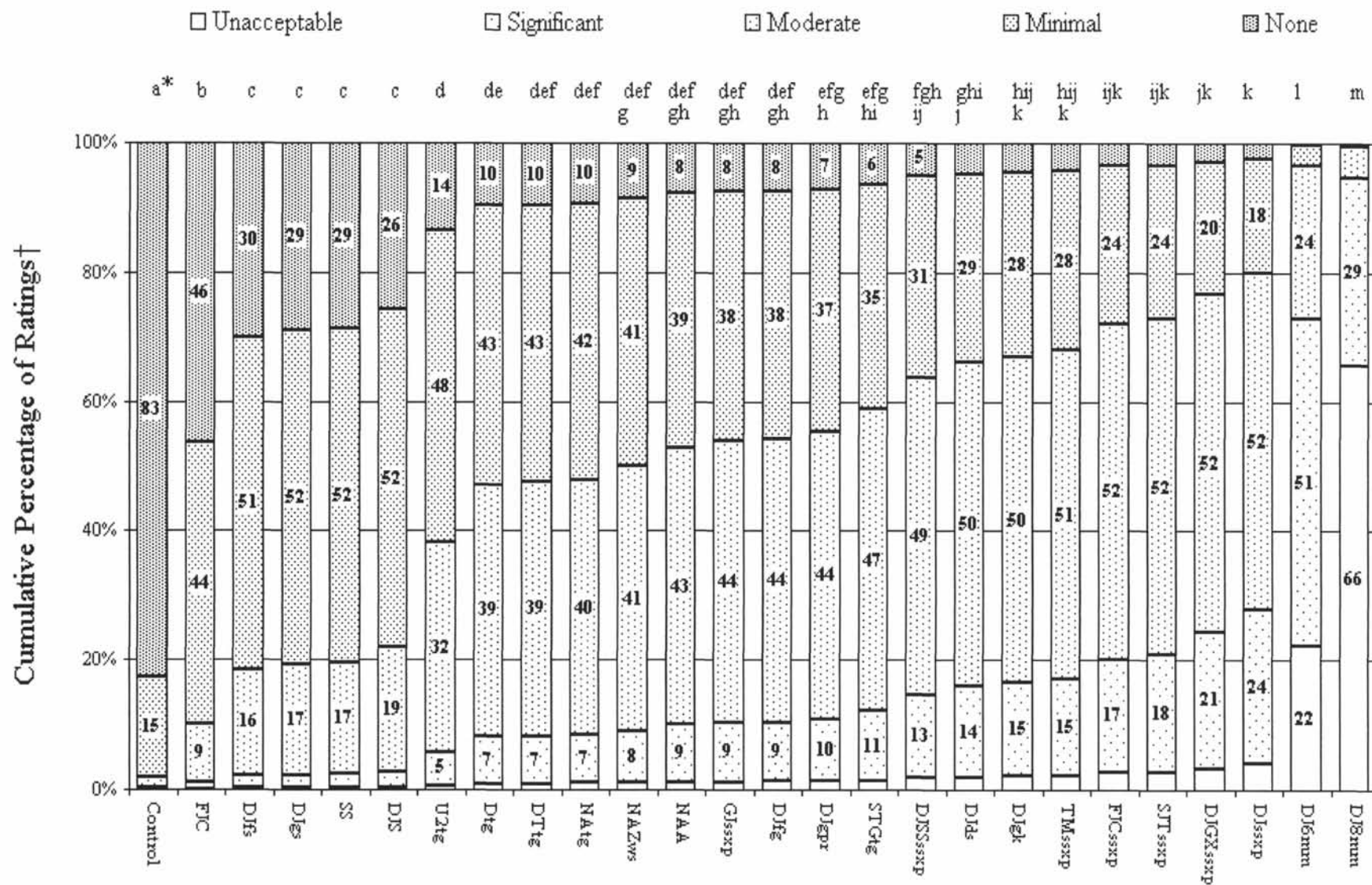
Figure 1. Effects of Spike/Sole on Wear Rating, Country Club of Detroit (July 1998)



*Shoe soles sharing a letter are not significantly different ($P < 0.05$).

†Numbers within the bars represent percentage of ratings for individual categories.

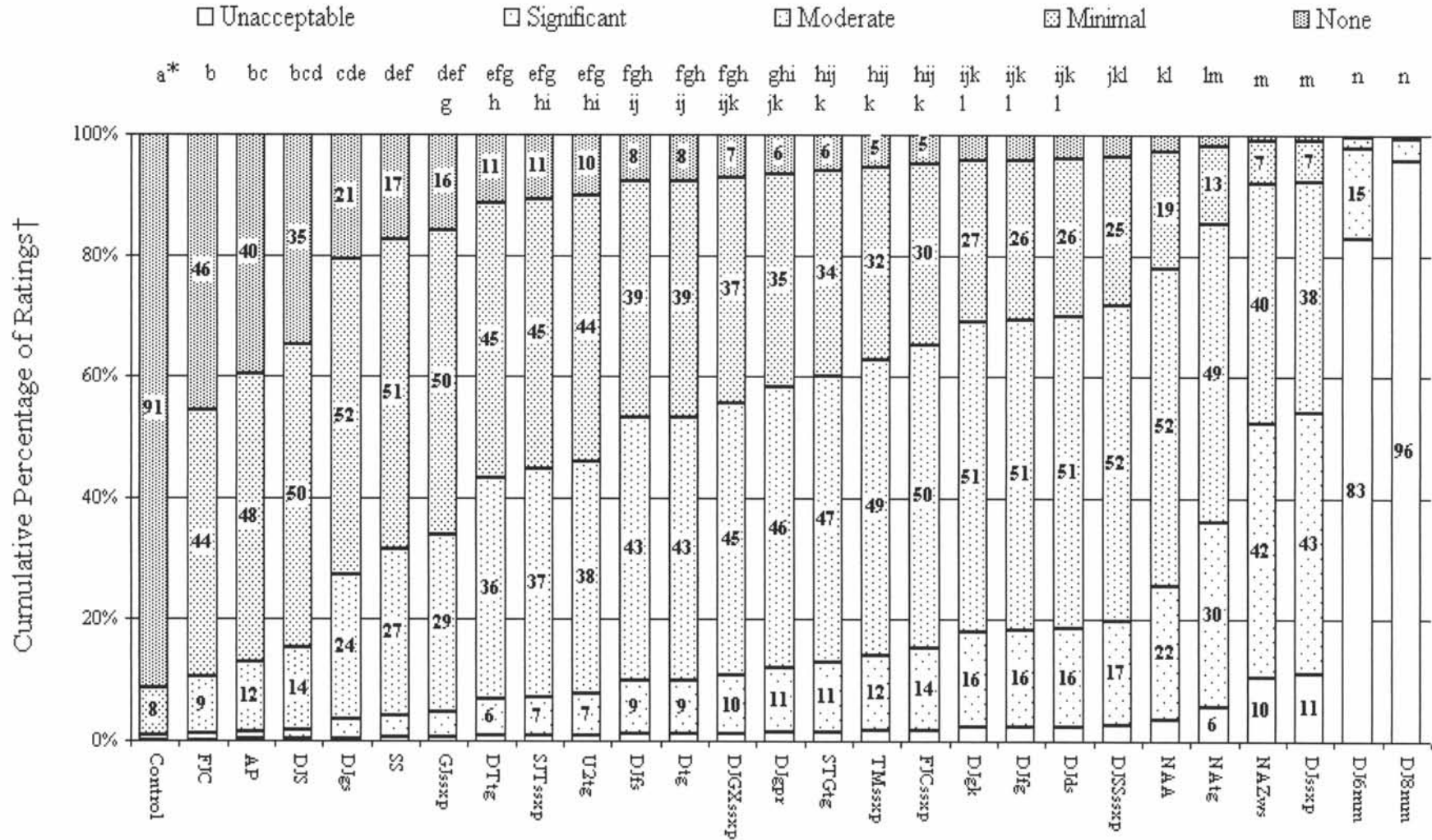
**Figure 2. Effects of Spike/Sole on Wear Rating,
Forest Akers Golf Course (July 1998)**



*Shoe soles sharing a letter are not significantly different ($P < 0.05$).

†Numbers within the bars represent percentage of ratings for individual categories.

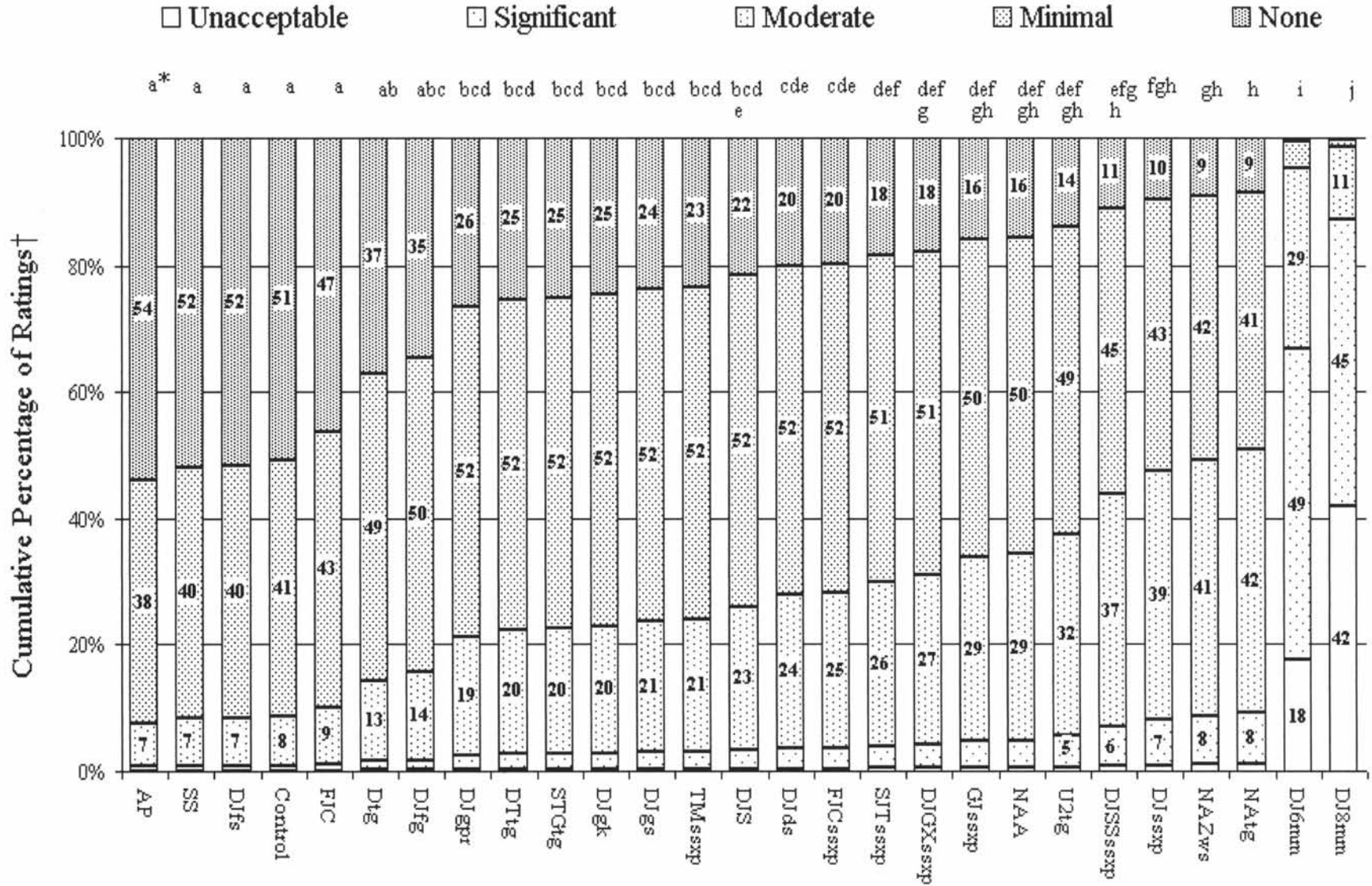
Figure 3. Effects of Spike/Sole on Wear Rating, Inverness Club (July 1998)



*Shoe soles sharing a letter are not significantly different ($P < 0.05$).

†Numbers within the bars represent percentage of ratings for individual categories.

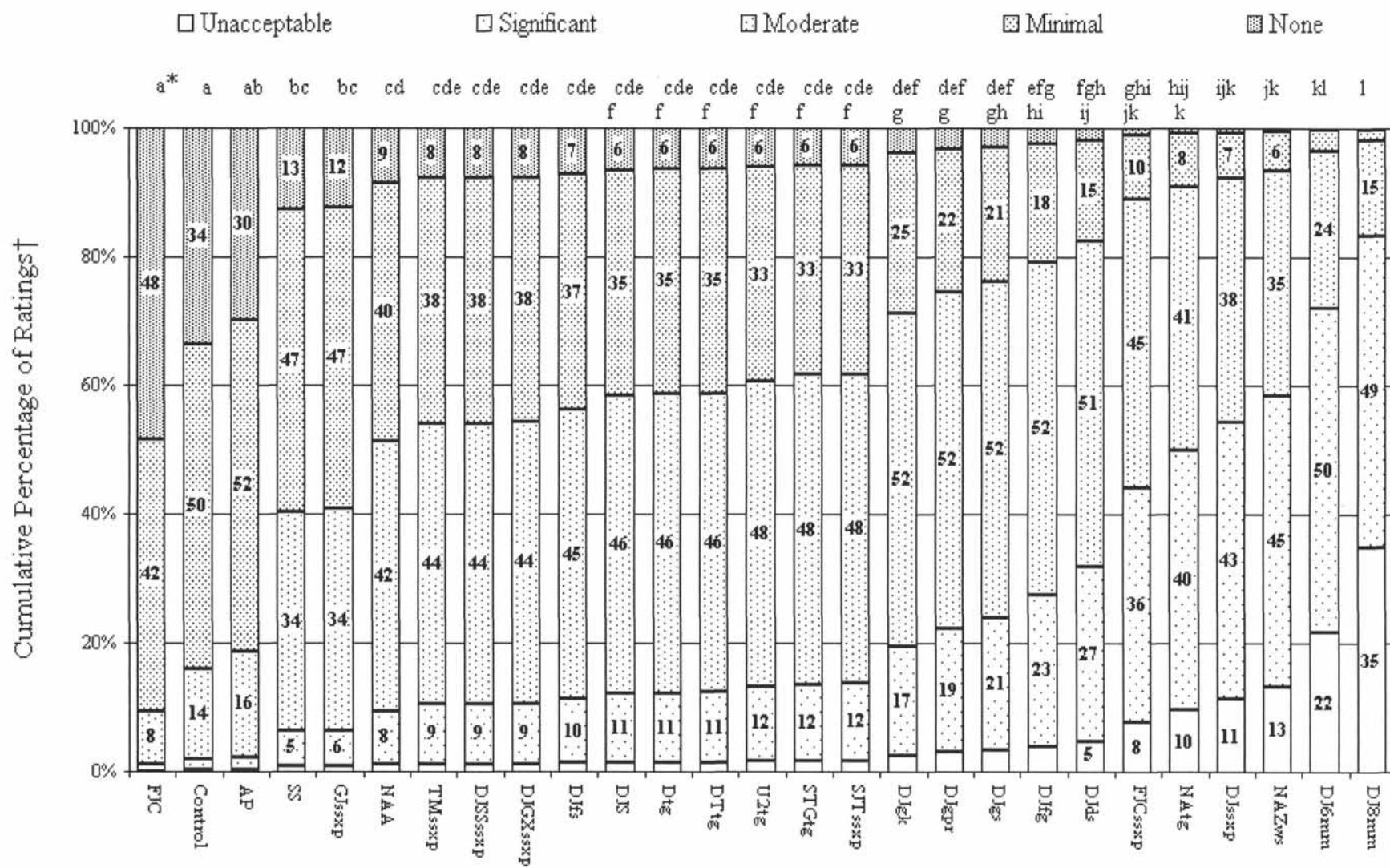
Figure 4. Effects of Spike/Sole on Wear Rating, Oakland Hills Country Club (July 1998)



*Shoe soles sharing a letter are not significantly different (P < 0.05).

†Numbers within the bars represent percentage of ratings for individual categories.

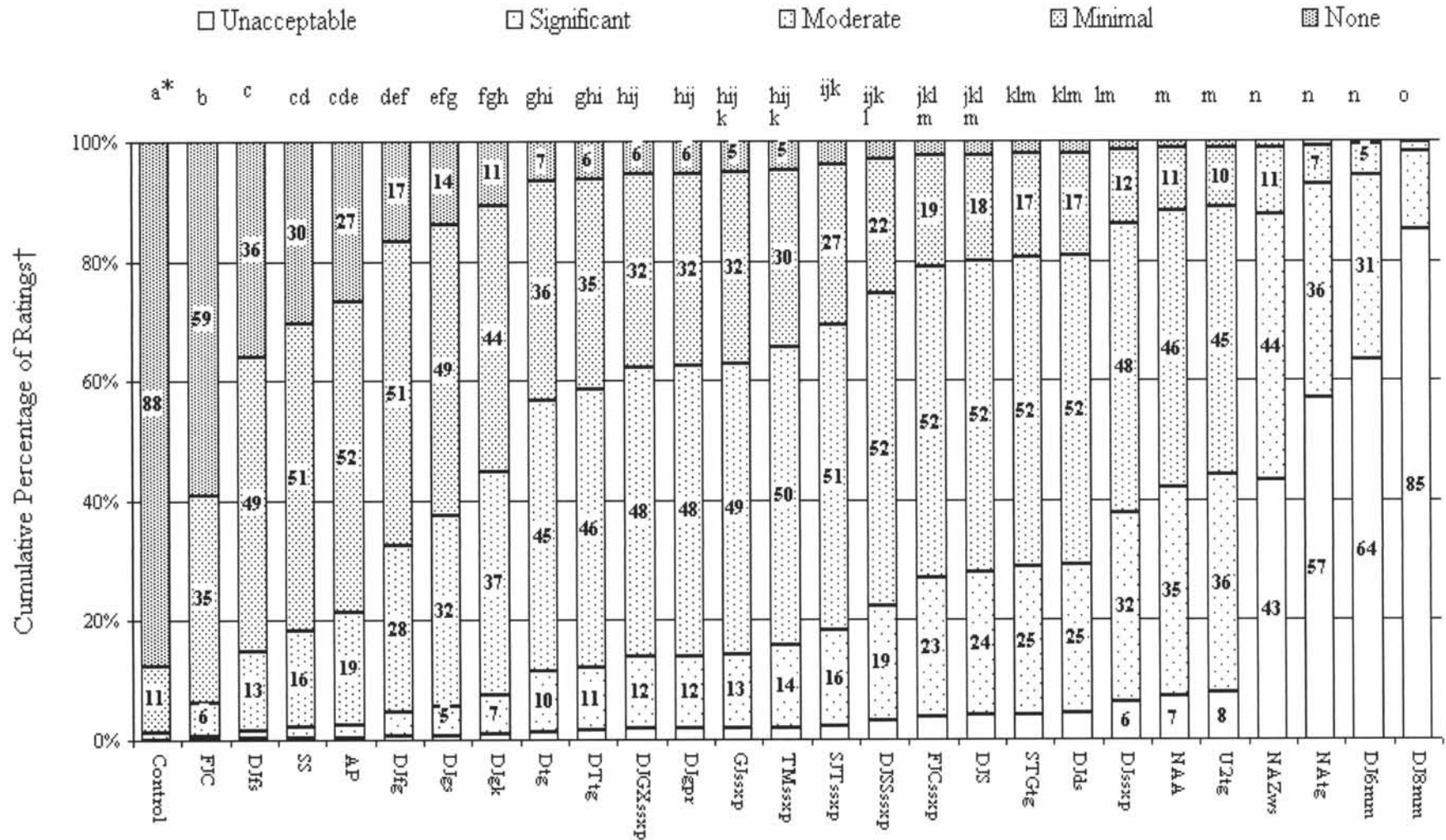
**Figure 5. Effects of Spike/Sole on Wear Rating,
Pine View Golf Course (July 1998)**



*Shoe soles sharing a letter are not significantly different ($P < 0.05$).

†Numbers within the bars represent percentage of ratings for individual categories.

Figure 6. Effects of Spike/Sole on Wear Rating, Red Run Golf Club (July 1998)



*Shoe soles sharing a letter are not significantly different ($P < 0.05$).

†Numbers within the bars represent percentage of ratings for individual categories.

Table 4. Effects of Spike/Sole on Wear Ratings, Sliced by Spike/Sole. 1998 Traveling Golf Spike Study - Michigan State University

Spike/Sole	Rating Category	OHCC	MSU	IC	PV	RRGC	CCD
All-Performance† <i>spikeless</i>	Unacceptable	0.1	na	0.2	0.2	0.3	na
	Significant	0.7	na	1.3	1.9	2.3	na
	Moderate	6.9	na	11.5	16.4	18.6	na
	Minimal	38.4	na	47.5	51.5	52.2	na
	None	54.0	na	39.5	29.9	26.6	na
	Significance*	<i>a</i>	<i>na</i>	<i>ab</i>	<i>ab</i>	<i>b</i>	<i>na</i>
	Rank‡	<i>1</i>	<i>na</i>	<i>3</i>	<i>3</i>	<i>5</i>	<i>na</i>
Control	Unacceptable	0.1	0.0	0.0	0.2	0.0	0.0
	Significant	0.8	0.2	0.1	1.6	0.1	0.3
	Moderate	7.7	1.8	0.8	14.2	1.2	3.2
	Minimal	40.6	15.3	7.7	50.2	11.0	24.2
	None	50.7	82.7	91.4	33.8	87.6	72.2
	Significance*	<i>b</i>	<i>a</i>	<i>a</i>	<i>b</i>	<i>a</i>	<i>a</i>
	Rank‡	<i>4</i>	<i>1</i>	<i>1</i>	<i>2</i>	<i>1</i>	<i>1</i>
DryJoys <i>6 mm metal spike</i>	Unacceptable	17.7	22.3	82.9	21.6	63.6	79.4
	Significant	49.0	50.5	14.9	50.4	30.6	17.9
	Moderate	28.6	23.7	1.9	24.4	5.2	2.4
	Minimal	4.2	3.2	0.2	3.3	0.5	0.2
	None	0.5	0.4	0.0	0.4	0.1	0.0
	Significance*	<i>a</i>	<i>a</i>	<i>b</i>	<i>a</i>	<i>b</i>	<i>b</i>
	Rank‡	<i>26</i>	<i>25</i>	<i>26</i>	<i>26</i>	<i>26</i>	<i>25</i>
DryJoys <i>8 mm metal spike</i>	Unacceptable	41.9	65.7	95.9	34.7	85.1	94.9
	Significant	45.1	29.0	3.7	48.5	13.0	4.5
	Moderate	11.5	4.8	0.4	14.9	1.7	0.5
	Minimal	1.3	0.5	0.0	1.7	0.2	0.1
	None	0.1	0.1	0.0	0.2	0.0	0.0
	Significance*	<i>a</i>	<i>b</i>	<i>c</i>	<i>a</i>	<i>c</i>	<i>c</i>
	Rank‡	<i>27</i>	<i>26</i>	<i>27</i>	<i>27</i>	<i>27</i>	<i>26</i>
DryJoy <i>duraspike</i>	Unacceptable	0.4	2.0	2.4	4.7	4.2	8.3
	Significant	3.3	14.0	16.2	26.9	25.0	37.4
	Moderate	24.3	50.1	51.4	50.9	51.6	43.9
	Minimal	52.0	29.2	26.0	15.4	16.9	9.3
	None	20.0	4.8	4.0	2.0	2.3	1.1
	Significance*	<i>a</i>	<i>b</i>	<i>b</i>	<i>bc</i>	<i>bc</i>	<i>c</i>
	Rank‡	<i>15</i>	<i>18</i>	<i>20</i>	<i>21</i>	<i>20</i>	<i>20</i>
DryJoy <i>flexigrip</i>	Unacceptable	0.2	1.2	2.3	3.9	0.5	4.8
	Significant	1.6	9.2	15.9	23.4	4.0	27.1
	Moderate	13.8	43.9	51.3	52.0	28.0	50.8
	Minimal	49.9	38.1	26.4	18.2	50.7	15.3
	None	34.6	7.6	4.1	2.5	16.8	2.0
	Significance*	<i>a</i>	<i>c</i>	<i>cd</i>	<i>d</i>	<i>b</i>	<i>d</i>
	Rank‡	<i>7</i>	<i>14</i>	<i>19</i>	<i>20</i>	<i>6</i>	<i>17</i>

Table 4. (continued)

Spike/Sole	Rating Category	OHCC	MSU	IC	PV	RRGC	CCD
DryJoy <i>flatspike</i>	Unacceptable	0.1	0.2	1.2	1.3	0.2	0.9
	Significant	0.8	1.9	8.8	9.8	1.5	6.9
	Moderate	7.5	16.2	43.2	45.0	13.2	38.5
	Minimal	40.1	51.4	38.9	36.8	49.3	43.6
	None	51.6	30.2	7.9	7.1	35.8	10.2
	<i>Significance*</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>c</i>	<i>ab</i>	<i>c</i>
	<i>Rank‡</i>	<i>3</i>	<i>3</i>	<i>11</i>	<i>10</i>	<i>3</i>	<i>4</i>
DryJoy <i>greenkeepers</i>	Unacceptable	0.3	2.1	2.3	2.5	0.8	10.8
	Significant	2.5	14.5	15.7	16.9	6.5	42.2
	Moderate	20.1	50.4	51.2	51.7	37.4	39.0
	Minimal	52.4	28.4	26.7	25.1	44.5	7.2
	None	24.7	4.6	4.2	3.8	10.7	0.8
	<i>Significance*</i>	<i>a</i>	<i>c</i>	<i>c</i>	<i>c</i>	<i>b</i>	<i>d</i>
	<i>Rank‡</i>	<i>11</i>	<i>19</i>	<i>18</i>	<i>17</i>	<i>8</i>	<i>21</i>
DryJoy <i>gripper</i>	Unacceptable	0.3	1.3	1.4	3.0	1.7	4.6
	Significant	2.3	9.5	10.6	19.3	12.3	26.5
	Moderate	18.8	44.5	46.3	52.3	48.5	51.1
	Minimal	52.3	37.5	35.1	22.3	32.0	15.7
	None	26.4	7.3	6.5	3.2	5.5	2.1
	<i>Significance*</i>	<i>a</i>	<i>b</i>	<i>b</i>	<i>bc</i>	<i>b</i>	<i>c</i>
	<i>Rank‡</i>	<i>8</i>	<i>15</i>	<i>14</i>	<i>18</i>	<i>12</i>	<i>16</i>
DryJoy <i>greenspike</i>	Unacceptable	0.3	0.3	0.4	3.2	0.6	1.0
	Significant	2.6	2.0	3.2	20.6	4.9	7.8
	Moderate	20.7	17.1	23.8	52.3	31.9	40.9
	Minimal	52.4	51.8	52.1	20.9	48.6	41.3
	None	23.9	28.9	20.6	3.0	14.0	8.9
	<i>Significance*</i>	<i>ab</i>	<i>a</i>	<i>ab</i>	<i>d</i>	<i>bc</i>	<i>c</i>
	<i>Rank‡</i>	<i>12</i>	<i>4</i>	<i>5</i>	<i>19</i>	<i>7</i>	<i>5</i>
DryJoyGX <i>softspike xp</i>	Unacceptable	0.5	3.3	1.3	1.2	1.7	3.1
	Significant	3.7	21.0	9.6	9.1	12.2	19.8
	Moderate	26.8	52.3	44.6	43.8	48.4	52.3
	Minimal	51.2	20.4	37.3	38.2	32.1	21.7
	None	17.8	2.9	7.3	7.6	5.6	3.1
	<i>Significance*</i>	<i>a</i>	<i>c</i>	<i>b</i>	<i>ab</i>	<i>bc</i>	<i>bc</i>
	<i>Rank‡</i>	<i>18</i>	<i>23</i>	<i>13</i>	<i>9</i>	<i>11</i>	<i>11</i>
DryJoy <i>spikeless</i>	Unacceptable	0.4	0.3	0.2	1.5	4.0	1.4
	Significant	3.0	2.4	1.6	10.7	24.0	10.4
	Moderate	22.7	19.2	13.7	46.4	51.9	45.9
	Minimal	52.3	52.3	49.8	35.1	17.7	35.7
	None	21.6	25.7	34.8	6.5	2.4	6.7
	<i>Significance*</i>	<i>a</i>	<i>a</i>	<i>a</i>	<i>bc</i>	<i>c</i>	<i>b</i>
	<i>Rank‡</i>	<i>14</i>	<i>6</i>	<i>4</i>	<i>11</i>	<i>18</i>	<i>8</i>

Table 4. (continued)

Spike/Sole	Rating Category	— % of ratings at each golf course —					
		OHCC	MSU	IC	PV	RRGC	CCD
DryJoy <i>studded sole softspike xp</i>	Unacceptable	0.8	1.8	2.6	1.2	3.0	4.6
	Significant	6.3	12.9	17.3	9.1	19.4	26.4
	Moderate	36.7	49.1	51.8	43.7	52.3	51.1
	Minimial	45.1	31.0	24.6	38.3	22.2	15.8
	None	11.1	5.2	3.7	7.6	3.2	2.1
	Significance*	<i>a</i>	<i>b</i>	<i>bc</i>	<i>ab</i>	<i>bc</i>	<i>c</i>
	Rank‡	<i>22</i>	<i>17</i>	<i>21</i>	<i>8</i>	<i>16</i>	<i>15</i>
DryJoy <i>softspike xp</i>	Unacceptable	0.9	4.0	11.1	11.3	6.1	21.2
	Significant	7.2	24.0	42.8	43.0	31.6	50.3
	Moderate	39.4	51.9	38.4	38.1	48.4	24.7
	Minimial	42.7	17.7	6.9	6.8	12.4	3.4
	None	9.7	2.4	0.8	0.8	1.6	0.4
	Significance*	<i>a</i>	<i>b</i>	<i>cd</i>	<i>cd</i>	<i>bc</i>	<i>d</i>
	Rank‡	<i>23</i>	<i>24</i>	<i>25</i>	<i>24</i>	<i>21</i>	<i>24</i>
Difference <i>turfgrrips</i>	Unacceptable	0.2	0.9	1.2	1.5	1.4	1.3
	Significant	1.4	7.1	8.9	10.7	10.0	9.8
	Moderate	12.6	39.1	43.2	46.4	45.4	45.0
	Minimial	48.7	43.0	38.9	35.0	36.4	36.8
	None	37.1	9.8	7.9	6.4	6.9	7.1
	Significance*	<i>a</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>
	Rank‡	<i>6</i>	<i>8</i>	<i>12</i>	<i>12</i>	<i>9</i>	<i>7</i>
Difference Tour <i>turfgrrips</i>	Unacceptable	0.3	0.9	0.8	1.5	1.4	3.5
	Significant	2.4	7.2	6.1	10.7	10.6	21.6
	Moderate	19.6	39.5	36.2	46.5	46.3	52.3
	Minimial	52.4	42.7	45.5	34.9	35.1	19.9
	None	25.3	9.7	11.4	6.4	6.5	2.8
	Significance*	<i>a</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>c</i>
	Rank‡	<i>9</i>	<i>9</i>	<i>8</i>	<i>13</i>	<i>10</i>	<i>13</i>
FootJoy Classic <i>spikeless</i>	Unacceptable	0.1	0.1	0.1	0.1	0.1	0.1
	Significant	1.0	1.0	1.0	0.9	0.6	0.9
	Moderate	9.0	9.1	9.3	8.4	5.7	8.6
	Minimial	43.4	43.6	44.0	42.1	34.6	42.7
	None	46.5	46.3	45.5	48.5	59.0	47.6
	Significance*	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>
	Rank‡	<i>5</i>	<i>2</i>	<i>2</i>	<i>1</i>	<i>2</i>	<i>2</i>
Foot Joy Classic <i>softspike xp</i>	Unacceptable	0.4	2.6	1.9	7.8	3.8	18.1
	Significant	3.3	17.5	13.5	36.3	23.1	49.2
	Moderate	24.5	51.9	49.7	44.9	52.1	28.2
	Minimial	51.9	24.3	29.9	9.9	18.5	4.1
	None	19.8	3.6	5.0	1.2	2.5	0.5
	Significance*	<i>a</i>	<i>b</i>	<i>b</i>	<i>cd</i>	<i>bc</i>	<i>d</i>
	Rank‡	<i>16</i>	<i>21</i>	<i>17</i>	<i>22</i>	<i>17</i>	<i>23</i>

Table 4. (continued)

Spike/Sole	Rating Category	OHCC MSU IC PV RRGCC CCD					
		— % of ratings at each golf course —					
GreenJoy <i>softspike xp</i>	Unacceptable	0.5	1.2	0.5	0.7	1.8	1.7
	Significant	4.2	9.0	4.3	5.6	12.5	12.2
	Moderate	29.1	43.6	29.2	34.4	48.7	48.3
	Minimal	50.2	38.5	50.1	46.9	31.6	32.3
	None	16.0	7.7	15.9	12.4	5.4	5.6
	<i>Significance*</i>	<i>a</i>	<i>bc</i>	<i>ab</i>	<i>abc</i>	<i>c</i>	<i>c</i>
	<i>Rank‡</i>	<i>19</i>	<i>13</i>	<i>7</i>	<i>5</i>	<i>13</i>	<i>9</i>
Nike Air Access II <i>spikeless</i>	Unacceptable	0.5	1.2	3.6	1.1	7.2	1.0
	Significant	4.3	8.7	22.1	8.2	34.8	7.8
	Moderate	29.4	43.0	52.2	41.8	46.1	40.9
	Minimal	50.0	39.1	19.4	40.4	10.6	41.3
	None	15.7	8.0	2.7	8.5	1.3	8.9
	<i>Significance*</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>ab</i>	<i>c</i>	<i>ab</i>
	<i>Rank‡</i>	<i>20</i>	<i>12</i>	<i>22</i>	<i>6</i>	<i>22</i>	<i>6</i>
Nike Air Zoom <i>turfgrrips</i>	Unacceptable	1.1	1.0	5.7	9.6	56.9	16.1
	Significant	8.1	7.3	30.4	40.1	35.6	48.0
	Moderate	41.6	39.7	49.1	41.3	6.7	30.7
	Minimal	40.6	42.5	13.1	8.1	0.7	4.7
	None	8.6	9.6	1.7	1.0	0.1	0.5
	<i>Significance*</i>	<i>a</i>	<i>a</i>	<i>b</i>	<i>bc</i>	<i>d</i>	<i>c</i>
	<i>Rank‡</i>	<i>25</i>	<i>10</i>	<i>23</i>	<i>23</i>	<i>25</i>	<i>22</i>
Nike Air Zoom <i>wafflespike</i>	Unacceptable	1.0	1.0	10.5	13.1	43.5	7.8
	Significant	7.7	8.0	41.8	45.3	44.3	36.4
	Moderate	40.5	41.3	39.5	35.0	10.9	44.8
	Minimal	41.7	41.0	7.4	5.8	1.2	9.8
	None	9.1	8.8	0.9	0.7	0.1	1.2
	<i>Significance*</i>	<i>a</i>	<i>a</i>	<i>b</i>	<i>b</i>	<i>c</i>	<i>b</i>
	<i>Rank‡</i>	<i>24</i>	<i>11</i>	<i>24</i>	<i>25</i>	<i>24</i>	<i>19</i>
SoftJoy Terrain <i>softspike xp</i>	Unacceptable	0.4	2.8	0.8	1.7	2.3	5.0
	Significant	3.6	18.2	6.5	12.0	15.8	28.0
	Moderate	26.0	52.1	37.4	48.1	51.2	50.4
	Minimal	51.5	23.5	44.5	32.6	26.5	14.7
	None	18.5	3.5	10.7	5.7	4.1	1.9
	<i>Significance*</i>	<i>a</i>	<i>cd</i>	<i>ab</i>	<i>bc</i>	<i>cd</i>	<i>d</i>
	<i>Rank‡</i>	<i>17</i>	<i>22</i>	<i>9</i>	<i>16</i>	<i>15</i>	<i>18</i>
Stabilite Softspikes <i>spikeless</i>	Unacceptable	0.1	0.3	0.5	0.7	0.2	0.5
	Significant	0.8	2.1	3.9	5.5	1.9	4.2
	Moderate	7.4	17.2	27.3	34.0	16.1	29.1
	Minimal	39.9	51.8	51.0	47.2	51.4	50.2
	None	51.8	28.6	17.4	12.7	30.3	16.0
	<i>Significance*</i>	<i>a</i>	<i>bc</i>	<i>cd</i>	<i>d</i>	<i>b</i>	<i>cd</i>
	<i>Rank‡</i>	<i>2</i>	<i>5</i>	<i>6</i>	<i>4</i>	<i>4</i>	<i>3</i>

Table 4. (continued)

Spike/Sole	Rating Category	% of ratings at each golf course					
		OHCC	MSU	IC	PV	RRGC	CCD
Stabilite Turfgrips <i>turfgrrips</i>	Unacceptable	0.3	1.5	1.5	1.7	4.2	2.0
	Significant	2.5	10.8	11.3	11.9	24.7	13.9
	Moderate	19.8	46.5	47.2	48.0	51.7	49.9
	Minimal	52.4	34.9	33.9	32.7	17.1	29.4
	None	25.0	6.4	6.1	5.7	2.3	4.8
	<i>Significance*</i>	<i>a</i>	<i>b</i>	<i>b</i>	<i>bc</i>	<i>c</i>	<i>bc</i>
	<i>Rank‡</i>	<i>10</i>	<i>16</i>	<i>15</i>	<i>15</i>	<i>19</i>	<i>10</i>
Turfmaster <i>softspike xp</i>	Unacceptable	0.3	2.2	1.7	1.2	2.0	3.4
	Significant	2.7	15.0	12.4	9.1	13.7	21.2
	Moderate	21.1	50.8	48.5	43.7	49.8	52.3
	Minimal	52.4	27.7	31.9	38.4	29.6	20.3
	None	23.5	4.4	5.5	7.7	4.9	2.8
	<i>Significance*</i>	<i>a</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>
	<i>Rank‡</i>	<i>13</i>	<i>20</i>	<i>16</i>	<i>7</i>	<i>14</i>	<i>12</i>
Ultimate 2000 <i>turfgrrips</i>	Unacceptable	0.6	0.6	0.9	1.6	7.8	3.7
	Significant	4.9	5.0	6.8	11.5	36.3	22.9
	Moderate	31.8	32.4	38.3	47.5	44.8	52.1
	Minimal	48.6	48.2	43.8	33.4	9.8	18.7
	None	14.1	13.7	10.3	5.9	1.2	2.6
	<i>Significance*</i>	<i>a</i>	<i>a</i>	<i>a</i>	<i>ab</i>	<i>c</i>	<i>b</i>
	<i>Rank‡</i>	<i>21</i>	<i>7</i>	<i>10</i>	<i>14</i>	<i>23</i>	<i>14</i>

*Golf courses sharing a letter are not significantly different. ($P < 0.05$).

†The All-Performance shoe was not included at MSU or CCD.

‡Rank among all 27 spikes/soles (26 at MSU and CCD).

Table 4 provides a numerical ranking of each spike for that respective golf course. This can be used to rapidly compare the relative responses of the individual spikes across golf courses. This can be useful in noting large deviance among the rankings to allow for further investigation of the source of the deviation. These rankings should not be used to quantitatively assess the order of each spikes response. Each number ranking could potentially be significantly different from several other spikes. Therefore, the only true method for comparison of this type is to evaluate and utilize figures 1-6.

One distinct difference in this study was the different responses of spikes across the various putting surfaces. While the characteristics of each green have been presented in Table 2, there was no attempt in this study to correlate the importance of various management practices to these spike responses.

There did appear to be differences in spike response based on the age and maturity of the putting surface, as well as the turfgrass species composition. Future studies should be designed to evaluate these factors in a controlled environment.

It should be noted that across all locations the 8mm spike was rated below all alternative spikes. (The 6mm spike was also ranked at the bottom with the 8mm on 4 of the 6 locations). This continues to indicate the golfers distinct displeasure with the metal spike.

One interesting method for comparing the differences among the spikes is to group them in similar categories. We suggest the following for comparison (remember to also use the control in the comparison).

Grouping Comparison	Spike to be compared (Treatment)
Dry Joy Shoe (smooth sole)	1-9
Soft Spike XP (various sole)	9, 10, 12, 13, 15, 16, 17
Turf Grips (various perforated soles)	18, 19, 20, 22, 24
Teaching sole	11, 14, 21, 23, 26

Conclusions

Some of the conclusions drawn from this study are bulleted below.

- The 8mm steel spike received the lowest rating at all six locations.
- The ratings varied among golf courses.
- Not all alternative spikes caused the same amount of wear.
- Results from the seven golf soles fitted with the Softspikes XP lead to the conclusion that the smooth golf shoe sole causes more visible wear than the perforated golf sole designs included in the study. The Dry-Joys and the Foot-Joy Classics fitted with the Softspike XP were golf shoes that had smooth soles with a heel.
- Results from the five golf soles fitted with the Turf-Grips lead to the conclusion that some perforated soles cause more wear than others.
- There were five golf soles included in the studies that had perforated soles without an insert for alternative or 8mm spikes. These soles are commonly called teaching golf shoes. The teaching golf soles caused different amounts of wear.

Future Studies

From listening to the concerns of all factions involved, through historical review, and through perfunctory steps in building a viable research base, MSU has built a knowledge base regarding the alternative spike/sole debate that is second to none. It is our contention to use this base to establish an alternative golf spike/sole research methodology that is pertinent and accurate that yields results that will be accepted world-wide. We have also come to the realization that through our publications and the speaking circuit many golf course superintendents anticipate annual reports on the newest alternative golf spike/sole designs. For this reason, in the spring and summer of 1999 MSU has chosen one individual that will give 100% of his time to this issue. He will not only study the alternative soles, but will also continue identifying cultural practices utilized by the golf course superintendent that minimize the visual effect of traffic.

References

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