Beach Surface Accessibility Study

FINAL REPORT

National Center on Accessibility
Indiana University Study # 00-4088

January 2002

by Edward J. Hamilton, Ph.D.

Previous research by the National Center on Accessibility has examined the effectiveness of various assistive devices and surface treatments on the accessibility of beach areas by people with mobility impairments[1]. Numerous temporary surfaces have been developed in the seven years since the original study. The purpose of the current study was to investigate the utility of various types of temporary beach surfaces that may provide accessibility to people with mobility impairments. The objective was to provide information to managers of beach areas that would allow them to compare the options regarding temporary surfaces for beach access.

Data were gathered at Daytona Beach, in Volusia County, Florida. Surfaces were installed by county employees with assistance from the Beach Patrol. The study was limited to the assessment of seven temporary surface products that purportedly create effective access for persons with mobility impairments across the sand to the water's edge. The study focused on consumer perceptions of the surfaces as well as costs, installation time, and maintenance.

Procedures

Upon arrival at the study site, participants read and completed an Informed Consent Form and Subject Data Form (Appendix A) with the assistance from an investigator. Subjects were then directed to the assigned starting surface and instructed to "try the surface at your own pace." When subjects reached the turn around area, the investigator asked, "Do you feel comfortable trying to move off of the surface and back on again?" If the person was willing, the investigator remained nearby to provide assistance if needed. Once a subject completed use of the first surface, the investigator and subject would complete the Surface Questionnaire (Appendix B) on the surface. The subject was then directed to the next assigned surface and the procedure was

[1] Hamilton, E.J., Burgess, M., & Hepfer, P. (1994). Beach access: Assistive devices and surfaces. (Technical Report). Martinsville, IN: National Center on Accessibility.

continued until all seven surfaces had been tested. The order in which surfaces were tested was changed each day of testing. Once all surfaces had been used, subjects were asked to rank the three surfaces they preferred.

Results

Subjects

There were 72 subjects who participated in the study: 35 (49%) were female and 37 (51%) were male. They ranged in age from 19 to 92 years with a mean age of 50.6 years. The subjects had a variety of disabilities—no one disability represented more than 16.7% of the total. Subject disabilities are listed in Table 1.

Table 1. Disabilities of Subjects.

Disability	Frequency	%
Amputation	12	16.7
Arthritis	5	6.9
Cerebral Palsy	6	8.3
Multiple Sclerosis	4	5.6
Muscular Dystrophy	7	9.7
Parkinsons	4	5.6
Post Polio	9	12.5
Spina Bifida	8	11.1
Spinal Cord Injury	11	15.3
Other	6	8.3
Total	72	100.0

Only four subjects (5.6%) did not use an assistive device. More than half of the subjects (61.5%) used some type of wheelchair or scooter. A third of the subjects (34.7%) used either a motorized wheelchair or electric scooter; and another 27.8% used a manual wheelchair. Subject assistive devices are listed in Table 2.

Table 2. Subject Assistive Devices.

Device	Frequency	%
Cane	7	9.7
Crutches	5	6.9
Electric Scooter	16	22.2
Manual Wheelchair	20	27.8
Motorized Wheelchair	9	12.5
Prosthesis	1	1.4
Walker	10	13.9
No Assistive Device	4	5.6
Total	72	100.0

To determine levels of independence, subjects were asked questions regarding the amount of assistance they required in using the beach surfaces and participating in physical activities. The majority of subjects functioned independently; 94.4% needed no or minimal assistance in crossing the beach surfaces and 59.7% reported they did not usually need assistance in physical activities.

Subjects also reported on their beach behaviors. Most subjects (84.7%) reported they avoided the beach “because it's difficult getting across the sand.” Nearly all subjects (95.8%) indicated they would visit the beach more often if they could get across the sand more easily. Independence on the beach was critical to the subjects, as 70.8% reported that it was important for them to be able to travel across the beach without assistance.

Surface Installation.

The surfaces were installed by Volusia County employees with assistance from the Beach Patrol. The same individuals were involved in installation of each of the surfaces. The staff supervisor completed a survey on each surface indicating the installation time, ease of installing surfaces, ease of removing surfaces for grooming of the sand, ease of transporting surfaces to other areas, and whether surfaces detracted from the beach environment.

The time needed to install the surfaces ranged from 20 minutes to 31 hours. The installation time for each surface is included in Table 3. The recycled plastic lumber was the surface that took the longest to install. The materials needed to be cut and connected much like wooden lumber, though the supervisor reported the material was easier to use than lumber.

Table 3. Surface Installation Time.

Surface	Installation Time
PATH	0 hr. 20 min.
Ecotrack	1 hr. 30 min.
Lattice	1 hr. 30 min.
Safety Deck	3 hr. 30 min.
Diamond Rubber Mat	4 hr. 0 min.
Super Deck	12 hr. 0 min.
Recycled Plastic	31 hr. 0 min.

Four of the surfaces were rated as extremely easy to install: Lattice, Recycled Plastic Lumber, Diamond Rubber Mat, and PATH. Of these, Lattice was rated as the easiest. Recycled Plastic Lumber was rated as one of the easiest surfaces to install despite the fact that installation time was significantly longer than any other surface. Two surfaces, Ecotrack and Super Deck, were rated moderately easy to install; and one, Safety Deck, was rated as extremely difficult to install. The supervisor's comments indicated that keeping the Safety Deck tiles even on the uneven sand was difficult. Also, connecting the tiles was difficult.

Maintenance.

Weekly maintenance logs were completed for each of the surfaces during the one-month study. Changes in surface conditions, environmental changes, safety issues, and actions taken to address changes or issues were recorded.

Weekly sand build-up occurred on each of the surfaces. The build-up was easily swept or shoveled (depending on the amount of sand) on all but one of the surfaces. Ecotrack was reported to be more difficult to clear due to the indentations in that surface.

Erosion around the edges was a problem for two of the thicker surfaces: Recycled Plastic Lumber and Super Deck. The drop off caused by the erosion produced a potential safety problem. Erosion occurred around each of the surfaces but wasn't as noticeable on the thinner surfaces.

Surface Preferences.

After using all of the seven surfaces tested, subjects were asked to rank the top three surfaces they preferred using. Subject preferences are listed in Table 3. No surface was selected as first choice by a majority of subjects, though three of the surfaces (Diamond Rubber Mat, Ecotrack, and Recycled Plastic) were selected as first, second or third choice by a majority of subjects. Diamond Rubber Mat was selected first choice by the largest number of subjects (29.6%) and was also selected as first, second or third choice by the largest number of subjects (78.7%). Recycled Plastic was first choice by 22.5% of subjects and was among the top three choices of 52.1%. Ecotrack was selected as first choice by only 16.9% of subjects; but it was selected as first, second or third choice by 78.7% of subjects.

Table 3. Subject Preferences for Beach Surfaces

	First Choice		Second Choice		Third Choice	
Surface	F	%	F	%	F	%
Diamond Rubber Mat	21	29.6	19	26.8	15	21.4
Ecotrack	12	16.9	22	31.0	21	30.0
Lattice	13	18.3	10	14.1	10	14.3
PATH	--	--	2	2.8	2	2.9
Recycled Plastic	16	22.5	8	11.3	13	18.6
Safety Deck	--	--	--	--	2	2.9
Super Deck	9	12.7	10	14.1	7	10.0
Missing	1	--	1	--	2	--
Total	71	100.0	71	100.0	70	100.0

Two of the surfaces, PATH and Safety Deck, were not rated as first choice by any of the subjects; Safety Deck also was not listed as second choice by any subject. These were also the least preferred surfaces as a third choice.

Subjects' general preferences were further revealed when asked whether they would recommend the surfaces be used for beach accessibility. Subjects' responses for each surface are available in Table 4.

Table 4. Subjects' likelihood of recommending surface for beach accessibility.

Surface	Strongly Agree (%)	% Agree	% Disagree	Strongly Disagree
Diamond Rubber Mat	70.4	25.4	2.8	1.4
Ecotrack	72.9	22.9	2.9	1.4
Lattice	73.9	18.8	4.3	1.4
PATH	23.0	59.0	6.6	11.5
Recycled Plastic	63.2	30.9	2.9	2.9
Safety Deck	30.9	52.9	5.9	10.3
Super Deck	59.4	36.2	2.9	1.4

Though a majority of subjects indicated they either strongly agreed or agreed that they would recommend each of the surfaces for beach accessibility, there were two surfaces that received fewer "strongly agreed" responses. To determine whether the differences were statistically significant, a Friedman Test was conducted on the mean rankings of all surfaces. The finding of a significant difference ($p<.01$, $\chi^2=65.13$, $df=6$) led to Wilcoxon Signed Rank Tests on paired responses to each test (Table 5). The results indicate that subject recommendation of PATH and Safety Deck was significantly lower than that of the other surfaces. There was no significant difference between PATH and Safety Deck.

Table 5. Wilcoxon Signed Rank Tests on Subject Recommendations of Surfaces.

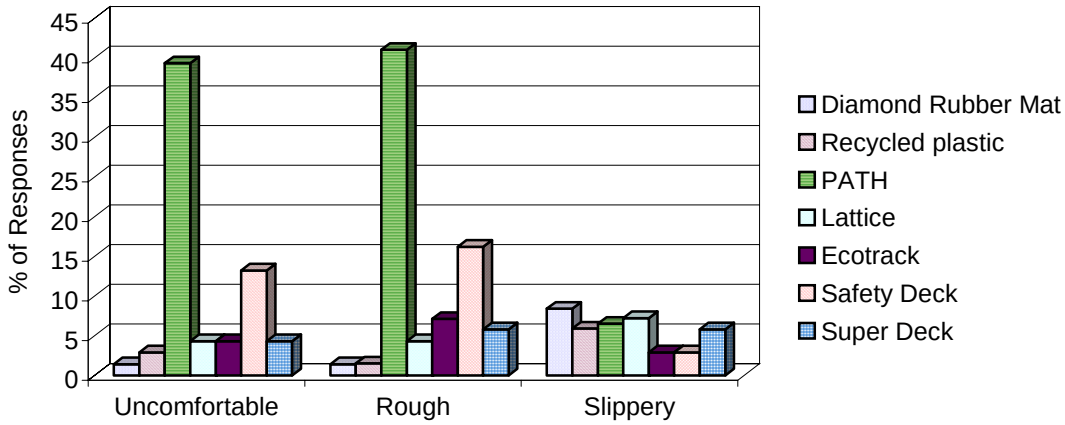
	Recycled Plastic	Ecotrack	Rubber Mat	Super Deck	Safety Deck	Lattice
Ecotrack	1.09					
Rubber Mat	1.06	0.29				
Super Deck	0.26	1.59	1.29			
Safety Deck	3.12[a]	4.00[a]	4,82[a]	3.57[a]		
Lattice	0.40	0.16	0.17	1.23	5.10[a]	
PATH	3.87[a]	4.65[a]	4.18[a]	3.71[a]	0.24	4.17[a]

[a]$p<.01$

Subjects' overall preferences for surfaces were further explored through their responses to questions in three major areas of function: tactual, mobility, and aesthetic. Discussion of each area of function is presented below.

Tactual Function. Tactual function was examined through subject perceptions of surface comfort, roughness, and slipperiness. Subject responses to each surface's tactile function are reported in Chart 1.

Chart 1. Subjects' Perceptions of Tactual Function



Visually, the responses to PATH and Safety Deck seemed significantly higher for subjects' perceptions of how uncomfortable and rough the surfaces were. The Friedman Test was conducted on the mean rankings for uncomfortableness and roughness ratings for all surfaces. The finding of a significant differences for uncomfortableness ($p<.01$, $\chi^2=51.88$, $df=6$) and roughness ($p<.01$, $\chi^2=66.41$, $df=6$) indicated the differences among the surfaces were statistically significant but could not reveal which differences were significant. To identify which differences were significant, Wilcoxon Signed Rank Tests were conducted on paired responses to each test for uncomfortableness (Table 6) and roughness (Table 7).

Table 6. Wilcoxon Signed Rank Tests on Subject Perception of Uncomfortableness.

	Recycled Plastic	Ecotrack	Rubber Mat	Super Deck	Safety Deck	Lattice
Ecotrack	0.51					
Rubber Mat	0.49	0.19				
Super Deck	1.90	1.67	1.98			
Safety Deck	2.26	1.76	1.98	0.48		
Lattice	1.10	0.58	0.91	0.82	1.27	
PATH	5.00[a]	4.53[a]	4.51[a]	4.12	3.23[a]	3.98[a]

[a]p<.01

Only the uncomfortable ratings for PATH were significantly different from those of the other surfaces. PATH was perceived as less comfortable than the other surfaces. Subjects' comments indicated that the surface was "bumpy" and "uneven," which made it more difficult to traverse for both ambulatory and non-ambulatory users.

Table 7. Wilcoxon Signed Rank Tests on Subject Perception of Roughness.

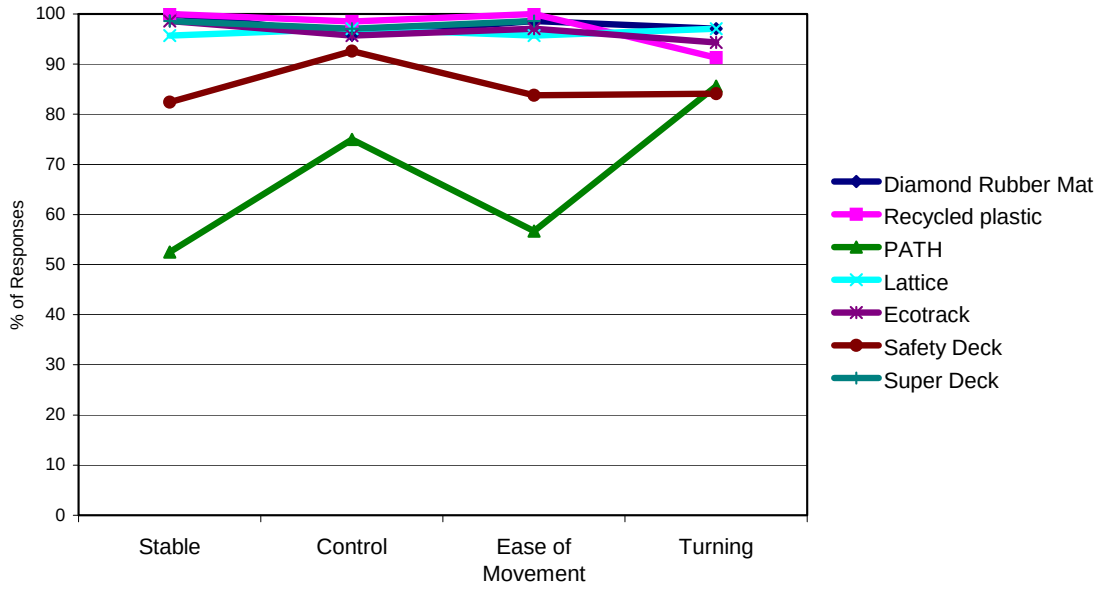
	Recycled Plastic	Ecotrack	Rubber Mat	Super Deck	Safety Deck	Lattice
Ecotrack	1.13					
Rubber Mat	0.82	0.34				
Super Deck	2.20	1.12	2.05			
Safety Deck	3.21[a]	2.58[a]	3.24[a]	2.23		
Lattice	2.41	1.28	2.06	0.16	2.16	
PATH	5.19[a]	4.70[a]	5.08[a]	4.14[a]	2.81[a]	4.05[a]

[a]p<.01

PATH and Safety Deck were rated as significantly rougher than the other surfaces. There were very few subject comments related to roughness, which prevented further examination of the underlying reasons for these perceptions.

Mobility. Examination of the second area of function, mobility, while important in itself, also provided insight into subject ratings of tactual function. Four elements of mobility were examined: stability, control, ease of movement, and turning. Subjects' responses to the mobility offered by each surface are presented in Chart 2.

Chart 2. Subjects' Perceptions of Mobility.



Most of the surfaces clustered together on each of the measures. Only two of the surfaces, PATH and Safety Deck, scored lower on the measures. The Friedman Test was conducted on the mean rankings for each measure. The finding of a significant differences for stability ($p<.01$, $\chi^2=86.59$, $df=6$), control ($p<.01$, $\chi^2=35.95$, $df=6$), ease of movement ($p<.01$, $\chi^2=79.25$, $df=6$), and turning ($p<.01$, $\chi^2=45.46$, $df=6$) indicated the differences among the surfaces were statistically significant. Wilcoxon Signed Rank Tests were conducted on paired responses to each test for stability (Table 8), control (Table 9), ease of movement (table 10), and turning (Table 11) to determine which differences were significant.

Table 8. Wilcoxon Signed Rank Tests on Subject Perception of Stability.

	Recycled Plastic	Ecotrack	Rubber Mat	Super Deck	Safety Deck	Lattice
Ecotrack	0.69					
Rubber Mat	0.96	4.26				
Super Deck	2.19	1.92	1.96			
Safety Deck	3.27[a]	3.08[a]	2.99[a]	2.40		
Lattice	2.54	1.90	1.86	0.59	1.79	
PATH	5.68[a]	5.65[a]	5.32[a]	5.24	3.71[a]	4.58

[a]p<.01

Safety Deck and PATH were rated as significantly less stable than Recycled Plastic, Ecotrack, and Rubber Mat. PATH was rated significantly less stable than Safety Deck. There were no significant differences among the other surfaces on stability. The three subjects who commented on the stability of Safety Deck indicated the surface was "too bumpy," "the tiles were coming apart," and "it had edges sticking up." The six subjects who commented on PATH stated that the surface "seemed to have movement," "was uneven," and caused the front wheelchair wheels to get stuck.

Table 9. Wilcoxon Signed Rank Tests on Subject Perception of Control.

	Recycled Plastic	Ecotrack	Rubber Mat	Super Deck	Safety Deck	Lattice
Ecotrack	0.22					
Rubber Mat	0.00	0.16				
Super Deck	0.76	1.10	0.92			
Safety Deck	2.50	2.73[a]	2.80	2.15		
Lattice	0.82	0.85	0.90	0.03	3.00[a]	
PATH	3.69[a]	3.87[a]	3.64[a]	3.46[a]	2.03	3.29[a]

[a]p<.01

Subjects perceived that they had less control of their movements on PATH than on any of the other surfaces except Safety Deck. There was no significant difference between PATH and Safety Deck, but Safety Deck was perceived as providing less control than Ecotrack and Lattice. There were no significant differences among the other surfaces.

Table 10. Wilcoxon Signed Rank Tests on Subject Perception of Ease of Movement.

	Recycled Plastic	Ecotrack	Rubber Mat	Super Deck	Safety Deck	Lattice
Ecotrack	1.07					
Rubber Mat	0.19	0.83				
Super Deck	1.73	0.65	1.73			
Safety Deck	3.98[a]	3.22[a]	4.20[a]	3.04[a]		
Lattice	1.48	0.48	1.38	0.20	3.85[a]	
PATH	5.20[a]	5.04[a]	5.35[a]	5.03[a]	2.54	4.73[a]

[a]p<.01

Ease of movement was perceived as significantly more difficult for Safety Deck and PATH than for any of the other surfaces. There was no significant difference between Safety Deck and PATH. There also were no significant differences among the other surfaces.

Table 10. Wilcoxon Signed Rank Tests on Subject Perception of Turning.

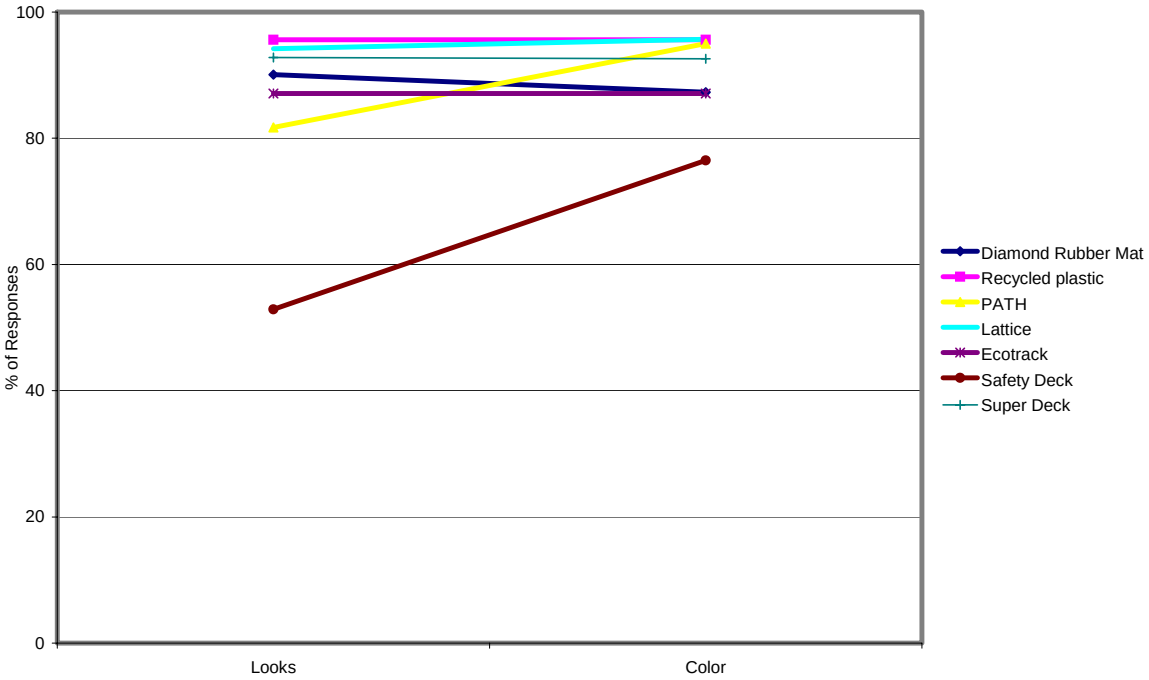
	Recycled Plastic	Ecotrack	Rubber Mat	Super Deck	Safety Deck	Lattice
Ecotrack	1.07					
Rubber Mat	0.19	0.83				
Super Deck	1.73	0.65	1.73			
Safety Deck	3.98[a]	3.22[a]	4.20[a]	3.04[a]		
Lattice	1.48	0.48	1.38	0.20	3.85[a]	
PATH	5.20[a]	5.04[a]	5.35[a]	5.03[a]	2.54	4.73[a]

[a]p<.01

Once again, PATH and Safety Deck were perceived as more difficult to turn on than any of the other surfaces. There was no significant difference between Safety Deck and PATH. There also were no significant differences among the other surfaces.

Aesthetics. The surfaces were also rated on their aesthetic qualities. Subjects were asked to rate each surface on the degree to which they "liked" how the surface looked and the color of the surface. Subjects were also asked whether or not they felt each surface "detracted from the beach atmosphere." Subjects' responses to the surface aesthetics are presented in Chart 3.

Chart 3. Subjects' Perceptions of Surface Aesthetics



Again, most of the surfaces clustered together on each of the measures. Safety Deck rated significantly lower on both "looks" ($p<.01$, $\chi^2=74.66$, $df=6$) and "color" ($p<.01$, $\chi^2=60.37$, $df=6$). There were no significant differences on subjects' perceptions of whether or not the surfaces detracted from the environment. Table 11 demonstrates that subjects strongly agreed that the surfaces did not detract from the beach atmosphere.

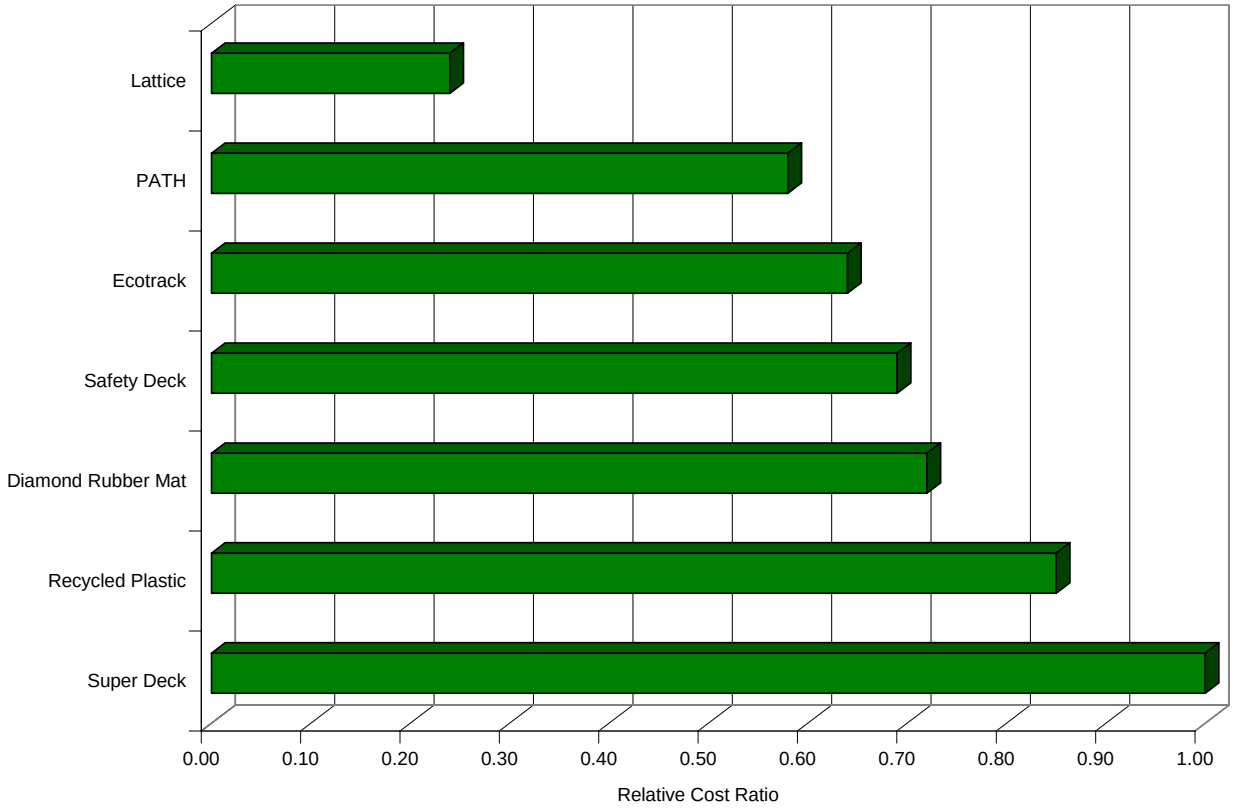
Table 11. Subject perception of surface detraction from beach atmosphere.

Surface	Surface Detracts	Surface Does Not Detract
PATH	7 (10.1%)	62 (89.9%)
Ecotrack	10 (14,3%)	60 (85.7%)
Lattice	12 (17.1%)	58 (82.9%)
Safety Deck	3 (4.2%)	69 (95.8%)
Diamond Rubber Mat	15 (22.1%)	53 (77.9%)
Super Deck	5 (7.2%)	64 (92.8%)
Recycled Plastic	9 (14.3%)	54 (85.7%)

Surface Costs.

The costs of the surfaces and their related installation costs varied and are included in Appendix C. In order to fairly measure the relative cost of the surfaces, actual costs were calculated for the materials needed for each of the test surfaces used. Relative costs were determined by dividing the cost of each surface by the cost of the most expensive surface. Thus, the most expensive surface, Super Deck, had a relative cost of 1.00 and the least expensive surface, Lattice, had a relative cost of .24, or 24% of the cost of Super Deck. Relative costs for all surfaces are included in Chart 5.

Chart 5. Relative cost of surfaces



Summary

Seven temporary surface products were evaluated to determine their effectiveness in providing access for persons with mobility impairments in beach areas. The study focused on installation time, maintenance, costs and user perceptions of the surfaces. Each of the surfaces provided greater access to beach areas.

The time needed to install the surfaces varied widely, ranging from 20 minutes to 31 hours. PATH took the least time to install and recycled plastic lumber was the surface that took the longest to install. Four of the surfaces were rated as extremely easy to install: Lattice, Recycled Plastic Lumber, Diamond Rubber Mat, and PATH. Of these, Lattice was rated as the easiest. Recycled Plastic Lumber was rated as one of the easiest surfaces to install despite the fact that installation time was significantly longer than any other surface. Two surfaces, Ecotrack and Super Deck, were rated moderately easy to install; and one, Safety Deck, was rated as extremely difficult to install.

Weekly sand build-up occurred on each of the surfaces. The build-up was easily swept or shoveled (depending on the amount of sand) on all but one of the surfaces. Ecotrack was reported to be more difficult to clear due to the indentations in that surface. Erosion around the edges was a problem for two of the thicker surfaces: Recycled Plastic Lumber and Super Deck.

The costs of the surfaces and their related installation costs varied. Super Deck, had the highest relative and Lattice had the lowest relative cost.

A majority of subjects indicated that they would recommend each of the surfaces for beach accessibility. No surface was selected as first choice by a majority of subjects, though three of the surfaces (Diamond Rubber Mat, Ecotrack, and Recycled Plastic) were selected as first, second or third choice by a majority of subjects. Two of the surfaces, PATH and Safety Deck, were not rated as first choice by any of the subjects;

Safety Deck also was not listed as second choice by any subject. These were also the least preferred surfaces as a third choice. Mobility and tactual function were instrumental in subjects' determination that PATH and Safety Deck were less desirable. Table 12 provides a comparison of the surfaces on all variables.

Table 12. Summary of surface comparisons.

	Install Time	Install Ease	Maintenance	Preference	Tactual	Mobility	Aesthetics	Detract	Relative Cost
Diamond Rubber Mat	5	2	+	1	2	2	4	+	5
Ecotrack	2	6	-	1	3	4	6	+	3
Lattice	3	1	+	4	4	5	2	+	1
PATH	1	2	+	6	7	7	5	+	2
Recycled Plastic	7	2	+	3	1	1	1	+	6
Safety Deck	4	7	+	7	6	6	7	+	4
Super Deck	6	5	+	5	5	3	3	+	7

1=Most favorable rating, 7=Least favorable rating.