Beach Access: Assist Devices and Surfaces
A Research Report of the National Center of Accessibility
Original Study Conducted at Bradford Woods (1993)

The lives of people with disabilities have been opened to a new era, an era of hope and opportunity. The passage of the Americans with Disabilities Act has made the elimination of architectural and programmatic barriers a reachable goal. Barrier-free designs for constructed facilities have become the expectation rather than the exception.

The advances in standards for architectural accessibility have moved our society to a point where we can begin looking beyond built environments toward outdoor environments to determine how people with disabilities might be given greater opportunities to enjoy the beauty and majesty of the outdoors. Yet, stepping out of the built environment and into the natural environment provides greater challenges for accessibility than ever before imagined. This is especially true of beach areas, whether they are coastal or inland.

In response to demands for beach access brought on by the Americans with Disabilities Act, there has been a rush to develop new products. These products have centered on two approaches: assistive devices and surfaces. The quick development of these products and the lack of local distribution sites, has left individuals with disabilities and agencies wishing to provide beach access unable to adequately evaluate these products. Therefore, the National Center on Accessibility undertook this study to address the need for objective comparisons of the advantages and disadvantages of the available products.

Method

The study was conducted at the beach on the 110 acre lake at Bradford Woods, Indiana University's Outdoor Center, between August and October 1992 and at an ocean beach in Dade County, Florida during March and April 1993. These sites were selected because of the differences in environmental conditions. The sand at the Bradford Woods beach had a coarse texture. Although an inland lake, unusually heavy rain fall during the data collection at Bradford Woods caused significant fluctuations in the water level of the lake and water run-offs across the beach. The lake was sheltered by steep, forested hills, which reduced wind blowing across the beach. The sand at Dade County, Florida had a very fine texture. As expected, there were significant water level changes due to the tides and ample wind blowing across the beach. Tidal changes caused the expected water level changes at Dade County.

Subjects

A total of 111 subjects participated in the study, 60 at the Indiana site and 51 at the Florida site. The demographics of the two sites were strikingly different, consequently, the combined demographic results as well as those of each site are presented. The combined sites provided a balanced distribution among the demographic variables. Complete demographic information can be found in Table 1.

Subjects ranged in age from 9 to 91 years with a mean age of 42.1 years for the combined sites.

However, subjects at the Indiana site had a mean age of 26.5 years, while the Miami subjects had a mean age of 60.8 years. For the combined study, 50.5% of the subjects were female. At the Indiana site 40% of the subjects were female, whereas 62.7% of the Miami subjects were female.

Impairment demographics were also very different for the two sites. A total of 19 impairments were reported by the subjects. For the combined sites, cerebral palsy (17), spinal cord injuries (17), spina bifida (13), and "walking difficulty" (12) were most frequently reported and accounted for 53.1% of the responses. There were 13 different impairments reported in Indiana with cerebral palsy (15), spina bifida (13), and spinal cord injury (13) accounting for 68.4% of the responses. At the Florida site, there were 16 separate impairments reported. Walking difficulty (11), stroke (8), and nonspecific paralysis (7) most frequently reported and accounted for 51% of the responses.
For the combined study, 33.3% of the subjects reported having had a disability from birth. Again, the sites were very different with Indiana subjects significantly more likely (chi square=12.2, $p<.05$) to have a disability from birth (54.9%) than subjects in Florida (8.9%). A total of 74% of the subjects at the two sites reported using manual (54.6%) or motorized (19.4%) wheelchairs. The remaining subjects reported using another type of mobility assistive device (22.4%) or were ambulatory (3.6%).

As one indicator of subjects' physical functioning, they were asked whether assistance was normally required to transfer into a wheelchair. For the combined sites, 55.8% of the subjects reported they needed no assistance to transfer or did not use a wheelchair, while 43.26% of the subjects indicated they needed assistance in transfers(Table 1). Only slightly fewer Indiana subjects reported needing assistance (41.7%) than did Florida subjects (45.1%).

Procedure

Upon their arrival at a beach area, subjects were given the study information sheet, the Informed Consent Form, and the Beach Access Survey. After completing the survey, subjects were taken to the beach area where the equipment and surfaces are located. Subjects were allowed to view the equipment and surfaces but not use them at that time. Subjects were asked which piece of equipment they would prefer to use and then which surface they would prefer to use. This information was recorded on the initial survey.

Once subjects had indicated their visual preferences, subjects were asked to use the equipment and/or surfaces on the beach and complete a questionnaire on each piece of equipment or surface used. When possible, subjects used their own equipment on the beach prior to using the test equipment. An investigator assisted those subjects who were unable to write. If a companion accompanied and assisted the user with a disability, the companion was asked to complete the Informed Consent Form and a Companion Questionnaire for each piece of equipment or surface on which he or she provided assistance.

After completing a questionnaire for each piece of equipment or surface used, subjects were debriefed by the investigator to determine additional thoughts on the equipment.

Results

The results of this study are broken into two major sections: assistive devices and surfaces.

ASSISTIVE DEVICES FACTOR ANALYSIS

The results of the survey's Likert-scaled questions were factor analyzed to determine whether the questions could be explained by underlying factors. The factor analysis with one rotation revealed three factors. The questions that loaded most heavily on the first factor were those related to the looks, color, and style, thus, the first factor was labeled "Appearance." The questions related to control, self-sufficiency, and ease of use compared to everyday use of assistive devices loaded most heavily on the second factor. Consequently, the second factor was labeled "Independence." Questions related to the devices' stability and safety loaded positively on the third factor. The degree to which users felt self-conscious using the device loaded negatively on the third factor. As self-consciousness might indicate a level of psychological safety as opposed to the physical safety indicated by the other questions, the third factor was labelled "Safety."

Subject responses to Likert-scaled questions were analyzed according to the three identified factors; appearance, independence, and safety. As three of the devices; Cobra, Knobby Tires, and Marvel, were only tested at the Florida site, consequently, the results of those tests are listed separately in the tables of this report.

Appearance

The means and standard deviations for subjects' scores on the appearance factor at each site as well as the combined sites are listed in Table 3. Two of the three devices tested only at the Indiana site, the Cobra and the Knobby Tires, were rated highest in appearance. Of the devices tested at both sites, the Surf Chair was perceived as most attractive when the scores of the two sites were combined, however, there was a significant difference between the sites. Subjects at the Florida site had significantly more favorable perceptions of the Surf Chair's appearance than those subjects at the Indiana site ($t=3.71$, $p<.05$). There were no significant differences between sites for subjects' ratings of appearance for any of the other devices.

The Marvel, which was only tested at the Florida site, received a slightly lower rating on appearance than the Surf Chair, but it rated higher than the Surf Chair on two of the three questions that made up the Appearance Factor (Table 6). Subjects reported a slightly greater preference for the color and style of the Marvel.

Independence

The means and standard deviations for subjects' scores on the Independence Factor at each site as well as the combined sites are listed in Table 4. The Marvel received the most favorable rating for independence, however, it was formally tested at only one site and with only six subjects. Interestingly, the Marvel was the only device with a disclaimer printed on the device to warn users about the dangers in using it unattended.

Of the other devices, the Sport Wheeler received the highest score for independence. Its design allowed the passenger to steer the device as it was being pushed from behind by someone standing. Thus, the passenger was able to actively participate in moving the device.

Safety

The means and standard deviations for subjects' scores on the Safety Factor are listed in Table 5. The Marvel once again was rated highest on safety, but it ws only formally tested at the Florida site with only six subjects. The Knobby Tires rated next highest, but it was only tested at the Indiana site with only three subjects. Of the devices tested at both sites, the ratings on safety were not significantly different from one another.

A more detailed analysis of each device was completed. Discussion of those findings are included under the headings of Comfort and Safety, Independence, Appearance, and Maintenance and Transport.

Fun Wheeler

The Fun Wheeler is a rickshawstyle cart designed for children. It's frame is constructed of one-inch PVC tubing. It is equipped with a rear-tilt bar and a cushioned vinyl seat with a short seat back that folds. The Fun Wheeler uses two Roleez 18-inch balloon wheels, which are made of an elastic, puncture resistant plastic. The Fun Wheeler weighs 40 pounds.

Comfort and Safety

Although users generally felt the device was comfortable, especially the younger users for whom the device was designed, users and their companions expressed several comfort and safety concerns with the Fun Wheeler. The most often mentioned concern was the tendency for the Fun Wheeler to tip forward and backward. In a stationary position the device would tilt the person forward at a severe angle, making it very uncomfortable. There was nothing to hold the device in a level position, unless the companion held it. This was not acceptable to users or their companions. A majority of the users felt the Fun Wheeler would tip back too easily, giving the impression they would fall. The design would actually prevent the device from tilting too far in the back, but it did not allay the concerns of users.

Several users and companions noted a need for arm rests or side supports on the Fun Wheeler. The Fun Wheeler sets very close to the ground, so the real danger to the user is minimal, nevertheless, users' perceptions of danger is important. Removable arm rests would give those users the added support while not interfering with transfers.

Companions noted two other safety concerns. The users and their companions were not instructed on how to use the device nor was information printed on the device. As the device resembled a rickashaw, several of the companions pulled the device from within the extended front pipes of the Fun Wheeler. The width and length of the device made this very difficult for the companion and uncomfortable for both the companion and the user.

Companions also reported a potential hazard with the umbrella holder on the rear of the device. The concern was with a person's bare foot or leg coming contact with the exposed edge of the holder when the umbrella is not being used. A cap to cover the holder or rounding the edge of the holder would eliminate any potential danger.

Independence

The Fun Wheeler was not designed for independent propulsion and consequently received very low scores for independence. The users liked being able to easily move across the sand but disliked "being stuck in one spot when no one was pushing." the emphasis on dependence was expressed by both users and companions. The fact that companions were required to hold the device even when sitting still, enhanced the feelings of dependency.

The Fun Wheeler also sits very close to the ground, which made it difficult for many of the users to enter and exit the device. Transferring from wheelchair seats, which were generally higher than the Fun Wheeler seat, was demanding.

Though the Fun Wheeler could not be used independently, the companions found it much easier than a wheelchair to move across the sand. This seemed to be more a factor of the Roleez wheels than the rickshaw design of the Fun Wheeler.

Appearance

For the most part, users and their companions did react very strongly to the appearance of the Fun Wheeler. It seemed that the younger users liked the rickshaw design of the device but their companions did not. One young girl commented she liked "my dad having to be the horse," as her dad despairingly commented that it "looked like a horse and cart."

Several individuals commented on the color of the Fun Wheeler, most expressing a desire for a brighter color than the beige upholstery on the model used. Consistent with this, several users and companions expressed approval for the bright orange Roleez wheels used on the Fun Wheeler.

Two other comments seemed particularly relevant. One youngster commented that the Fun Wheeler "didn't make me look disabled" and another stated, "I felt special having the only one on the beach."

Maintenance and Transport

The Fun Wheeler would be relatively easy to maintain. The frame, constructed of PVC pipe, is resistant to the effects of water, salt, and sand. The Fun Wheeler has very few moving or metal parts. It does have a vinyl seat that could crack or split with prolonged exposure to the sun and water.

Though not collapsible, the Fun Wheeler is easily and quickly disassembled for transportation by automobile.

Sport Wheeler

The Sport Wheeler is an "all terrain" cart designed for adults. It has an aluminum frame, cushioned seats, no armrest, and three 18-inch Roleez balloon wheels made of an elastic, puncture resistant plastic. It is pushed from behind by an attendant and the steering is controlled by the user with a large triangular handle in the front of the unit. It is equipped with wheel locks, a seat belt, and a chest strap. The Sport Wheeler weights 55 pounds.

Comfort and Safety

Comfort was not one of the strong points of the Sport Wheeler. Users at both the Indiana and Florida sites mentioned the cramped leg and foot room of the device. The rigid chair back was also reported to be uncomfortable.

The Sport Wheeler sits close to the ground, which caused problems when entering and exiting the device. Transfers were complicated further by the steering device, which protruded into the seating area.

No safety concerns were noted by users or their companions. The Sport Wheeler is solidly constructed of metal tubing. Though not reported by any of the subjects, there is the potential for the metal to become hot after extended exposure to the sun.

Independence

The Sport Wheeler provides an element of independence not present with most of the other assistive devices. Though it can only be propelled by an ambulatory companion, the Sport Wheeler allows the user to steer. Users and companions at both sites commented that they enjoyed having the increased involvement of guiding the device, which could account for the Sport Wheeler's relatively high mean score on the independence factor (Table 4).

The Roleez Wheels enable the Sport Wheeler to be pushed across the sand more easily than a standard wheelchair. This was true on both the coarse sand at the Indiana site and the fine sand at the Florida site.

Appearance

The Sport Wheeler has a distinctive look that was appreciated by users and their companions at both sites. The device seems well named, as its "sporty" look was noted. One user also remarked that the device "didn't make me look disabled."

Maintenance and Transport

The Sport Wheeler consists of relatively few movable parts, which would seem to ease the maintenance requirements for the device. The metal frame may be problematic in beach

environments, however, no difficulties were evident during the time the Sport Wheeler was tested.

The Sport Wheeler was relatively light and compact enabling easy transport.

Adventure MK2

The Adventure MK2 is marketed as an "all terrain" wheelchair and must be propelled by a companion from behind the user. It has a welded steel tubular frame, three pneumatic all terrain tires, and hinged arm rests. The seat and high back are cushioned with a grey vinyl upholstery. The Adventure MK2 is equipped with hand breaks operated by the companion. It is available in both youth and adult sizes.

Comfort and Safety

Many of those who preferred its appearance commented that the Adventure MK2 "looked comfortable," which was confirmed when they used the device. They particularly liked the feel of the seat, the arm rests, and the unique hand grips on the arm rests. Users were also pleased with the ease with which transfers could be made to and from the device. This was facilitated by the height of the seat and the movable arm rest.

According to users, the Adventure MK2 did not handle bumps well. The position of the foot rest was reported to be uncomfortable and allowed some users' feet to drag on the front wheel. The vinyl upholstery got hot with prolonged exposure to the sun, which could be dangerous for someone with impaired sensation in their lower extremities.

A number of users and companions also expressed concern with the design of the front wheel, which caused the device to feel unbalanced. At times, the front wheel didn't turn very well, creating maneuverability problems.

Independence

The area in which the Adventure MK2 rated most poorly was independence. Users seemed particularly frustrated with this device. Their comments: "I'm disabled, but I'm not lazy"; "I want to interact with others, not have them take care of me;" "people looked at me like I was a pity case;" and "I felt self-conscious because I couldn't move unless I was pushed." Many of the users commented on the their displeasure with being pushed.

A majority of the users and companions found the Adventure MK2 difficult to push across the sand. This was especially true on soft, wet sand.

Appearance

The Adventure MK2 mean score on the Appearance Factor (Table 3) was relatively high in comparison to the other assistive devices. Nevertheless, the comments reflected sharp differences in opinions regarding the device. Though some liked the subtle nature of the light

grey upholstery, others thought it was dull and "too bland for the beach." Some thought the Adventure MK2 looked "sporty" while others thought it looked like a "farm machine" or an "invalid carrier."

Maintenance and Transport

The metal tubular frame and vinyl upholstery are potential maintenance problems with the Adventure MK2. The metal tubing is susceptible to rusting. Even if not used in water, the continued proximity to moisture increases the potential for rusting. The vinyl upholstery seems prone to cracking and splitting with prolonged exposure to sun and water.

The Adventure MK2 is large, heavy (70 lbs.), and bulky. It does not collapse for easy transporting to and from a beach area by automobile.

Beachmaster

The Beachmaster is advertised as an "aquatic wheelchair". It resembles a standard wheelchair with especially adapted wheels. The Beachmaster is crafted of stainless steel with red vinyl upholstery. The two rear wheels are perfectly flat four-inch wide bands of stainless steel that are coated with 1/8 inch of plastic polymer. A foot rest extends from the front of the chair to a large (8 inch) plastic ball that serves as the front wheel. The Beachmaster has a folding frame and removable arm rests. It also comes with optional front pool wheel attachments and front sandshoes. The Beachmaster weighs 54 pounds.

Comfort and Safety

The Beachmaster, with its standard wheelchair style seat, provided a comfortable sitting position for most users. The arm rests afforded good side-to-side support but were considered too high. Otherwise, there were no repeated comments, positive or negative, regarding the comfort of the Beachmaster.

On safety the Beachmaster had a high mean score relative to other assistive devices (Table 5). However, the vinyl upholstery and ample metal parts of the Beachmaster pose potential safety concerns. The vinyl upholstery doesn't allow moisture from the person's body to evaporate, which can be both uncomfortable and unsafe. The moisture can be of particular concern for those prone to skin problems. The metal can become very hot with extended exposure to the sun.

Independence

Unlike the majority of the assistive devices, the Beachmaster allowed some users to be more independent. The importance of this independence was reflected in one user's comment, "I could get into the water on my own and that was great." Nevertheless, the mean score on the Safety Factor (Table 4) was low relative to other devices. The Beachmaster was not as easy to propel across the sand as some devices (Table 6). The wide, flat wheel was difficult for users to grasp, so many users were still dependent on others to push. Several users commented that

"push rims" would make the device easier to push independently. That the Beachmaster gave the appearance of independent function seemed to frustrate some users more than those devices that obviously could not be used independently, which was illustrated in several users' comments of "it was hard to propel, and I wanted to do it independently."

Appearance

Appearance was the greatest weakness of the Beachmaster. It had the lowest mean score on the Appearance Factor (Table 3) of all the assistive devices tested. The Beachmaster used an outdated standard wheelchair and adapted the wheels. It gave the appearance of a "hospital chair", as several users referred to it, rather than a sporty, streamlined device one might expect on a beach. Some users felt self conscious using the device.

Maintenance and Transport

As with the Adventure MK2, the Beachmaster has potential problems with its metal frame and vinyl upholstery. The metal tubing is inclined to rust when exposed to moisture, which is inevitable with beach chairs. The vinyl upholstery would seem prone to cracking and splitting with prolonged exposure to sun and water.

Although heavy, the collapsible frame and removable front wheel apparatus allow the Beachmaster to be transported by automobile.

Surf Chair

The Surf Chair is constructed of white PVC pipe and uses four 18-inch Roleez balloon wheels made of an elastic, puncture resistant plastic. This device is equipped with a cushioned seat and back rest covered in a water resistant material. It also comes with a removable umbrella. The seat of the Surf Chair tested for this study sat 17 inches above the ground. As the testing was concluded, a low-profile version of the Surf Chair has been developed, which sits 15 inches above the ground.

Comfort and Safety

Comfort was one of the strengths of the Surf Chair. The cushioned seat and back rest combined with the large Roleez wheels afforded a very smooth, comfortable ride. Several users also commended the Surf Chair for its detachable umbrella.

The arm rests and height of the seat diminished the comfort of the Surf Chair for some users. The arm rests were fixed and therefore complicated movement to and from the Surf Chair. Movable or removable arm rests would facilitate transfers. Several users commented that the height of the seat was 6"-8" too high for a comfortable transfer.

The Surfchair that was tested had a high profile, a relatively short wheelbase, and used the cushioned Roleez wheels. As a result of those factors, it gave the sensation that the device would easily tip. The Surfchair did become somewhat unstable when operated in shallow water,

but only one user tipped the device over when it was on the sand, and he was attempting to tip it over and using it incorrectly.

Independence

Although no user could use the Surf Chair independently, it received relatively high mean scores on the Independence Factor (Table 4). This appeared to be a result of the ease with which the Roleez Wheels moved across the sand rather than its independent function. Users' mean score on the question of the device's ease of pushing across the sand was relatively high (Table 6) but the mean score for control of the chair was very low.

This was consistent with users' frequent comments that the Surf Chair made them feel "totally dependent" on another person.

Appearance

The Surf Chair received relatively high ratings for its appearance. However, there was a significant difference ($t=3.31$, $p<.05$) in the mean scores of Indiana and Florida users. The Florida users rated the Surf Chair much higher on appearance than did Indiana users (Table 3). The Florida users raved about the color and brightness of the chair. Many of the Indiana users and companions berated the Surf Chair for its bright colors and large PVC tubing, feeling it drew "a lot of attention" and caused the person to be "self-conscious." Again, the differences in the two user groups' age and functional abilities may have contributed to the differences in perceptions.

Maintenance and Transport

The Surf Chair would be very easy to maintain. The frame, made of PVC pipe, is resistant to water, salt, and sand damage. The seat and back cushions are made of a water-resistant material that breathes, preventing the buildup of moisture.

The Surf Chair does not collapse, but it can be disassembled with moderate effort for transportation by automobile.

Marvel

The Marvel aquatic wheelchair is an amphibious device that can be pushed across the sand and into the water then paddled like a canoe. It is designed to provide access across the the beach but also serve as a safe and efficient boat. The front wheels are six-inch, hollow plastic balls that can be raised once the device enters the water. The rear wheels are mountain bike wheels that can be easily removed and stored on top of the device once it enters the water. The cushioned seat has an adjustable back. An opening in the front base of the device is covered by mesh, which provides for convenient storage of small items. There are cup holders on either side of the seat. A collapsible kayak paddle is standard equipment.

Comfort and Safety

The Marvel proved to be an relatively comfortable device for those who used it. None of the six users who tried the Marvel reported any physical discomfort while using it (Table 6), despite the fact that the majority felt the product did not fit their bodies. Also, several users commented that the cushion was too hard.

Transfers to the Marvel were performed immediately in front of either of the rear wheels. The wide, flat surface made transfers relatively easy. Once on the device, users had to pull themselves or be pulled by someone else into the seat. None of the users reported any problems in completing transfers.

Of all of the devices, the Marvel received the highest mean score on the Safety Factor (Table 5). There were no sharp edges reported and the plastic body did not seem to overheat with extended exposure to the sun. The lever mechanism used to raise and lower the front wheels once the device enters the water did jam several times and pinch a few fingers when it was tested at the National Center on Accessibility in Indiana. However, neither problem occurred on the model tested by users in Florida.

Although this study did not test the aquatic abilities of the device, the Marvel was developed as an amphibious device. It was successfully used in the Atlantic Ocean by subjects of this study. The Marvel manufacturer has placed a warning sticker on the device cautioning users not to use the device when unaccompanied.

Independence

Again, the Marvel received the highest mean score on the Independence Factor of all the devices (Table 4). It also scored highest on each of the questions that comprised the Independence Factor. Users felt they could control the device and felt more self- sufficient using it, both of which may have been a function of the Marvel's amphibious design. Most users also perceived that the device pushed across sand more easily than the chairs they usually used each day. Some users, however, experienced difficulty in reaching the wheels, which reduced their ability to push.

Appearance

The Marvel received relatively high mean scores on the Appearance Factor. It received high scores on its style, color, and looks, and was not perceived by most users as being "out of place" on a beach. The Marvel was perceived by users and their companions as sporty and "cool," a comment of numerous users.

Maintenance and Transport

The frame of the Marvel is a single molded plastic form. The frame is durable and resistant to water, sand, or sun damage. All of the metal parts are stainless steel.

The mechanism to raise the front wheels caused some early problems but this seemed to have been remedied when the device was actually tested with users. The rear wheels are easily detached and the seat folds forward for transporting the device.

Cobra

The Cobra is an off-road wheelchair that was originally designed for mountain trails. It has a rigid metal frame, 24-inch pneumatic mountain bike tires in the rear and 9-inch pneumatic tires on the front. The cushioned seat and back rest are covered with a water-resistant material. A patented double-wide tire is designed to provide greater tire surface contact with the sand thereby diminishing the tendency to sink into the sand. It is equipped with hand brakes mounted near the front wheels. The Cobra weighs 44 pounds.

Comfort and Safety

The Cobra was only available a short time for testing and therefore was only used by three individuals. Each of the three users were physically uncomfortable using the Cobra (Table 6). The seat was too narrow, the seat sat "too low - hindering reach to the top of the wheels," and the lack of push rims on the wheels caused discomfort for some users.

Transfers to and from the Cobra were arduous for all but those who could stand. The placement of the wheels and the frame surrounding the seat made it difficult for someone in a wheelchair to get his or her wheelchair close enough to complete a comfortable and safe transfer to the Cobra.

The Cobra's mean score on the safety items was relatively low (Table 5), yet the only safety concern expressed by users related to their arms hitting the top of the wheels when pushing. Examination of the individual items that comprised the Safety Factor revealed a relatively high mean score on the individual safety items (Table 6). Another of the items, stability (Table 6), was relatively low, yet one of the strengths of the Cobra was the stability created by its long wheelbase. These inconsistencies appeared to be a result of the small sample of Cobra users.

More than any of the devices, the Cobra was designed to be used as independently as possible, yet its mean score on the Independence Factor was modest. Users found the Cobra easier to use on the beach than the chairs they typically used but considered its control and self-sufficiency relatively low. Again, the inconsistencies were probably due to the small number of users who tested the Cobra.

Users comments indicated that the Cobra maneuvered "uphill on sand fairly easily." The foot placement on steep inclines interfered with the "power push." Also, the knobby tire made grasping the wheel difficult for some.

Appearance

The Cobra had the highest mean score on appearance items among all of the assistive devices (Table 3), although that may have been a factor of the small sample for the Cobra and testing at only one site. Nevertheless, the Cobra was well received by those who used it. The Cobra has a "rugged' look that appealed to younger, more independent users.

Maintenance and Transport

The manual disk brakes seem to be vulnerable to the effects of water and sand. The frame is a rust resistant metal. The seat and cushion are covered with a material that prevents the build up of moisture.

The Cobra is not collapsible, although the rear wheels do have a quick release mechanism. Its length would require it to be transported by station wagon or van.

SURFACES FACTOR ANALYSIS

Responses to the surface questionnaire were factor analyzed to determine whether the questions could be explained by underlying factors. The factor analysis revealed four factors: Function, appearance, texture, and width (Table 7). Questions related to the ease of pushing on the surface, social interaction, and self-esteem loaded on the factor labelled Function. Respondents approval of the looks and color of the device loaded on the Appearance factor. Questions related to the abrasiveness and slipperiness of the device surface loaded on the Texture factor. The final factor concerned questions related to subjects' perceptions of the surface width.

Beachrings

The Beachrings are 1-foot square interlocking plastic tiles. The Beachrings derive their name from the ring constructed under each tile, which digs into the sand to prevent slipping. The Beachrings are 1/4 inch thick and snap together to form any size surface needed. The light weight of the Beachrings also make it easy to move.

Appearance

As with all of the surfaces, the Beachrings scored relatively high on the Appearance Factor, although there was greater variability in the Beachring ratings than for other surfaces (Table 8). The variability may have been due to the mixed reactions to the color of the Beachrings. There were those who appreciated the bright blue color, as it made locating the surface on the sand much easier. Others felt the color was 'too conspicuous," looked too 'artificial,' and 'drew attention to this as a path for people who needed special assistance.

Function

The Beachring tiles were thin, which created a pliable surface that conformed to the contour of the sand. Many of the users appreciated the movement in the surface, as it gave the "feel' of being on sand. For a number of other users, however, conforming to the contours of the sand made it more difficult to push on the Beachrings. Also, wheelchair users reported loss of traction when the surface was wet or had sand on it.

Safety

There were two safety concerns expressed by users of the Beachrings: the surface edges and the traction. Several users mentioned that the edges of the Beachrings were potentially dangerous. The edges were not beveled and could scrape someone's foot, especially at the corner or each tile. Also, if the tiles were to become disconnected, which did occur during testing, the uneven surface might cause problems for those using canes or crutches.

The second safety concern was related to traction. Several users commented that they lost traction when the tiles became wet or sandy, an obvious likelihood when used at beaches. Conforming to the contour of the sand increased the probability of slopes where traction would be important.

Mountain Grout

Mountain Grout is a soil stabilizer. Sprayed onto or mixed into the sand, Mountain Grout binds with the sand to form a hardened surface within hours. Initially, the surface darkens after Mountain Grout is applied, however, the contrast with the untreated sand lessens with time.

Appearance

The Mountain Grout received scores for appearance comparable to those of the other surfaces tested. Users' comments on the appearance of the Mountain Grout were generally very favorable. Many of the users commented on the "natural look' of the Mountain Grout. A few users commented on the difficulty in distinguishing the hardened surface from the untreated sand, thus making it difficult to locate.

Function

The Mountain Grout received relatively high ratings for function (Table 8). It provided a hard surface that was "easy to push on', as evidenced by its high scores on questions regarding the ease with which users could control and push their wheelchairs on the surface in both dry and wet conditions (Table 9).

Safety

Concern was expressed regarding the safety of the Mountain Grout for those who would walk on the surface and for those with visual impairments. Some users felt the texture of the surface was rough and provided a 'sharp edge' when the sand eroded from the hardened surface. At least one user raised concern for people with low vision using the surface because of the lack of contrast between the sand and the hardened surface.

Snow Fence

Snow Fence is a thin, plastic coated mesh that is placed upon the surface of the sand. It can be purchased in either green or yellow.

Appearance

The Snow Fence received relatively high scores on appearance (Table 8). The "low-tech" look (what one user called the "chicken wire" look) of the Snow Fence was attractive to many of the users. The green Snow Fence provided color contrast with the sand, however, the yellow Snow

Fence was more difficult to detect.

Function
The Snow Fence received the lowest rating for function among the surfaces tested (Table 8). Although it provided better traction than sand, the fact that it conformed to the contour of the sand made it difficult to use for some. Also, it would often "bunch up' under the front casters of wheelchairs. This could be easily overcome with a manual chair by popping the front wheels over the gathered surface. With electric wheelchairs, however, it was much more difficult to become untangled.

Safety
The fact that the Snow Fence was not raised above the surface of the sand relieved some users of their concern for falling off the side. The tendency of the Snow Fence to bunch under the front casters of wheelchairs was mentioned as a safety concern by many of the users.

Superdeck

Superdeck modular walk and deck panels are made of polyethylene with ultra-violet light inhibitors. The panels are connected using stainless steel hardware. Each panel is 66 by 42 inches, and is 3 1/6 inches thick. It can be purchased in either white or tan. For this test, the Superdeck was installed so that the top of the surface was flush with the sand.

Appearance
The Superdeck received the highest rating for each of the factors, including appearance (Table 8). Both the look of the Superdeck and its color were appreciated by users.

Function
The Superdeck provided a very firm and hard surface. As the surface was imbedded in the sand, the slope could be altered slightly during installation. The surface also seemed to function well when wet (Table 9.)

Safety
The most often mentioned safety issue related to the width of the surface. As with the other surfaces, users desired as wide a surface as possible. For this test, a 42-inch wide section of Superdeck was used. Sand could easily erode away from the sides of the Superdeck causing a sharp drop-off.

The Superdeck also has the potential for causing tripping or stubbing of toes for those walking perpendicular to the run of the surface. The light colors blend in with the sand, which may make it difficult to detect the surface.

RECOMMENDATIONS

Accessible surfaces seem to provide the greatest opportunities for access to beaches by people with mobility impairments. A properly installed and maintained surface allows all users to have access to and across the sand and to the water. An accessible surface may be the only way to provide access to those

wheelchair users who have difficulty transferring from their own chair to an assistive device, or to those who cannot easily adapt to a standard assistive device. As assistive devices require greater staff attention for management than do surfaces, the latter would seem to provide access at all times rather than just peak use times.

RECOMMENDATION: All public beaches should provide at least one accessible surface to and across the sand, continuing to the water.

RECOMMENDATION: As assistive devices provide access to all areas of a beach, a combination of accessible surfaces and availability of assistive devices would seem most effective.

Though each of the assistive devices provides greater opportunity for access to beaches and water, none is designed to be used independently. This situation has resulted for two primary reasons:

> **1)** the difficulty in providing a manually operated device that can be easily operated on sand, and
>
> **2)** the liability concerns of manufacturers related to providing a device that might be used independently in the water.

Manufacturers fear an increase in liability if devices are used independently in the water. Nevertheless, independent use is of primary importance to people with disabilities.

RECOMMENDATION: Additional research be conducted to explore means by which assistive devices can be operated more independently on sand.

RECOMMENDATION: Policies related to the use of motorized vehicles on public beaches be examined.

RECOMMENDATION: The development of assistive devices that are motorized should be explored. If developed, these devices should be as inconspicuous as possible in terms of size and noise, as well as affordable.

RECOMMENDATION: Discussions with insurers, attorneys, manufacturers, and users should be held to clarify the liability issues.

RECOMMENDATION: Of the devices tested, those equipped with the Roleez Wheels provided the easiest movement across the sand. The size and lack of tread enable the tires to easily ride across the sand. These same features reduce the opportunities for independent use of those devices. Those devices using the Roleez Wheels should examine ways to allow users to propel the devices.

The cost of many of the devices seemed prohibitive for many potential users. There is a tendency for any type of assistive devices for people with disabilities to be expensive. This may be due to the size of the market, the cost of the manufacturing, insurance costs, or the common reimbursement by a third party insurer for "medical equipment." Regardless of the cause, the fact remains that many users and many agencies will have limited ability to purchase such a device.

RECOMMENDATION: Discussions should be held with manufacturers, recreation agencies, and users on ways to reduce the cost of assistive devices.

Beach Access: Assistive Devices and Surfaces

Table 1. Subject demographic data.

Variable	*Demographic*		
	Indiana	Florida	Combined
N	60	51	111
GENDER			
Female	24 (40%)	32 (62.7%)	56 (50.5%)
Male	36 (60%)	19 (37.3%)	55 (49.5%)
Mean Age (years)	26.5	60.8	42.1
DISABILITY			
Amputee	2 (3.3%)	4 (7.8%)	6 (5.4%)
Arthritis	-	3 (5.9%)	3 (2.7%)
Balance	2 (3.3%)	1 (2.0%)	3 (2.7%)
Cerebral Palsy	15 (25.0%)	2 (3.9%)	17 (15.3%)
Multiple Sclerosis	2 (3.3%)	1 (2.0%)	3 (2.7%)
Muscular Dystrophy	6 (10.0%)	-	6 (5.4%)
Paralysis Nonspecific	2 (3.3%)	7 (13.7%)	9 (8.1%)
Post Polio	2 (3.3%)	1 (2.0%)	3 (2.7%)
Spina Bifida	13 (21.7%)	-	13 (11.7%)
Spinal Cord Injury	13 (21.7%)	4 (7.8%)	17 (15.3%)
Stroke	-	8 (15.7%)	8 (7.2%)
Walking Difficult	1 (1.8%)	11 (21.6%)	12 (10.8%)
Other	2 (3.3%)	9 (17.6%)	11 (10.0%)
Disability Present at Birth			
Yes	28 (46.7%)	4 (7.8%)	32 (28.8%)
No	23 (38.3%)	41 (80.4%)	64 (57.7%)
Did not answer	9 (15.0%)	6 (11.8%)	15 (13.5%)
Assistive Device Normally Used			
Ambulatory	-	5 (9.8%)	5 (4.5%)
Amigo/scooter	1 (1.7%)	2 (3.9%)	3 (2.7%)
Cane	2 (3.3%)	4 (7.8%)	6 (5.4%)
Crutches	4 (6.7%)	-	4 (3.6%)
Manual Wheelchair	33 (55.0%)	26 (51.0%)	59 (53.2%)

Motorized Wheelchair	**16 (26.6%)**	**5 (9.8%)**	**21 (18.9%)**
Prosthesis	**1 (1.7%)**	**-**	**1 (0.9%)**
Walker	**2 (3.3%)**	**7 (13.7%)**	**9 (8.1%)**
did not answer	**1 (1.7%)**	**2 (3.9%)**	**3 (2.7%)**
Require Assistance for Transfers			
Yes	**25 (41.7%)**	**23 (45.1%)**	**48 (43.2%)**
No	**31 (51.7%)**	**17 (33.3%)**	**48 (43.2%)**
Not applicable	**4 (6.7%)**	**10 (19.6%)**	**14 (12.6%)**
Did not answer	**-**	**1 (2.0%)**	**1 (0.9%)**

Beach Access: Assistive Devices and Surfaces

Table 3. Mean scores and standards deviations for the Appearance Factor

Product	Indiana	Florida	Combined
Adventure MK2			
N	18	11	29
Mean	2.35	2.50	2.41
Standard Deviation	0.54	0.57	0.54
Beachmaster			
N	15	4	19
Mean	1.95	2.13	1.99
Standard Deviation	0.73	0.75	0.71
Fun Wheeler			
N	12	4	16
Mean	2.06	2.50	2.17
Standard Deviation	0.87	0.41	0.79
Sport Wheeler			
N	5	7	12
Mean	2.20	2.50	2.38
Standard Deviation	0.89	0.14	0.57
Surf Chair			
N	15	24	39
Mean	2.18	3.01	2.69
Standard Deviation	0.68	0.46	0.68
Cobra			
N	3		3
Mean	3.08		3.08
Standard Deviation	0.52		0.52
Knobby Tires			
N	3		3
Mean	2.58		2.58
Standard Deviation	0.63		0.63
Marvel			

N		**6**	**6**
Mean		**2.88**	**2.88**
Standard Deviation		**0.74**	**0.74**

Beach Access: Assistive Devices and Surfaces

Table 4. Mean scores and standards deviations for the Independence Factor

Product	Indiana	Florida	Combined
Adventure MK2			
N	14	9	23
Mean	1.79	2.48	2.06
Standard Deviation	0.84	0.75	0.86
Beachmaster			
N	13	4	17
Mean	2.21	1.83	2.12
Standard Deviation	0.67	0.33	0.62
Fun Wheeler			
N	9	4	13
Mean	1.70	2.75	2.03
Standard Deviation	0.61	0.50	0.75
Sport Wheeler			
N	4	7	11
Mean	2.75	3.10	2.97
Standard Deviation	1.00	0.46	0.67
Surf Chair			
N	10	20	30
Mean	1.80	2.67	2.38
Standard Deviation	0.63	0.79	0.84
Cobra			
N	3		3
Mean	2.33		2.33
Standard Deviation	0.88		0.88
Knobby Tires			
N	4		4
Mean	2.50		2.50
Standard Deviation	0.58		0.58
Marvel			

N		**6**	**6**
Mean		**3.33**	**3.33**
Standard Deviation		**0.56**	**0.56**

Beach Access: Assistive Devices and Surfaces

Table 5. Means and standard deviations for the safety factor.

Product	Indiana	Florida	Combined
Adventure MK2			
N	18	11	29
Mean	1.30	1.27	2.29
Standard Deviation	0.66	0.49	0.59
Beachmaster			
N	15	4	19
Mean	1.51	1.33	2.47
Standard Deviation	0.49	0.61	0.50
Fun Wheeler			
N	12	4	16
Mean	0.67	1.42	1.85
Standard Deviation	0.65	0.69	0.72
Sport Wheeler			
N	5	7	12
Mean	1.40	1.57	2.50
Standard Deviation	0.28	0.32	0.30
Surf Chair			
N	15	15	39
Mean	1.11	1.11	2.40
Standard Deviation	0.79	0.79	0.66
Cobra			
N	2	-	2
Mean	2.00	-	2.00
Standard Deviation	0.47	-	0.47
Knobby Tires			
N	3	-	3
Mean	2.56	-	2.56
Standard Deviation	0.69	-	0.69
Marvel			

N	**-**	**6**	**6**
Mean	**-**	**2.94**	**2.94**
Standard Deviation	**-**	**0.39**	**0.39**

Beach Access: Assistive Devices and Surfaces

Table 6. Means and standard deviations of assistive device responses.

QUESTION		Adventure MK2	Beach-master	Cobra	Fun Wheeler	Knobby Tires	Marvel	Sport Wheeler	Surf Chair
The chair was stable and secure when I transferred to it.	N	29	19	3	16	3	7	12	39
	M	2.97	3.37	2.67	2.63	3.33	3.57	3.33	3.15
	SD	.73	.50	1.15	1.02	.58	.79	.49	.78
I felt safe when I was using the chair.	N	29	19	3	16	4	6	12	39
	M	3.10	3.21	3.33	2.63	3.50	3.83	3.25	3.21
	SD	.67	.63	.58	.81	.58	.41	.45	.73
I could control the chair when I was using it.	N	26	19	3	16	4	7	11	37
	M	1.77	2.00	2.00	1.75	3.25	3.43	3.09	1.95
	SD	.71	.75	1.00	.93	.50	.79	.54	.74
Compared to my everyday chair, this chair was easy to push across sand.	N	25	17	3	13	4	6	11	33
	M	2.40	2.47	3.00	2.54	2.25	3.17	3.00	2.97
	SD	1.12	.94	1.00	1.05	.96	.75	.89	1.07
QUESTION		Adventure MK2	Beach-master	Cobra	Fun Wheeler	Knobby Tires	Marvel	Sport Wheeler	Surf Chair
This chair allowed me to be as self sufficient on the beach as I wanted.	N	29	19	3	16	4	6	12	38
	M	2.07	1.84	2.00	1.69	2.00	3.17	2.83	2.26
	SD	1.00	.83	1.00	.79	1.15	.75	.83	.95
I like the way the chair looks.	N	29	19	3	16	4	7	12	39
	M	3.00	2.32	3.67	2.75	3.25	3.00	2.83	3.21

	SD	.65	1.00	.58	1.00	.50	1.15	.72	.86
I like the style of the chair.	N	29	19	3	16	3	7	12	39
	M	2.90	2.21	3.67	2.56	3.33	3.29	3.08	3.15
	SD	.82	.98	.58	1.09	.58	.76	.51	.81
I like the color of the chair.	N	29	19	3	16	3	7	12	39
	M	3.10	2.63	3.67	2.94	3.33	3.29	2.75	3.26
	SD	.67	.90	.58	1.00	.58	.76	.75	.79
QUESTION		Adventure MK2	Beach-master	Cobra	Fun Wheeler	Knobby Tires	Marvel	Sport Wheeler	Surf Chair
I felt self-conscious when I used the chair with others around.	N	29	19	2	16	4	7	12	39
	M	2.21	2.16	2.00	2.69	1.75	1.71	2.08	2.15
	SD	.77	.90	1.41	1.08	.96	.76	.51	.84
Were you physically uncomfortable?	Y	12(41%)	10(47%)	3(100%)	6(37%)	0	1(14%)	5(42%)	12(31%)
	N	16(55%)	9(53%)	0	8(50%)	4(80%)	6(86%)	7(58%)	27(69%)
Were there any sharp edges?	Y	12(41%)	3(16%)	0	0	0	1(14%)	0	2(5%)
	N	17(59%)	15(79%)	3(100%)	16(100%)	3(60%)	6(86%)	12(100%)	36(92%)
Was the device too hot?	Y	5(17%)	2(10%)	0	1(6%)	1(20%)	0	-	5(13%)
	N	21(73%)	14(74%)	3(100%)	13(81%)	2(40%)	7(100%)	11(92%)	30(77%)
Did the product fit your body?	Y	23(79%)	13(68%)	0	9(56%)	0	2(29%)	3(25%)	27(69%)
	N	4(14%)	5(26%)	3(100%)	6(37%)	1(20%)	4(57%)	9(75%)	11(28%)

Beach Access: Assistive Devices and Surfaces

Table 7. Factor analysis of Likert-scaled statements on surfaces.

Statements	Factor 1: *Function*	Factor 2: *Appearance*	Factor 3: *Texture*	Factor 4: *Width*
The surface was too rough.	-.29146	-.15759	.76583	.20568
The surface was too slippery.	-.06250	-.07392	.85514	.01662
I could control my movement when I was using the surface.	.74430	.03806	-.31026	.06965
I was concerned that I might fall off the sides of the surface.	-.27144	.20621	.14762	.76488
It was easy to push on this surface.	.69829	-.10627	-.49149	.07708
I was able to interact freely with other people on the beach while using this product.	.68801	-.02856	.09727	-.20030
I like the way the surface looks.	.26159	.83749	-.06587	.00387
The surface seems too narrow.	-.04262	-.21183	.04890	.82852
I like the surface color.	.05994	.90492	-.10961	-.00645
I think people without a disability would use this surface to access the beach and water.	.55238	.26851	-.08593	.40924

I felt self conscious using this product with others around.	**-.64054**	**-.23984**	**.15486**	**.09525**
Other people seem uncomfortable when I use this product.	**-.69721**	**-.13528**	**.20088**	**.19389**
I felt good about myself when I used this product.	**.65652**	**.23092**	**-.03978**	**-.12265**

Beach Access: Assistive Devices and Surfaces

Table 8. Mean scores and standards deviations for surfaces

Surface	Appearance	Function	Texture	Width
Beachrings				
N	43	40	44	44
Mean	2.91	2.20	0.94	0.58
Standard Deviation	0.58	0.46	0.47	0.61
Mountain Grout				
N	13	11	13	12
Mean	2.92	2.65	1.91	0.83
Standard Deviation	0.95	0.50	0.69	0.58
Snow Fence				
N	44	43	48	49
Mean	2.91	2.05	0.85	0.85
Standard Deviation	0.51	0.45	0.52	0.53
Superdeck				
N	21	17	22	20
Mean	3.12	2.65	1.30	0.90
Standard Deviation	0.50	0.39	0.37	0.60

Beach Access: Assistive Devices and Surfaces

Table 9. Means and standard deviations of surface responses.

Statements		Beachrings	Mountain Grout	Snow Fence	Superdeck
The surface was too rough.	N	45	13	48	22
	M	2.09	1.85	2.15	1.55
	SD	.56	.90	.62	.51
The surface was too slippery.	N	44	13	48	22
	M	2.02	1.77	2.15	1.86
	SD	.51	.73	.62	.47
I could control my movement when I was using the surface.	N	44	13	49	21
	M	2.45	3.00	2.29	3.19
	SD	.66	.82	.65	.68
I was concerned that I might fall off the sides of the surface.	N	45	13	49	22
	M	2.31	2.15	2.02	1.95
	SD	.63	.99	.56	.90
It was easy to push on this surface.	N	43	11	46	20
	M	2.86	3.55	2.59	3.45
	SD	.64	.52	.88	.51
I was able to interact freely with other people on the beach while using this product.	N	45	13	47	22
	M	2.76	2.77	2.68	2.82
	SD	.61	.93	.66	.66
I like the way the the surface looks.	N	44	13	47	22
	M	2.91	2.92	2.89	3.09
	SD	.60	1.12	.63	.61
The surface seems too narrow.	N	44	12	49	20

	M	2.55	2.17	2.29	2.35
	SD	.70	.72	.65	.81
I like the surface color.	N	43	13	46	21
	M	2.91	2.92	2.85	3.14
	SD	.61	.86	.60	.48
I think people without a disability would use this service to access the beach and water.	N	44	13	49	20
	M	2.86	3.08	2.35	3.10
	SD	.59	.64	.63	.64
I felt self-conscious using this product.	N	43	13	48	21
	M	2.14	1.69	2.19	1.81
	SD	.64	.48	.73	.60
Other people seem uncomfortable when I use this product.	N	44	13	48	21
	M	2.18	1.85	2.08	1.76
	SD	.62	.69	.68	.54
I felt food about myself when I used this product.	N	44	13	48	21
	M	2.89	3.08	2.75	3.10
	SD	.65	.76	.81	.70
Did the surface have any sharp edges that might scratch or cut?	Y	3(7%)	3(23%)	9(18%)	1(4%)
	N	41(91%)	7(54%)	39(80%)	21(94%)
Did the surface get too hot?	Y	5(11%)	2(15%)	1(2%)	1(4%)
	N	37(82%)	8(62%)	45(92%)	16(73%)
Did the surface move, or slip when you pushed on it?	Y	8(18%)	1(8%)	22(45%)	6(27%)
	N	36(80%)	9(70%)	24(49%)	15(68%)