Guiding the Design of Inclusive Playgrounds through Needs Assessment and Materials Selection

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***Abstract*—Playgrounds can serve as an influential site in children's lives, but their designs and features often exclude those with disabilities and their social, emotional, and physical needs. This study was conducted in collaboration with Bennett's Village, a Charlottesville-based nonprofit seeking to build an inclusive playground. The purpose of the study was to investigate the needs of adolescents and young adults in the disability space and to create a materials recommendation for playground surfacing. The parameters of these analyses were established and prioritized alongside Bennett's Village. For the qualitative needs assessment, the team recruited members from organizations focused on the disability community and had 6 participants in the semi-structured interviews and 77 participants in the survey. Through qualitative content analysis of interview and open-ended survey responses and descriptive statistics analysis of close-ended survey responses, we found that, among other trends, participants viewed playgrounds as a site for community and socialization, wanted open spaces that could serve a variety of purposes, and emphasized the importance of nature. For the materials recommendation, the team created a life cycle assessment and cost-benefit analysis and found that poured-in-place (PIP) rubber was the optimal surfacing material with regard to factors such as permeability, local weather factors, and traffic/usage. These findings will be passed on to Bennett's Village to use in their design of their playground and will also contribute to future inclusive playground design broadly.**

Keywords—inclusive playground, disability, adolescents, young adults, needs assessment, playground materials, ground surfacing material

I. Introduction

Community playgrounds provide opportunities that positively guide childhood development, but the needs of those with disabilities are not typically considered in existing design standards. For example, the 2010 Americans with Disabilities Act (ADA) guidelines require accessibility in terms of entry or access to the play features, but they do not regulate accessibility of the equipment itself [1]. Although some playgrounds may be ADA compliant, the materials used for the playground surfaces are not conducive to people with varying degrees of ability and/or mobility impairments [2]. The 2010 ADA guidelines address accessibility rather than inclusivity, and if disability is considered, it largely focuses on users who require wheelchair assistance and neglects other types of disabilities. Very few parks incorporate inclusive features such as parking accommodations, accessible play spaces and components, and park paths or routes [3]. This exclusion is detrimental to children's growth, so it is imperative that playgrounds not only meet but exceed technical guidelines for accessibility and account for the emotional and social needs of all guests.

In addition to playground design in terms of play features and layout, playground surface material selection is a key component in exclusion of users. Surface materials typically used for playgrounds, including pea gravel, sand, wood chips (mulch), and shredded rubber, can hinder users from entering or navigating the playground. These loose fill surface materials are difficult to traverse for people with varying modes of mobility and are therefore not recognized as ADA-approved materials [4]. Unitary or fixed-form surface materials, on the other hand, would better ensure inclusion of playground users. Existing literature on playground surfacing materials does not include quantitative values such as life-time costs, so this can be expanded upon through further research [5].

Exclusion extends to the adolescent and young adult demographic, particularly those with disabilities, in how they are not typically given agency or power in the decisions that concern them [6]. They are forced to acclimate to a society that does not accommodate them because their experiences are not accounted for in the design of their environment [7]. In the playground setting, there is more focus on allowing those with disabilities to be present rather than creating opportunities for them to engage in social play [7]. Although existing research has explored the needs of playground users, much of it focuses on young children; an additional needs assessment can be conducted to holistically understand adolescents and young adults, especially in the disability community [8].

Bennett's Village, a nonprofit in Charlottesville, Virginia, is seeking to meet this need by designing and constructing an all-abilities, multi-generational playground [9]. In collaboration with the organization, the team aims to fill the demographic research gap of adolescents and young adult playground users ages 12 through 26 and playground accessibility gap through analysis of surface materials.

II. Methods

A. Overview

Based on dialogue with Bennett's Village and the existing gaps in the literature, the team identified the objectives of the study: conducting a needs assessment on playground visitors' needs and determining an optimal surfacing material for the playground. The team used a mixed methods approach for the study. For the needs assessment, the team used qualitative approaches to analyze semi-structured interviews and open-ended survey responses and descriptive statistics to analyze close-ended survey responses. Recruitment was completed through outreach to organizations in the disability space. We received approval from the UVA Social and Behavioral Sciences Institutional Review Board in March of 2021 to conduct this portion of our study. For the materials

recommendation, we analyzed unitary materials using a life cycle assessment for quantitative cost data and cost-benefit analysis for qualitative data.

B. Sample

The research team used a combination of convenience sampling and snowball sampling to recruit participants for the online interviews and survey for the needs assessment. Eligible participants were individuals between the ages of 12 and 26 who were involved in the disability space and had playground experience. This could mean that they themselves self-identified as having a disability and/or they care for or are a companion to someone with disabilities. These participants were grouped into two categories: adolescents, 12-17 years old, and young adults, 18-26 years old. This demographic was chosen to fill the gap in existing general research and research conducted by Bennett's Village.

C. Recruitment

The needs assessment involved the distribution of outreach messages to local, regional, and national organizations to call on their members to participate in an online survey and/or virtual interview. The recruitment message included the purpose of the study and instructions on how to schedule an interview and access the survey. These messages were sent out in March and April of 2021. Interested interview participants reached out through self-selection to one of two researchers organizing the interviews, and survey participants were given access to the survey link through initial outreach messages. Interview participants were compensated with $20 Visa gift cards, and survey participants were entered into a drawing for a $40 Visa gift card.

D. Data Collection

The interviews were semi-structured, consisting of 47 questions and lasting approximately 40 minutes. There were seven objectives focused on:

1) *General inquiry*
2) *Current playground experiences*
3) *Previous playground experiences*
4) *Knowledge of inclusive play*
5) *Ideal park design*
6) *Feature and space preferences*
7) *Demographics*

Verbal consent was provided at the beginning of the interviews. Audio recordings and transcriptions were stored on UVA Box, a secure cloud storage platform that only the researchers on the team can access. Upon completion of each interview, the researchers ensured that the interview data were de-identified to maintain confidentiality.

Surveys were conducted through Qualtrics and included 41 closed-ended questions and 3 open-ended questions. These were broken up into categories relating to playground experiences, park elements, and playground preferences. Once the survey period concluded, the data were downloaded and securely stored on UVA Box.

Research data regarding material selection were collected during February and March of 2021. To form materials recommendations, the team first narrowed down candidate materials to those that were unitary, ADA compliant, and deemed viable by Charlottesville Parks and Recreation. These materials included PIP rubber, rubber mats/tiles, artificial/synthetic grass, and bonded rubber mulch. Data were then tabulated over several iterations to include information such as notes on costs, specifications, choice variety, and source citations.

E. Data Analysis

The interviews were recorded, transcribed, and analyzed using conventional content analysis through Dedoose Version 8.3.47b [10]. The team examined the interviews for overall trends before determining codes to define themes and draw example quotes. Conventional content analysis was used for both interview and open-ended survey responses while descriptive statistics was used specifically for the close-ended survey responses [10]. Directed content analysis was used to group the categories of ideal park features and unfavorable park features. Conventional content analysis was then used to determine themes across participant responses within each category [10].

To obtain a comprehensive understanding for materials recommendation, the team elected to complete a life cycle assessment to better understand the longevity, cost, and qualitative components [11]. This assessment was conducted across a 10-year period for a playground area of 4,000 square feet. To simplify analysis, the team also worked under the assumption that the candidate materials would have equal monetary and labor maintenance costs since further research showed that maintenance was similar across candidate materials. The candidate materials were all compliant with ASTM and ADA standards, and costs were found to account for a critical fall height of ten feet to increase safety and limit potential injuries. Qualitative aspects including permeability, usage/traffic, and weather factors were also compared. The researched materials, which are all unitary, included:

1) *Poured-in-place rubber*
2) *Rubber mats/tiles*
3) *Bonded mulch*
4) *Artificial/synthetic grass*

III. RESULTS

A. Needs Assessment

a) Sample Characteristics

Six individuals self-selected to participate in online interviews based on specified criteria. All of these participants were in the young adult age group. Sixty-seven percent identified as white with the remaining 33% identifying as Asian. Sixty-seven percent identified as having a chronic health condition. Fifty percent identified clearly as having a disability while 33% gave conditional positive responses, such as not fully identifying with the term personally but considering themselves disabled medically. A total of 77 survey participant responses were recorded. Over 130 surveys were submitted, but only 77 responses met the eligibility required for age and 50% completion. Of the 77 qualified participants, about 94% were young adults, about 60.5% considered themselves as having either a long-term or temporary disability, and about 95% had

experience with playgrounds. These survey demographics can be seen in Table 1.

TABLE I. DEMOGRAPHIC INFORMATION OF SURVEY PARTICIPANTS

	Demographic Information		
	Demographic Category	***Demographic subcategory***	***n(%)***
Demographics	Age Division	Adolescents (12-17)	5(6.5)
		Young Adults (18-26)	72(93.5)
	Gender	Female	53(72)
		Male	14(19)
		Genderqueer/gender non-conforming	6(8)
		Other	1(1)
	Long-term or Temporary Disability (self-reported)	Yes	43(60.5)
		No	20(28)
		Prefer Not to Say	5(7)
		Other	3(4)
	Has Experience with Playgrounds	Yes	72(95)
		No	4(5)
	Race	Asian	14(18)
		Black or African American	3(4)
		Hispanic or Latino	4(5)
		Native Hawaiian or Pacific Islander	2(2.5)
		White	50(64)
		Prefer not to answer	2(2.5)
		Other	3(4)

b) Themes

The following themes were drawn from both the interviews and survey. The quotes and reference counts were pulled from the interviews and the open-ended survey questions, and the quantitative data were pulled from the survey responses.

THEME 1: MOTIVATIONS

Participants identified sense of community and relaxation as motivations for visiting playgrounds.

- Community: Playgrounds were identified as being a site conducive to community building and bonding. Some participants went to socialize with new people: *"... A chance to grow their social networks."* Other participants went to playgrounds to bond and connect with their existing network: *"Sometimes I love walking around my neighborhood and those parks when I have the time with my friends and grow everlasting friendships."* Participants also expressed the desire for multi-generational interactions, which would require equipment that could be flexible with various body type, sizes, and accommodations: *"Even though she's small… people her age don't still go to the park… so probably younger children she has interaction with at the park."* Ninety-one percent of survey respondents indicated that they visited playgrounds with one or more individuals or in a group, which further supports the socialization motive. Survey participants made 19 references to how this socialization or community could be facilitated through entertainment spaces, like amphitheaters, or event spaces for large gatherings, like pavilions: *"I really liked the idea of the amphitheater/entertainment center - type of addition. I don't think I have ever seen that in a park/playground before, but I would very much enjoy that."*
- Relaxation: Playgrounds were identified as offering a source of relaxation from stressful situations because of their atmosphere: *"It's definitely, like, more carefree at a playground."* From the survey, 19% of responses indicated that leisure or relaxation served as a motivation for playground visits. They also serve as a site for breaks or decompression from everyday routines: *"Just as a way to, you know, obviously, promote coming home from, like, a long school day and just a wave of relaxation."* About 21% of survey respondents indicated a desire for relaxation spaces. This theme lends to the desire for quiet spaces and natural spaces, which will be further detailed in Theme 3: *"If I'm, like, really stressed out, like, being around nature kind of really relaxes me."*

THEME 2: LAYOUT

Participants expressed a desire for the general layout of the playground to be open for versatile usage and offer ample space for various activities.

- Open, versatile spaces: There was an expressed preference from both interview and survey participants for open areas that could be used by a wide variety of audiences, *"like a good mix of a lot of things that you, like, would cater to a lot of people."* This aligns with Bennett's Village's goal of creating a playground for all abilities and all ages to create community-building opportunities. Meeting this goal would allow playground visitors to accommodate the space to their own activities and *"switch between different activities"* as needed.
- Spread out spaces: There was also an expressed preference for the playground features to be spread out: *"It might get overcrowded and … people may not properly be able to enjoy their space."* This is especially important for children who require more space to accommodate their physical needs and to make them feel like they have room to play independently: *"Sometimes you'll have limited space and someone's trying to plan the equipment in such a tight spot that the kids don't have the luxury to spread their wings."* From the survey, over 63% preferred spaced-out layouts instead of centralized layouts. Survey respondents also made 19 references to a desire for space to enjoy the playground without encroaching on the space of others.

THEME 3: DESIRABLE FEATURES

In order to provide a sense of independence and connection to playground visitors, participants identified ground surfacing materials, handrails, seating, shaded areas, natural features, and swings as important features to consider.

- Ground surfacing materials: Participants expressed a preference for PIP rubber: *"If it could maybe be rubberized... the spongey type of, it was rubber, like, rubber flooring."* Over 20% of survey respondents preferred rubber tiles, and 23% preferred solid rubber surfacing.
- Handrails: For a greater sense of safety and stability while moving throughout the playground and its features, participants wanted handrails and handles: *"Kids with Down syndrome have typically flat arches and low muscle tone so it's hard to control sometimes… so to have the railing is just an added precaution for them for stability."* This also provides a greater sense of independence for visitors to navigate the playground on their own: *"I think you also like the handrails to be sure of yourself. They matter to her in regards to that independence."*
- Seating: Interview participants expressed a desire for seating for physical rest and relaxation. Benches would allow participants to take a necessary break from physical activity: *"It definitely makes things really difficult just physical activity wise… Having a place to sit down, it's just such a huge deal for me now."* Seating can also be used as a playground feature for stress relief: *"For me, it's having… a place where I can sit in peace and quiet sometimes… Moments of clarity and moments of stress free."* Survey participants made 24 references to the importance of the availability of diverse seating in terms of size and design at various locations within the park. Over 75% of survey responses indicated interest in large seating areas, and more than 76% of survey respondents expressed desire for private seating spaces at playgrounds.
- Shaded areas: With regard to weather concerns, there was a widespread desire for shade across both interviews and surveys: *"I think we'd like if it was more shady. Some type of canvas protection."* This served to be especially important with blocking out direct sunlight in hot weather: *"Just having shade or something if there's really bad, like, heat or something to prevent the overheating and things like that."* There were 11 references made in the surveys with regard to this need for shade.
- Natural features: There was a trend across interview participant preferences for playgrounds to emphasize surrounding nature or other natural features: *"I guess it, like, highlights, like, the natural environment so, like, I'd like to see, like, grass, and, like, I guess nothing that looks, like, too artificial."* Over 28% of survey respondents noted that they enjoyed the natural environment in playgrounds. These natural features were also connected to the stress relief motivation for visiting an outdoor space. There were 36 survey references to nature, including flowers, birds, butterflies, grass, forests, and trees, the most of any park element. They described nature as an essential environmental factor for parks and playgrounds. Tracks or trails throughout the park, which were referenced 22 times, can also accommodate this desire.
- Swings: Swings were the most frequently mentioned traditional playground feature with 20 references in the survey. Further, participants specifically referred to the importance of a variety of swing designs, including those for people of all ages and abilities, and its importance in their playground experiences: *"She gets a lot of sensory input from it, um, in regards to swinging."*

THEME 4: UNDESIRABLE FEATURES

In order to provide accessibility and inclusivity in the playground setting, metal structures, loose playground surfacing materials, and loud or unmaintained settings were indicated as features that should be avoided at playgrounds.

- Metal structures: Participants made 6 references to metal structures, especially metal slides, as features to avoid. Participants noted that metal features are vulnerable to weather conditions, particularly when it is hot and sunny: *"No metal slides—gets too hot."*
- Loose playground surfacing materials: Loose fill ground surface was referenced 23 times in the survey as a hazard, irritant, or a generally undesirable material. Examples of these materials, which could serve as barriers in playground participation, included sand, pea gravel, and wood chips/mulch: *"No pea gravel because if you have kids in wheelchairs, they're not gonna be able to maneuver in that stuff."* When asked about which ground surface materials they did not prefer, survey participants indicated 26% sand, 25% pea gravel, and 19% mulch/wood chips.
- Loud or unmaintained setting: Survey participants referenced their dislike for loud, noisy, or distracting playground surroundings. This aligns with playgrounds being seen as a site for stress relief or relaxation: *"A park without any sort of way to really escape lots of noise and distractions would not be ideal."* With regard to maintenance, there was a remarked emphasis placed on all playground features being in order for operation and general cleanliness across the space: *"I wouldn't feel comfortable going to a park that isn't, like, kept clean, or, like, making sure, like, everything is working, because, I guess, then it gives me the sense that it was kind of, like, abandoned or not, like, taken care of, so I wouldn't feel quite as safe going there."*

B. Materials recommendation

Table 2 displays the results of the life cycle assessment for the four candidate materials.

TABLE II. LIFE CYCLE ASSESSMENT OF CANDIDATE MATERIALS FOR PLAYGROUND SURFACING OVER A TEN-YEAR PERIOD

Aspect		***PIP Rubber***	***Rubber Mats/ Tiles***	***Artificial / Synthetic Grass***	***Bonded Rubber Mulch***
Section	***Categ -ory***	***Cost***	***Cost***	***Cost***	***Cost***

Installation Cost	***Site Preparation***	$16,000	$15,000	$14,000	$8,000
	Materials, Labor	$80,000	$60,000	$92,000	$48,000
Maintenance	***Monthly***	$20	$20	-	$20
	Annually	$430	$9,600	$2,740	$5,000
Longevity		15 years	10 years (max)	8-10 years	10 years
Total		$102,700	$84,620	$133,400	$73,400

Artificial/synthetic grass was the most expensive, costing an estimated $133,400 whereas bonded rubber mulch was the least expensive, costing an estimated $73,400. Qualitative elements of the playgrounds were then analyzed through a pros and cons list.

- Permeability: PIP rubber, rubber mats/tiles, artificial/synthetic grass, and bonded rubber mulch are all porous surfaces that aid in efficient drainage and limit runoff. PIP rubber requires the installation of an additional drainage system beneath the surface to ensure proper drainage. If soil and under layering expand due to excess water build up, the rubber mats/tiles could become unlevel in certain areas.
- Weather Factors: PIP rubber has a high ultraviolet resistance, meaning the material resists temperature change so the material will not generate significant amounts of heat on sunny days. Artificial/synthetic grass and bonded rubber mulch are vulnerable to the sun and typically generate surface heat on sunny days. Rubber mats/tiles are likely to warp or curl around the edges and corners, creating mobility hazards due to weather conditions that cause the expansion and contraction of the underlying ground.
- Usage/Traffic: PIP rubber is designed for heavy foot traffic areas and can withstand light vehicular traffic. Artificial/synthetic grass is also designed for high foot traffic settings. Rubber mats/tiles are durable, but if the mats/tiles warp or curl around the edges, high traffic settings will further worsen the state of the tiles. Bonded rubber mulch is not a durable surface and is designed for landscaping or low traffic areas. Bonded rubber mulch is 50 times less durable than PIP rubber and quickly diminishes in quality when used in high traffic environments.

IV. DISCUSSION

A. Summary of Key Findings

Four key themes emerged from the qualitative data from interviews and surveys: motivations, layout, desirable features, and undesirable features. Participants were motivated to visit these spaces in order to experience a sense of community and relaxation. There was an expressed desire for open, flexible-use spaces. Specific desirable features included handrails, seating, shaded areas, natural features, and swings. Specific undesirable features included metal structures, loose surfacing materials, and loud or unmaintained settings.

PIP rubber was determined to be the optimal material for playground surfacing across several parameters through both the needs and life cycle assessments. PIP rubber surfacing is especially durable to heavy foot traffic and is UV resistant, which both play a key role in ensuring longevity. It also requires minimal maintenance and has high permeability, which will aid in providing a playground space that is safe and can be used more frequently. Additionally, while costly upfront, PIP rubber has the longest life expectancy and significantly lower long-term costs.

B. Comparison to Previous Research

The needs assessment findings with adolescents and young adults with disabilities included preferences for open and private spaces, natural settings, and large community events, which align with research conducted by the program, Growing Up Boulder, which examined the needs of teens without disabilities [12]. Additional research that aligns with our assessment suggests that public programs like comprehensive education, training, and coaching programs would enhance participation of play for people with disabilities as well [13].

There has been an emphasis in existing research on features regarding athletic activities in creating multi-generational spaces. The conducted research highlighted needs of creating a sense of community and relaxation. Features including amphitheaters, event spaces, and nature spaces could cultivate multi-generational relationships in addition to athletic features.

From the research results, it was clear that many participants raised concerns about loose fill material surfacing for the playground. Many existing playgrounds are composed of loose fill material options, which introduce potential accessibility issues. Our materials assessment emphasized the importance of unitary materials by purposely excluding loose fill materials to meet the goal of inclusivity within playgrounds.

While previous research emphasizes ideas that adolescents and young adults have regarding features that they would like to see implemented, the team's research extends findings by inquiring users' thoughts on features, both positive and negative, beyond surfacing materials [12]. Existing research highlighted playground components that users would like to see such as accessible surfacing, safety and light features, and nature features [12]. The conducted research takes a step further into assessing what factors users do not prefer in terms of maintenance, metal structures, and distracting surroundings.

C. Implications

In terms of design, the team's findings indicate clear desires and needs of users and present a more vivid understanding as to how these users conceptualize playground spaces. Our findings could be used to modify or extend existing ASTM and ADA standards to meet the playground surfacing needs expressed in the interviews and surveys. This research can also be disseminated to parks and recreation departments to implement these inclusive features or throughout communities to educate and build greater awareness of these needs.

D. Limitations

Within the scope of this project and its research, there are several limitations that should be noted. One limitation is the amount of research the team procured in terms of materials. While compiling information, there could be variability in reported costs depending on materials sourcing and characteristics. A sensitivity analysis is needed to account for this. Within the scope of the needs assessment, the team's understanding of users' experiences is reliant on limited narratives due to a relatively small sample size. The demographics of the research participants may not reflect local communities, so further research should be conducted to consider this aspect. These factors would have an impact in terms of comprehensively portraying the experiences of playground users but could over time be improved by obtaining more survey respondents and interviewees.

E. Future Research

In designing inclusive playground spaces, more research can be conducted surrounding what inclusion truly means. It would also be advantageous to conduct additional interviews with the study demographic to gain more insight in terms of age diversity, especially with the adolescent population. Additionally, it could be beneficial to investigate not only standardized surfacing materials for the playground, but also emerging prototype materials which may not traditionally be used as surfacing but could be considered.

V. Conclusion

In order to create a playground that is inclusive across the spectrums of age and ability, a needs assessment was conducted to learn about the lived experiences of adolescents and young adults in the disability community. Through interviews and survey responses, factors emerged such as the importance of open and versatile use areas and spaces that highlight surrounding nature. These elements, including access to seating or shade, can increase inclusivity and facilitate the sense of community and relaxation in playgrounds for adolescents and young adults in the disability community. Through the materials analysis, poured-in-place rubber was identified to be the best option in terms of factors such as high permeability, durability in various weather conditions, and high usage/traffic. This information can be employed by Bennett's Village and other playground designers in future all-abilities, multi-generational playgrounds.

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