# Sensory informed design: Human processes and emerging sensory tools

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ABSTRACT: The paper examines the process of designing a Mobile Autism Assessment Unit, and the consideration of the development of a Post Occupancy for use in further design of products and spaces for people with sensory processing issues. Emergent processes are considered as a mode for examining user metrics in a space for people with sensory issues. The possibilities of evaluation of human comfort through study are also examined.

KEYWORDS: Sensory Design, Autism, Post Occupancy, Informed Design

#### INTRODUCTION

In building for change, the question of framing a problem correctly is often the path to realization. As designers, we often find ourselves in the role of question makers, and continually the answers come from the process of information gathering and research (Dickenson et al 2009) In design, the problem to be solved is first framed by need, and increasingly the needs of specialized clients require novel research and outcomes. This work will study the multidisciplinary nature of the well-framed question through the ongoing speculative development of an evidence-based process. In the process this paper will lay out a possible initial method for developing a metric that will create quantifiable and adjustable relationships between humans and their material environment in the design of interior environments. Using the van project as a basis as well as the examination of several areas of architectural research, the hope is to lay out a path of the development of such a metric. This metric creates the base to design a digital modelling tool via which it will be possible to measure material scenarios for their relative human comfort factors and their spatial and sensory outcomes for various populations with special needs. In considering the possibilities for analysing such an approach to interior space and comfort, the author hopes to understand how three areas of study can overlap to create possibilities for tool development. These three areas are the study of sensory disorders, computational design tools and the current ways we look at spatial comfort. In order to create a novel metric these three areas will be examined to lay out initial ways that they may contain affinities to create a system for analysis and understanding of space based on human interaction, use and reaction. This work contains process speculation which is distinct from the actual future assessments that may take place to fulfil the processes examined here.

#### 1.0 MOBILE\_REACH VAN

#### 1.1. Design process

In the summer of 2012, The A.J. Drexel Autism Institute and a multidisciplinary group of students at Drexel University collaborated on a design to create a mobile clinic for the use of the Institute. The first mobile assessment unit in a heavily populated urban area and one of very few mobile clinics for autism in the U.S., this clinic will work to reach underserved populations in this urban area. (A.J. Drexel Autism Institute Website, 2013) The design was developed through a six-week studio course, in which four multidisciplinary teams of students developed designs for the project. The program included designing the interior and exterior of the mobile unit.

The process included advisers and researchers from the field as well as parents with children on the spectrum. The students created visual research boards to document their findings and information gathering in relationship to designing spaces for children on the spectrum. The initial program was laid out as an introductory document for the students into the needs of this specific user group:

Following are suggested specifications for the mobile assessment units:

Interior:

Clinical assessments for children with autism require one-to-one interaction. The interior of the assessment (rear) area of the unit should optimally accommodate this need for space and movement given the constraints and possibilities of different family members attending along with the clinical staff.

Individuals with autism often have specific sensory needs. Dimmable lights, neutral tones and textures, and minimization of outside sounds are ideal. Some child-friendliness to the theme is desirable. Needs to accommodate an assessor, one parent and a child. Should be movable seating available for all in the assessment space. Seating should be quickly stow-able, so that the space can be quickly cleared for floor play. Perhaps multiple sized seats should be available or loadable into the van based on what is known about the participants being seen that day.

A convertible table with room for adjustable heights and parent or guardian is needed.

Two-way viewing form the front seat area of the van for electronic and safety control is necessary.

"Lab" area. A designated area for a small refrigerator for temporary transport of collected bio-samples and a small flat work surface where a portable centrifuge could be run (this would require a power outlet). Stowage for the centrifuge would also be necessary although this portion of the unit would not be used when participants are in the vehicle for assessment.

Storage. There should be closable, lockable storage for laptop, notes and files. Also should be storage to accommodate a range of toys/stimuli needed for assessment, although these toys will be loaded on and off the vehicle as needed. For example, one commonly used autism assessment (the Autism Diagnostic Observation Schedule or ADOS) includes a stimuli kit that comes in a large plastic tub (950cmx570cmx505cm). There should be additional storage for other testing equipment, including a portable eye tracker (approximately 50cmx25cm) and other equipment (potentially up to 100cmx150cmx50cm). There should also be some additional flex storage.

Exterior:

Mobile assessment units will have a flexible exterior design flexible exterior design. Particularly for research studies, any mention of "autism" will need to be removable to protect the health information of participant individuals and families. Yet for other occasions, it would be helpful to emphasize "autism."

The mobile assessment units should be approachable if parked in a community and have the ability to be branded in multiple languages.

Units must have a safe, navigable, inviting entry for participants. Because the space is somewhat smaller and more confining, it is important that the entry not be intimidating.

Paraphrased from the project brief provided by the client

SCHEMATIC DESIGN #1: WORK THROUGH TECHNOLOGY





Figure 1: In progress visual research boards from the course Source: (Author 2014)

The students presented their initial design findings to the experts and received feedback in the form of lists of issues that could be better addressed. The students soon discovered the needs of these users had distinct areas that were important in terms of security, calming, interactive stimulation and interface. In some ways the van was thought to be an excellent space for such interactions as it is enclosed and controlled form a spatial standpoint. Documented in the table below, these suggestions created a very specific arena in which the students' designs could operate in terms of the users' needs.

Table 1: Autism expert Suggestions Source: (Author's Class Notes 2014)

"Would be great if the table for testing could not only adjust in height and width, but a have a corner to "trap" kids in one section of the van. My idea would be to have the t collapse and stored in the floor of the van but that might not be feasible Windows should definitely be put in, but they should be at the highest point possible the side of the van so as to not distract testing. Not only will this detract from the kid looking out the window, but would also help others from looking in and being distract	lso able on ing"
"Interior walls of the van should be neutral and not distracting to the eye."	
"Important to carpet and pad the interior floor, because participant may collapse to the floor or tantrum"	е
"Having just one exit, with the lock set high, would be helpful to diminish elopement"	
"Skylight would be great"	

# INTERIOR - PERSPECTIVES





Figure 2: Chosen Scheme Source: (Author 2014)



Figure 3: Chosen Scheme; team presenting to local experts Source: (Author 2014)



Figure 4: Final Van Source: (left, Courtesy A.J. Drexel Autism Institute; Right Author 2014)

Students worked to address the concerns and the discussions in the studio centered on the ways in which the users' needs differed from the needs of users in different situations. At the conclusion of the term one option was chosen for development. The chosen option represented the hopes of the Institutes staff and the needs of the users most successfully. At that point, a team including faculty collaborated to create the final design with the institute. This charrette lasted several months and was a way to compile the findings of the student teams. With the Van completed, this team is now compiling an interdisciplinary research study of the mobile assessment process in order to understand the particulars of the space. The project and the further research outcomes will be used to frame the question: is mobile assessment successful, and if so, why? In the study, Research questions will be asked pertaining to both the use of the space and the increased access to underserved populations. The project will examine the questions, which frame this area for further work based in the research created by the multidisciplinary team and for future projects. In tracing and re-framing the process behind the in-progress research project, the author hopes to draw out the ways that such projects and processes can create ongoing multidisciplinary problem solving. The study will include referencing video of interactions to observe and map in space the interaction between assessor, family and child. In addition the possibility of eye tracking scanning tools have been considered in order to study the level of engagement on the part of the child in the assessment.

#### 1.2. Post occupancy

In designing a post-occupancy study, the team has examined literature related to human comfort metrics. These include resources on architectural post occupancy review. In reviewing these resources it has be become evident that human comfort is often measured in the most general ways that do not always apply for special populations. (Leaman, 2003) The ongoing project will examine the questions, which frame the area of post occupancy in a van for future projects based in this research created by the multidisciplinary team. Currently research approaches developed by the team in-group meetings include the below:

Table 2: Question and Topic inventory: (Author's Meeting Notes 2014)

TYPES OF ACTIVITIES AND USES	TYPES OF INTERACTIONS AND QUESTIONS	TYPES OF USERS
OUTPATIENT THERAPY ON WHEELS	RANGE OF POSSIBLE WAYS TO USE	KIDS
ANALYSIS	ASK THEM ABOUT HOW THEY FEEL	PARENTS
		COMMUNITY
FUNCTION BASED ANALYSIS	FAMILIAR VS NEW	LEADER
NEGATIVE ASSOCIATIONS	ACCESS TO SERVICES?	
MULTIPLE OPTIONS FOR ASSESSMENT	NEGATIVE ASSOCIATIONS	
WHAT IS POTENTIAL IN VAN? GENERAL	BARRIERS? LEGAL STATUS? LANGUAGE?	
SCHOOL DISTRICT PROVIDED THERAPY	WHAT DRAWS PEOPLE?	
COST BENEFIT	FOLLOW UP QUESTIONS?	
OBSERVATIONAL DATA	PLAY IN ADOS MAY BE DIFFICULT	
UNDERSTANDING WHAT IS ON OTHER? UNDERSERVED POPULATIONS - DOES IT	2 -30 ITEM QUESTIONS ABOUT THE VAN FUNCTIONALITY	
ADDRESS?	RANDOMI E VAN VS. SPACE	
WHAT HAPPENS AFTER EVENTS?	HOW USEFUL? MEANING OF ASSESSMENT	
AVERSIVE OR CONDUCIVE DISCRETE TRAINING RESOURCE CENTER?	WOULD THEY GO TO FOLLOW UP?	
ASSESSMENTS: JOINT ATTENTION EYE CONTACT		

Simply put, the team will study how the van is used, and how this use could be improved in future iterations. The ongoing study will include both clinical information and design based spatial mapping information. The goal is to understand the challenges found in the assessment process due to the space inside the van, and then to design and implement solutions to those challenges. The team will look to the assessment interaction to understand the relative success or challenge of the space. Factors such as disruption, hyperactivity, anxiety or aggression could be rated and observed; in addition, the use of the space will be observed through diagrammatic mapping of the space. These two sets of observations will then be correlated in order to create a better understanding of the issues at hand. In specific behavior assessment is something that has been identified as a possibly difficult thing to measure due to the subjective nature of this. Recent development in the study instrument has created the opportunity for asking the family members for feedback on the child's mood during the interaction as a way of balancing the information gathered from the assessor. The line between the clinical study and the study of the space has been a much-discussed topic for the team. Non-mobile assessments will be examined in the same manner in order to create a baseline for understanding how the interaction occurs in space. The research is planned to occur both in the field and in the usual non-mobile assessment environment and will piggyback onto a clinical assessment that is in the process of being planned. Research will be culled from the documentation of ongoing assessments and also the physical measuring and mapping of space. Mapping as a research tool here will include the drawing and representing the space and plotting of the movement of inhabitants repeatedly in order to track the manner that the interaction takes place physically. The effect being mobile has on the assessment process from a physical and behavior standpoint is a main area of interest in this study. For example, the study will undertake to understand if there are more disruptions involved in the mobile study, and if these disruptions can be attributed to something in the mobile environment.

The chief assessment process employed by the Institute in the Mobile Unit is the Autism Diagnostic Observation Schedule 2 (ADOS-2). This is a 30-60 minute interaction between the researcher and the child, and holds within many challenges for studying and understanding the child's behaviors.(http://www.autism.net.au/Autism diagnosis.htm; 2014) We are hoping to draw conclusions that will lead to the development of solutions that will be both space-based, and product-based. Space based solutions are different adjustments that might be made to spaces as assessments take place in order to create less disruptions and anxiety to the subjects. For example, ceiling heights could be adjusted to better accommodate the perceptions of subjects and give them focus during the assessment. Product based solutions are evidence based ideas that arise through observations of how to improve the space. Product based solutions could be translational research that could lead to bringing products to market for use by other units doing assessments for instance an assessment chair, or screen hat is designed around the findings form this study. Because of the proscriptive nature foo the interaction both physically and in terms for time, the assessment interaction is uniquely positioned to reveal possibilities for user comfort and calming. The research will also determine the types of adjustments to spaces for assessment that would be optimal for the subjects. In addition the research will be used to design and prototype possible product add-ons to similar spaces that could be implemented in other situations that are not designed for assessment to take place.

Primary research questions for the Van have mostly to do with the genus loci of the assessments occurring. Does mobile space augment or diminish the assessment process? This will be determined through data related to subject behaviors. What are the physical challenges that are created in the spaces that emerge in assessing children on the autism spectrum? How does the mobile setting increase or decrease these challenges? Is it possible to design and produce features that mitigate these interactive challenges in the space?

# 2.0 EMERGING CONSIDERATIONS: ASSESSMENT AND METRICS

## 2.1. Design for autism

The information on user metrics for users with special needs is scarce, other than temperature control and air quality not much is available. "Sensory Design Theory is based on the concept of the sensory environment as a major role player in the process of perception and behavior development. Much like the concept of the "sensory diet" (Willbarger & Willbarger, 1991 and Anderson, 1998), this environment is considered something that can be manipulated to the benefit of the autistic user." Mostafa, M. (2008)

In the article: ARCHITECTURE FOR AUTISM: Autism ASPECTSS<sup>TM</sup> in School Design, M Mostafa lays out the two ways that we can design for people with sensory disorders including those on the Autism spectrum. The first is "Neuro-Typical" design in which the user must adapt their senses to the world around them; being exposed to the more typical kind of environment as a process of acclimating. (Mostafa 2014) In addition, Mostafa describes Sensory Environmental design as giving the user the opportunity to adjust their environment in order to be comfortable. The chart of sensory design issues developed in Mostafa's article are the closest user impact research found on the sensory impact of spatial issues for this population. This is a viewpoint in which the issues of ASD are considered through a design influences lens. In fact, in the table Mostafa qualifies the findings of her understanding of sensory issues in design through the design requirements laid out in From Space and Order by Frances D.K. Ching, including structure balance quality and dynamic. Each of these are broken down into the Ching spatial descriptors of closure proportion, scale focus symmetry rhythm harmony balance etc. (Ching, 1996; Mostafa, 2014)by mapping the relationship between the "subjective" topics and user sensitivities, this author is able to create a design based rating of spaces. From this work, we can extract the following: that zoning the space into sensory zones based on the level of interference from the environment can lead to successful design typologies for users with ASD. In addition, from Mostafa's work it becomes clear that the priority in terms of designing for those with sensory issues is auditory, followed by the sequencing of spaces and visual/tactile. According to this body of work, the priorities for designing for those with autism spectrum disorder (ASD) are as follows:

1. Acoustics: Children with ASD respond positively to sound controlled environments.

2. Spatial Sequencing: That spatial arrangement should have a logical order, that routine be re-enforced through space.

3. Escape Space: Provide sensory respite to users so that they cannot get overwhelmed.

- 4. Compartmentalization: Keep sensory stimuli separated and to a minimum.
- 5. Transition Zones: Overt zoning of transitions between the zones

6. Sensory Zoning: Zoning based on the relative amount of stimulus a space contains as opposed to the usual functional zoning that occurs in spaces.

7. Safety: Highly important for people with special needs.

(Mostafa 2014).

# 2.2. Measuring space for the senses

As stated above most of the building assessment currently undertaken has not measured the affect, or effect of the built environment of the senses as closely as one might hope for a project such as this. (Leaman 2003) Mostafa's system of design leads us to ask what would a system of assessment look like in order to measure for the success of a design for those with these issues. Current literature includes the BUS Occupant Survey (http://www.busmethodology.org.uk/, 2014) this assessment directly evaluates the occupants reaction to the space, but the metric is subjective. Perhaps a more objective mode could be deployed through a layered mapping that plots the user's satisfaction against sensory data that is collected in the space?

"Emergence is a consolidation of a profound change in knowledge and materialization that has made significant changes to science and technology, and to the way in which we think of architecture and the way we produce it. Emergence provides an explanation of how natural systems have evolved and maintained themselves and a set of models and processes for the design and fabrication of architectural forms that exhibit complex" (Menges 2014)

Several sensory sites discuss the sensitivities inherent not just those with ASD. Elements of sensitivity to sound would most definitely need to be measured, "The sensory system is made up of seven areas, tactile, olfactory, auditory, visual, taste, vestibular, and proprioception (sense of body/joint movement and knowing where the body is in space)." (http://southpawenterprises.com/content/signsofspd.asp, 2014) How to measure the response of

users on that level without the use of sensors, may be found through the processes associated with emergent and parametric design. These processes involve the layering of systems for generation of unique models in ways that follow the inherent flow of various structures based on natural structures, at a molecular level. The author asks the question, would it be possible to re-structure the analysis of a space based on a subtler set of criteria that might be emergent in nature? The physicist Jessica Green has done this in her work with the study of the air handling qualities within the biome of a building. Autodesk is creating tools that allow for environmental and biome tracking, this user proposed a peon based tool for the tracking of comfort. (Markoff, 2013) Emergence requires that we look to complex structures to create new structures for design. The author sees the evolution of data, emergence and human behavior as a true opportunity to examine the multifaceted needs of a burgeoning population. This kind of compound mapping would seem to be necessary in order to understand the nature of assessing spaces for the needs of such complexly inhibited users. The final question of this paper exists as a snapshot of the developing process traced in the van project through the development of the speculative study and into the coding and creation of data models as a next step. From design, to tracking users, to creating parametric models-the development of a visually programmed universal tool could create a way to test the success of spatial interventions.

## CONCLUSION

The design and construction of spaces for children with sensory processing issues will become more prevalent as the percentage of our society with these issues continues to increase. (Newschaffer et al, 2009) The van project is one example of this type of space, and it is a concentrated example due to the homogeneity of the intended population. In developing the research for the van, the ideas of what a true tool must touch on have emerged, and these include measurements for user comfort that more closely address these sensory issues. The cross-section of our society with some concern in this regard is growing, and the best way to address the needs of children within many different ranges; through both treatment and support in everyday life makes this an extremely relevant issue for the design of the built environment. This paper lays out options for both data collection and data mapping to assess how to create comfortable spaces for people with these requirements in everyday life and to posit a path for assessing more closely the possible responses users might have to these types of specific situations in the built environment.

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