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DESIGNING FOR AUTISM: AN ASPECTSS™ POST-OCCUPANCY EVALUATION OF LEARNING ENVIRONMENTS

Magda Mostafa

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Abstract

The objective of this paper is to demonstrate the application of the Autism ASPECTSS™ Design Index in the Post-Occupancy Evaluation of existing learning environments for children along the autism spectrum. First published in 2014 this index outlines 7 design criteria that have been hypothesized to support environments conducive of learning for children with autism spectrum disorder (ASD).
Using the index as a framework, this paper outlines a case study of a Post-Occupancy Evaluation (POE) of an existing pre-K-8th grade public charter purpose-built school for children on the autism spectrum. The tools used for the evaluation were: the ASPECTSS scoring of the school through a survey of teachers and administrators; on-site behavioral in-class observation; and focus groups of parents, teachers, staff and administrators. The results informed a design retro-fit proposal that strived to assess any ASPECTSS compliance issues and implement the index across the learning spaces, therapy spaces, support services and outdoor learning environments of the school.
This paper will outline the application of the index and the resultant design from this process. The results will strive to present a scalable and replicable methodology and prototype for improving existing built environments for learners with ASD.

M. Mostafa
Associate Professor of Design and Associate Chair of Architecture at the American University in Cairo (AUC), Cairo, Egypt.

*Corresponding Author's email address: m_most@aucegypt.edu

INTRODUCTION

Autism has been classically defined using a triad of characteristics (Wing, 1997) namely social challenges, communication challenges and repetitive behaviours. A revision of this original behaviour-centric definition has recently been developed to include the underlying factors leading to this behavioural triad, namely "visual as opposed to linguistic processing, impaired abstraction, and lack of theory of mind" (Cashin, A., Sci, D. A. and Barker, P., 2009).

First proposed as a spectrum by Wing, the more encompassing term Autism Spectrum Disorder has become more commonly used to describe the large range of behaviours and challenges faced by individuals with autism. The sensory theory of autism poses that these behaviours and challenges may be related to the range of sensitivities that an individual on the spectrum may have towards the five senses of hearing, sight, touch, smell and taste. First posed by Rimland in 1964 and later expanded by Delacato and Lovaas, this theory presents the intersection where the built environment can influence those behaviours and challenges. In accordance to this theory (Rimland, 1964; Delacato, 1974; Lovaas et al 1971), it can be hypothesized that, as the primary source and controller of the majority of sensory inputs, the built environment can potentially play a tremendous role in exacerbating or alleviating the challenges faced by those along the spectrum of autism. In its relation to the built environment, this paper therefore further poses that autism is a different but equally valid way of perceiving the sensory environment afforded by the physical world around us. This concept was presented in 2008 as the Sensory Design Theory as related to ASD (Author, 2008). Inspired by the "Catalyst for Discussion" tool of the UK's DfEE (DfEE, 2001), the theory is manifested in the Sensory Design Matrix which intersects Francis Ching's (Ching, 1996) categorization of architectural form, space and order, against the perceptual senses- sight, touch, hearing, smell, taste and proprioception to catalyse, hypothesize and generate design guidelines for testing.

The Autism ASPECTSS™ Index is the result of such testing and was developed as an application of this theory (Mostafa, 2008, 2014). It is a set of criteria developed specifically for the design and assessment of built environments for individuals along the spectrum of autism. First published in 2014 the Index, like the autism it supports, is itself a spectrum and provides a framework for design thinking as opposed to a prescriptive set of recommendations (Mostafa, 2014). It is comprised of seven design concepts outlined in the excerpt below, which should be considered when designing for autism (adapted and updated with permission from Architecture for Autism: Autism ASPECTSS™ in School Design, 2014).

Acoustics

This criterion proposes that the acoustical environment be controlled to minimize background noise, echo and reverberation within spaces used by individuals with ASD. The level of such acoustical control should vary according to the level of focus required in the activity at hand within the space, as well as the skill level and consequently severity of the autism of its users. For example, activities of higher focus, or according to Sensory Design Theory, those taking place in "low stimulus zones", should be allowed a higher level of acoustical control to keep background noise, echo and reverberation to a minimum. Also provisions should be made for different levels of acoustical control in various rooms, so students can "graduate" from one level of acoustical control to the next, slowly moving towards a typical environment in order to avoid the "greenhouse" effect, where skills are demonstrated in a perfectly sensory mitigated room but not generalized elsewhere (Mostafa, 2008).

Spatial Sequencing

This criterion is based on the concept of capitalizing on the affinity of individuals with autism to routine and predictability. Similar to what was later identified by Suskind as Affinity Therapy (Suskind, 2016), this principle applies to individuals with ASD's specific affinity to routine and predictability as a spatial manifestation. Coupled with the criterion of Sensory Zoning, which will be discussed shortly, Spatial Sequencing requires that areas be organized in a logical order, based on the typical scheduled use of such spaces. Spaces should flow as seamlessly as possible from one activity to the next through one-way circulation whenever possible, with minimal disruption and distraction, using Transition Zones which are discussed below.

Escape Spaces

The objective of such spaces is to provide respite for the users with autism from the over-stimulation found in their environment. Empirical research has shown the positive effect of such spaces, particularly in learning environments (Mostafa, 2008). Such spaces may include a small partitioned area or crawl space in a quiet section of a room, or throughout a building in the form of quiet corners. These spaces should provide a neutral sensory environment with minimal stimulation that can be customized by the user to provide the necessary sensory input.

Compartmentalization

The philosophy behind this criterion is to define and limit the sensory environment of each activity, organizing a classroom or even an entire building into compartments. Each compartment should include a single and clearly defined function and consequent sensory quality. The separation between these compartments need not be harsh, but can be through furniture arrangement, difference in floor covering, difference in level or even through variances in lighting. The sensory qualities of each space should be used to define its function and separate it from its neighbouring compartment. This will help promote conditioned responses and provide sensory cues as to what is expected of the user in each space, with minimal ambiguity, mitigating adjustment time and getting users on task with increase efficacy.

Transition Zones

Working to facilitate both Spatial Sequencing and Sensory Zoning, the presence of transition zones helps the user recalibrate their senses as they move from one level of stimulus to the next. Such zones can take on a variety of forms and may be anything from a distinct node that indicates a shift in circulation to a full sensory room that allows the user to re-calibrate their sensory stimulation level before transitioning from an area of high-stimulus to one of low-stimulus. More recent anecdotal evidence using acoustical pods as transition zones has also begun to show a larger scope of use for such spaces than originally anticipated. These include the use of the space as a positive reinforcement tool as well as a safe space to initiate social interactions with peers and school community members. More research is needed to quantify and verify this use, but preliminary findings of ongoing research are promising.

Sensory Zoning

This criterion, based on the concepts of Sensory Design, proposes that when designing for autism, spaces should be organized in accordance to their sensory quality, rather than the typical architectural approach of functional zoning. Grouping spaces according to their allowable stimulus level, spaces are organized into zones of "high-stimulus" and "low stimulus". The former could include areas requiring high alertness and physical activity such as physical therapy and gross motor skill building spaces. The latter could include spaces for speech therapy, computer skills and libraries. Transition zones are used to shift from one zone to the next.

Safety

A point never to be overlooked when designing learning environments, safety is even more of a concern for children with autism who may have an altered sense of their environment. Research has shown that injury and mortality are significantly increased in individuals with autism as compared to the general population (Lee et al, 2008; Svend, 2013). Specifying robust materials, safety fittings to protect from hot water, detailing fixtures to avoid small removable parts or hanging strings and an avoidance of sharp edges and corners are examples of some of the considerations that may reduce these risks. (Adapted with permission from Mostafa, 2014b)

Research has shown the applicability of these criteria to the design of various environments such as residential (Mostafa, 2014a) and learning (Mostafa, 2014b) as well as an assessment tool (Mostafa, 2014c). In this paper the ASPECTSS Index is used as a framework for a Post-Occupancy Evaluation of a purpose-built school for students on the autism spectrum. This evaluation was commissioned by the board of directors of the Foundation that constructed the school building on a 26-acre campus where the school is located, with the objective of proposing retrofit design interventions to better align the school's learning environment with ASPECTSS principles.

The school under assessment, a public charter school for students with ASD, which includes Pre-K to 8th grade, served approximately 114 students at the time of assessment, ranging in age between 3-14 years. This school is the first phase of a multi-phase campus, and is part of a larger building which houses the foundation and its services. The Foundation runs programs that are open to families worldwide. Both the charter school and Foundation utilize the campus facilities to offer services including early intervention, speech, occupational therapy, behavioural therapy, mental health counselling, music, art, fitness, golf, yoga, vocational training, cooking and life skills, and global educational outreach and training. This demonstrates efficient and creative use of space and the services they provide both functionally and operationally, capitalizing on the available resources to maximize their benefit to the largest community possible, both locally and globally.

A further scope of re-design proposals for a second public charter school also housed on the same campus that serves students 14-21 years old was commissioned as part of the POE, but is not the scope of this paper. As of the writing of this paper, the second school building was complete and running its first academic year of instruction in its new location. Prior to this point the second public charter school had been running successfully for over 15 years in a different premises.

Academically the school bases its curriculum and interventions on evidence-based practices and primarily adopts applied behaviour analysis (ABA) as the foundation of all instructional intervention. Its students are organized across 8 grades as well as pre-kindergarten and kindergarten, distributed primarily by age but also by skill and ability. The typical class size was 6-8 students with one class teacher and 1-2 teacher aids, in addition to shadow teachers of some specific students. The school is also staffed with specialist staff in the areas of Speech and Language therapy (SLP), Behavior, Occupational Therapy, Physical Education, music therapy, and art instruction.

Spatially the building has 20 classrooms, distributed along two wings of a U-shaped plan across a single storey, 14 of which were in use as regular classrooms during the assessment. The remaining spaces were used for storage, fitness/PE, foundation classrooms and aftercare programming. The main base of the form houses the main entrance, administration spaces, services such as bathrooms, and therapy and specialist spaces and offices and specialty learning labs. These include a life skills lab, music room, art room, library and computer lab, as well as individual therapy rooms with adjacent observation rooms. Each flank of the U-shape opens directly to outdoor spaces. The campus itself is accessed via a security perimeter by car (Fig. 1). The design of the building included many positive spatial, material and operational features that were purpose-built for provision of an appropriate built environment for its users. These features included:

- Smartboards;
- concealed cabinetry for clutter control;
- wide hallways and high ceilings for the creation of a sense of open space;
- calming neutral colors throughout;
- bathrooms in the classrooms to reduce transitions with the option for public bathroom in the older side to teach proper bathroom use;
- uses of Acoustiblok in the walls to reduce permeation of noise between rooms;
- LED lighting throughout;
- cameras throughout that record audio and video for professional development and research;
- specialty furniture and specialty playground equipment for universal design compliance and maximum accessibility;
- placement of windows in rooms to reduce distraction;
- observation rooms in 18 of the 20 classrooms;
- specialty labs;
- golf course.

METHODOLOGY

The evaluation itself was carried out in two stages: remotely through an online ASPECTSS Survey of parents, teachers and administrators to score the environment's compliance, as well as an on-site stage. The on-site stage of the evaluation consisted of behavioral in-class observation and focus groups of parents, teachers, staff and administrators of the school. The retrofit design interventions proposed were at the whole school, classroom and outdoor space levels. Given the existing nature of the school these interventions were limited and excluded any reconstruction or major physical alterations to the school layout.

The ASPECTSS survey completed online was composed of 21 questions, 12 of which surveyed the compliance of the environment to the 7 ASPECTSS criteria across a 5-point Likert scale. 6 introductory questions gathered general data about the surveyed and the school, including one question measuring the "autism-friendliness" of the school across a 5 point Likert scale. The remaining 3 questions were open-ended solicitations of general observations about design features that were conducive or disruptive, as the case may be.

Six behavioural observations of the general classrooms were conducted over three days utilizing the observation rooms available for that purpose. These rooms were centrally located and each overlooked 2 classrooms using one-way mirrors and a sound-system. This allowed for minimal disruption of classroom activity and minimized the influence of the observation itself on the data collected. Observations included all functional activities typically conducted in the classrooms, including group work, push-in one-one instruction, small-group simultaneous sub-groups, specialist instruction and snack time. Classrooms were also visited when students were not present to observe detailed furniture arrangement, resource organization practices and layout opportunities and challenges. The focus of the observation was to map user-space relationships, identify target areas for re-design and generally assess the ASPECTSS compliance of the classroom.

Focus groups were also conducted over three days with the following groups: foundation staff, school administrators, PreK-8th grade school teachers, 14-22yr school teachers located off campus in another location, PreK-8th grade school parents, 14-22yr school parents, and Board of Trustee members. Interviews were conducted with members of the Foundation staff, the PreK-8 public charter school and 14-22 yr public charter school including: the Foundation Project Manager, Construction; Foundation Program Director; Foundation Assistant Director for Clinical Services; Foundation Recreation and Services Coordinator, Adult Services Coordinator, and PreK-8 School Principal and 14-22 yr School Principal. The following questions provided a framework of the discussions in the focus groups and interviews:

- The Autism ASPECTSS Design Index and its criteria are based on the premise that the architectural environment provides the vast majority of man-made sensory input to the autistic user, and that as a result can have a huge impact on how the user perceives and consequently behaves within the space, depending on his or her sensitivities. Do you agree with this premise?
- How would you rank the importance of the following- acoustics, tactility, visual environment, smell, taste and proprioception?
- Do you think the physical setup of this school is conducive of learning for its autistic users? If yes, in what ways? And if no, what issues are problematic?
- How about the non-autistic population? What works and what doesn't?
- Have you made adjustments to your own environments (home, class, office, therapy space) to make it more effective for the autistic user? What problem were you addressing and how did you resolve it? Was it successful? How so?
- How do you manage your spaces with such a diverse spectrum as the sensory needs of autistic students? For example one student may enjoy tactile environments while another does not.
- Therapy: pull-out vs. push-in? Is the decision for either or a result of the spaces that the therapy spaces are currently housed?
- How often are observation spaces used?

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- I've observed different furniture layouts throughout the Lower School. What are your criteria for those layouts, and what has worked for you? Are they activity/skill/age dependent?
- Are the embedded teacher desk spaces in classrooms ever a distraction for the kids? For those of you who have it slightly partitioned off- does that work better?
- Escape: the index calls for the provision of escape spaces. What are your thoughts on their usefulness and location? Would that be a tool that you would like to see introduced? It could be on several levels- preventative before an over-stimulation happens, as opposed to reactive after it does.
- The ASPECTSS Index calls for 7 criteria to be put in place to make built environments more effective, have you applied any to your spaces?
- Have you visited places where you felt the physical setup was ideal for autism? Can you describe it? What problem/s did it seem to address?
- If you could make improvements to your classroom/workspace, what would they be? How about the school as a whole?
- Are you familiar with the future plans for the schools upper school? Do you have any suggestions, thoughts, concerns?
- If there were something you would like me to communicate to your other counterparts anonymously related to the design of the school and its future phases, what would it be?

RESULTS

The survey was provided to Foundation staff, PreK-8 school staff (both teachers and specialist staff) as well as parents. The response profile of the ASPECTSS survey was 7 teachers out of a total of 12, 4 specialists and therapists, 21 administrators and support staff and 13 parents. The ASPECTSS scores indicated a well-designed school with a provision of an appropriate sensory, spatial and functional environment for the needs of the students. The average score received by the school from the total number of applicants was 44.37 points out of a possible 60. This is slightly below previously assessed purpose-built autism schools which showed strong alignment between perceived design excellence and ASPECTSS score, which averaged 52.32 with a range of 46.4 to 57 points out of a total possible 60 (Mostafa, 2014c).

The ASPECTSS assessment of the school, as ascertained by classroom observations, interviews, focus groups and site assessments are summarized as follows:

1. *Acoustics*

1.1. Assessment:

1.1.1. The acoustics of the school building were assessed with respect to the following space categorizations:

- Classrooms:
  - The classroom spaces in general performed well acoustically when they were fully furnished and occupied. Despite the high ceilings there was manageable echo, partially due to the soft furnishings like carpets and cushions throughout the space. The more sparsely furnished rooms had more echo. The exception

to this acoustical performance was the doorways, which transmitted sound from the corridor spaces.

- Significant acoustical distraction was observed from the bathroom fans, particularly with those that were motion activated with the lights and turned on and off as the children entered and exited the bathrooms. This was distracting for the children working in the class, as well as occasionally frightening for some of the children using the bathrooms.

- Observation rooms:
  - The acoustical performance of these rooms was adequate.

- Circulation spaces:
  - Hallway spaces are typically areas of concern acoustically. Their need for a generous spatial dimensioning coupled with their linear configurations often present acoustical challenges. The main hallways here also demonstrated significant echo, particularly when a number of students were moving from one class to another, a common occurrence throughout the day. Of particular concern was the central node immediately after the reception area as you enter the school proper past the double doors (fig. 1, room 1025). The combination of the elevated ceiling and the intersection of three corridors create a sound trap that amplifies the echo and reverberation in the vicinity. This is of particular concern when the circulation spaces are operating at peak times, such as the beginning of the school day, the end of the school day, and between classes, when large numbers of students and teachers are moving through the school. Given that this space is the first to meet the children as they begin their day, the sensory overload possibly created by this acoustical condition is not the optimum spatial experience. It may not be the most conducive of transition from their arrival to school to the beginning of the school day, or vice versa from their school day to their departure from school. This observation was very much shared by the administration and staff of the school, who prioritized this space as a priority issue.

The same could be said for visitors of the school who are met by this acoustical amplification when they first enter the school. Albeit subconscious, this may give a more chaotic first impression than necessary to these visitors- and very undeservedly so- given the overall order, organization and flow of the rest of the school. Mitigating this problem would therefore have several levels of benefit for students, staff and visitors.

1.2. Recommendation:

1.2.1. Soundproofing may be installed in the doorways.
1.2.2. Higher efficiency fans with quieter performance could be installed, with switches operated manually to avoid sudden activation.
1.2.3. It is suggested that acoustical panelling be installed along the lengths of the walls of the corridors. This should be kept neutral in colour and avoid any sharp edging, small parts or detailing that may result in injury. It will serve a triple purpose of mitigating echo, providing an opportunity to personalize the school space and allow for encouraging display of student's work which will reward and raise self-esteem, as well as assist with way-finding when coordinated with the proposed colour scheme.

1.2.4. It was suggested that the echo and "sound trap" condition of the central node 1025 be addressed. This may be through installing acoustical wall panelling similar to that proposed in the corridors, in addition to a non-visually disturbing ceiling treatment. Ceiling treatments could be colour coded and arranged to follow the scheme proposed as part of the way finding and navigation solutions proposed later in the report. Installation pattern was to be kept regular and minimally distracting.

2. *Spatial Sequencing*

2.1. Assessment:

2.1.1. The spatial sequencing internally within the school proper, and between the spatial zones, generally follows the best practices advised by the ASPECTSS™ Index. Administration, General classrooms, Specialist Spaces and Outdoor Areas (formal playgrounds and courtyard) are organized in a logical and routine aligned sequence. Classes are also organized by age, flowing sequentially from younger to older. The benefit of this sequencing however is not fully realized as a result of less than desirable transitioning between major shifts in these zones, particularly from outdoors to indoors and vice versa, as well as from corridors to classrooms. This will be discussed in more depth in 5. Transition Spaces. Furthermore the strict symmetry of the school does not allow for one-way progression of this sequencing, although this is not expected to be an issue of concern given the pattern of use of the school.

2.1.2. Spatial sequencing internally within classrooms varied greatly throughout the school as observed during the post-occupancy evaluation observations. The majority of the classrooms sequenced activity stations in a manner that flowed logically with the activities at hand. These included stations for group work, one to one, individual work, escape spaces, resource storage and teacher planning space. A few classrooms however did not have clear and ordered definitions for these stations, which will be discussed in 4. Compartmentalization. A documentation of the observed classroom patterns of use, their consequent furniture layouts, and proposed standardized patterns that would accommodate the apparent needs of the teachers and students will be outlined in the Behavioral Mapping section of this report.

2.2. Recommendation:

2.2.1. Teachers were encouraged to draw from the proposed classroom patterns and furniture layouts proposed as modular templates to help sequence their classrooms more efficiently (fig. 2). This was to be considered in alignment with the typical daily routine and schedule of the class and its students as closely as possible. A pattern that provides the most flexibility was to be used to avoid constant changes in classroom arrangement. Such constant change is not only time and energy consuming for the teachers, but creates an environment of unpredictability that does not capitalize on the students' skill in adhering to routine and order. This is particularly the case in the younger classes who may have a stronger need for such predictability.

2.2.2. Older classes may have more flexible and changing layouts, to allow the students to transition to the possibly less-ordered environments of the Upper

School classrooms or mainstream junior high or high schools that they may be transitioning to. Figures 2 illustrates this flexibility.

3. *Escape Spaces*

3.1. Assessment:

3.1.1. At the time of assessment the lower school had two levels of escape space provision throughout. The first was found in the majority of the classrooms, in the form of a carpeted area with soft furnishings such as cushions and/or beanbags, typically located in the corner of the room opposite the wet area sink counter along the exterior wall. In no more than 3 cases the escape space was improvised in another space in the room, but this commentary relates to the intended location of the escape space, which is the former. These spaces were used for sensory breaks and quiet time for students within the classroom.
The location and configuration of these escape spaces at the time of assessment was not ideal for various reasons. They were large, day lit, open to the classroom and adjacent to an exterior wall. Although the latter may not be an issue at this stage of the lifetime of the school, when later stages are complete and the courtyard is in more regular use, there may be an issue of external noise transmission. An alternative smaller configuration, that limits the environment a student has to process during escape, was seen perhaps to be preferable.

A second level of escape, although not originally intended for this purpose, was located at two key points in the school at the ends of the east and west wing corridors in rooms 1117 and 1052. Although originally intended for small group informal activities- such as board games, reading or listening to music- for which it is better suited- they evolved into calming areas, perhaps indicating a need for such a space. This space however was found not to be ideal for calming purposes, understandably as it was not designed with this function in mind. The space is large, with high ceilings, promoting echoes and reverberation, which may be encouraging of loud behaviors in some students, reinforcing as opposed to de-escalating the issue at hand. The large space also expanded the scale of the sensory environment that the student was required to process and handle during de-escalation. These spaces were also located at the extreme ends of the school making their accessibility limited, particularly from classrooms further away. For safety the doors of these spaces needed to be left open during de-escalation, which provided visual access from the corridors, which could also have reinforced behaviors.

3.2. Recommendation:

3.2.1. It was suggested that efforts be made on four levels: improving the in-class escape space configuration; improving the de-escalation space configuration; providing a third intermediate level of escape space opportunity spatially woven throughout the school for de-escalation; and reducing the frequency of sensory overload while mitigating the need for escape in the first place throughout the school. It was expected that the latter be achieved through the application of the collective recommendations of the Post-Occupancy Evaluation. The remaining levels were to be addressed as follows:

Suggested escape space configurations are illustrated in the proposed templates and prototypes (fig. 2). In general however this re-configuration was suggested to include making the in-class escape spaces smaller, providing opportunity for tighter tactile stimulation, by creating corners and surfaces for students to curl up against and between safely. This could be achieved through anything from a customized cushioned built in crawl spaces to a simple arrangement of cushions in a corner. Generally the escape space was to be kept neutral in colour, texture and other forms of stimulation, as well as be located in the quietest part of the room whenever possible.

The proposed space was also to be at least partially separated from the remainder of the classroom. This helps reinforce the perception of separation from the over-stimulation that leads to the need for escape in the first place. This was proposed to varying degrees, ranging from almost complete visual and physical partitioning using bookcases or other low partitioning, to minimal gestural partitioning that can be as subtle as coloured masking tape marking off the area, or placement of an area rug. This will depend on the level of the students in the class and their need for isolation during escape. Individualized sensory kits to be made available for the different students for use during escape were also suggested. These could include tactile stimulation props like safe bristle brushes, bouncing ball-seats, swinging/rocking seats, visual stimulation toys such as fibre optic lights or cool temperature lava lamps. It was seen as essential however that any partitioning always allows the teacher and any other supervisors to be able to see the student using the escape space at all times.

In general this level of control in the escape space should be gradually changed in accordance to the skill level and age of the children to avoid a reliance on its presence, and difficulty in transitioning to more neuro-typical spaces- in other words to avoid the "greenhouse effect". It should be noted however, that it is the position of the ASPECTSS™ practices, that provision of escape for individuals with autism is perhaps, along with transition spaces, the easiest and most effective spatial support that should be required of any space that individuals with autism will use- whether it is a future school, residence or job placement.

4. *Compartmentalization*

4.1. Assessment:

4.1.1. The general classroom layouts and patterns used throughout the school all demonstrated some level of compartmentalization. In the majority of the classrooms different teaching activities were located in discrete spaces, spatially separated from one another. Some classes achieved this distinction and clarity better than others, with the most successful arrangements utilizing the furniture in as close as possible an alignment to their original intended arrangements (fig. 1). Other classes improvised for their needs using the available furnishings, an indication of a need to re-assess the furniture arrangements and their best fit for purpose in the activities carried out in the classrooms.

4.1.2. An exception to this, and of particular interest was the different ways teachers used the desk space allocated to them. The original furniture layout provided a

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large linear desk space, parallel to the built-in storage closet, configured back to back with a set of computers for students use. The teacher's desk gave its back to the classroom space, an arrangement that seemed counter-intuitive to many, judging by the number of teachers who abandoned the original configuration. Many made adjustments to make better use of the space, relocating their computer to a smaller drawer unit on wheels, making it movable around the classroom, or even relocated their computers to a shelf inside the storage cupboard so it could be tucked away. One well-managed classroom had the teacher's desk completely removed.

In focus groups and interviews with teachers, the majority noted that they did not use the desk as originally intended. They felt that the visual and physical accessibility of teaching material on the desk was distracting to many students, and caused some to go off task, once they saw another activity on the teacher's desk that they preferred to work on. They also rarely used the desks for lesson planning or other work, given its accessibility to the classroom space.

4.2. Recommendation:

4.2.1. An assessment of the existing vs. the intended use of classroom space, and their consequent furniture layouts, is illustrated in Behavioral Mapping. Proposed templates for the behavioral geometries and activity prototypes observed in the post-occupancy assessment are also proposed in that section. These templates will help summarize the recommendations proposed addressing classroom arrangement.

4.2.2. It was generally recommended that alternative teacher desk configurations be used to make better use of the available space.

4.2.3. It was recommended that activity stations should be clear in their spatial territory, defining the activity to be carried out in each. This activity/space pairing was to be kept as consistent as possible, particularly in younger classes, to capitalize on a certain level of predictability. Consistency in this may help students get on task more quickly. Flexibility in these arrangements may be introduced gradually as the grades progress to prepare for more flexible upper school configuration, typical classroom arrangements in a mainstream school placement should that occur, and general adaptation to less reliability on space/activity pairing in typical environments outside of the classroom.

5. *Transition Spaces*

5.1. Assessment:

5.1.1. In general transition spaces were not discretely defined throughout the school. Movement between different sensory zones was generally direct, using typical vestibule and hallway arrangements. Sensory zone transition requiring attention included; car drop-off to entry vestibule (1002 & 1005); entry vestibule to main hallway (1025); playgrounds to hallways (1135 & 1137); hallways to classrooms (1134 & 1068); hallways to specialist spaces (1144, 1087, 1077); and school to courtyard (1116, 1053, 1085).

5.2. Recommendation:

5.2.1. It was suggested that generally these spaces should provide a certain opportunity for transition between high stimulation to low stimulation, and provide the sensory environment to support that. The entry vestibule 1025 is a prime example, and was discussed under Acoustics. Proposed provisions could be in the form of lowered acoustical ceiling treatments and a calming colour scheme within a geometrically framed space.

5.2.2. Car drop-off to entry vestibule (1002) was also suggested to be reconfigured, to provide for better transition at the beginning and the end of the day, as well as help with the functionality of how drop off and pick-up are currently being conducted. It is proposed that the covered drop-off area (1002) be fenced off with a low safe fencing system to allow students to sit and await pick up outside with supervision. It was suggested that gates be installed to allow entrance and exit to and from the paved walkways, as well as to and from the car drop off, which must also be supervised. Appropriate, comfortable seating should also be made available to make transition more comfortable.

5.2.3. Hallways to classrooms (1134 & 1068): This transition is perhaps one of the most essential as it moves the child into his or her core functioning space. It was proposed that acoustical seating pods be made available in some of the setback spaces off the hallways at the entrance of each classroom/observation room unit. These pods will create a quiet oasis space that will allow students a moment to adjust at the return from one sensory stimulation level of experience to that of the classroom. This can be in the form of comfortable seating that may allow for some tactile enclosure and acoustical separation. Fig 3 shows an example of such seating, which could be customized in scale to provide a more intimate enclosure for younger children, as well as possibly provide an upper space for storage of cluttering objects like school bags and coats, similar to hallway lockers in typical school arrangements.

5.2.4. Hallways to specialist spaces (1144, 1087, 1077): These spaces needed to provide perhaps the biggest sensory adjustment, as they mark the entrance to spaces such as music, art, life skills, occupational therapy and sensory integration, which are considered high stimulation zones. In the case of 1077, the space marked the entry to a low-stimulus zone of the computer lab and library. It was suggested that an acoustical pod may be made available, particularly in the OT, SI transition vestibule, to allow for children to remove and store their shoes before entering the SI room. Some geometric framing and colour coding was suggested a transition for 1077 leading to the library and computer lab.

5.2.5. School to courtyard (1116, 1053, 1085): As the more granular use and operation of the courtyard evolved with different phases of the school's completion, it was suggested that these covered areas may evolve more clearly as transitions, with seating and more enclosure introduced.

6. *Sensory Zoning*

6.1. Assessment:

6.1.1. Generally the main sensory zones of the school were well organized and clearly defined. These included: parking drop/off (high stimulus); entry hall/admin (low stimulus and transition); specialist spaces (high stimulus);

library/computer (low stimulus); classrooms (low stimulus); playgrounds (high stimulus), courtyard (possible future natural sensory transition space). There was minimal sensory ambiguity amongst these zones, although transition may be better managed, as discussed above.

6.2. Recommendation:

6.2.1. There were no additional recommendations for the sensory zoning arrangement of the school, other than how it relates to other criteria such as Transition Spaces.

7. *Safety*

7.1. Assessment:

7.1.1. Safety was clearly of a very high priority to the school, particularly with regards to accessibility to and from the campus. Much thought was put into the levels of security put in place for access to the public areas of the auditorium and foundation from the outside, with an additional layer of security for access to the lower school premises. Safety measures were also put in place for the exit of students from the premises to avoid eloping and wandering.

7.1.2. Physical safety of students was also carefully considered throughout the school. Furniture, fittings and equipment were generally selected and installed with safety in mind.

7.2. Recommendation:

7.2.1. It was recommended that intercoms be placed on the exterior wall at key-card access doors leading to the outdoor playground and courtyard spaces. If for any reason a teacher or staff member was locked outside, they have no way to get back into the school. Also, should a child be injured, a teacher may not be able to leave them to go get help, and will need an immediate means to summon assistance.

ADDITIONAL OBSERVATIONS AND RECOMMENDATIONS

Other framing considerations provided in the evaluation were:

(1) Independence-drive design: A framing concept of the ASPECTSS™ Design Index is to support learning and skill development with the ultimate objective of as much independence as the student is capable of achieving. This should be considered for independence within the lower school premises, the upper school premises and as the students interact with typical environments either if and when they are placed in a mainstream school or place of employment, or in their daily lives with their families outside of school.

(2) Avoidance of "green-house" effect: As an extension of independence-driven design, the ASPECTSS™ Index advocates against the use of completely customized and ideal environments throughout a child's education. In the earlier stages these supports, such as those outlined in this paper, are key to providing a window of learning opportunity for the child to develop the necessary skills to communicate, interact and learn. Once these skills begin developing, and are more established,

typically as the child grows and progresses, such supports should be gradually reduced, and spatial tactics that are more aligned with typical environments should be gradually introduced.

(3) An example of this would be the gradual migration of classroom layout towards a more typical setup as the grades progress in the lower school, whether for preparation to move to the upper school, or to a mainstream inclusion program, as the case may be. Opportunities for different levels of graduating architectural accommodations to allow for ease of transition to typical environments should be created.

(4) Managing artificial light: The use of LED lights throughout the school is the ideal artificial lighting source for users with autism. The return on the investment put into these systems in the form of a more comfortable, calm environment for the students, is clear throughout the school. It is suggested however that dimmer switches be introduced in some of the spaces, particularly 1117 and 1052, where a more controlled management of light may be useful for the proposed function of the room. Some of the specialist spaces, such as Sensory Integration (SI) as well as the younger classes may also benefit from such control systems.

(5) Way finding and Navigation: Way-finding and navigation throughout the school, despite its clear layout, was found to occasionally be confusing, even for typical users. Data collected from the interviews, focus groups and surveys of parents, teachers and staff supported this observation. The Post-Occupancy Evaluation observational data seems to indicate that this is a result of: the symmetry of the building; the lack of distinguishable external visual navigational indicators partially as a result of that symmetry, and the use of a neutral consistent color palette throughout the school. The former issue cannot be changed with any retrofit solutions, being part of the structure and layout of the school, however the other issues can be addressed.

(6) In addition, the spatial sequencing along the main corridor running through 1025, was ambiguous and did not provide sufficient visual-spatial cues to distinguish entrances to main hallways (1134 and 1068), specialist space vestibules (1144, 1087 and 1077) bathrooms (1073) and courtyard exit hall (1086). The following was therefore recommended:

    i. Creation of identifiable external visual indicators, to distinguish the east playground, west playground and two northern courtyard exits. Examples of such visual indicators would be identifiably different landscape features such as differently coloured and configured playground equipment or distinctly different soft landscape choices. A simple solution could also relate to color coding the interior walls framing the doors to follow the east and west colour coding system. In addition a safely mounted, easily distinguishable flag could be installed along the line of site of the hallways looking towards the playgrounds, to help distinguish east from west and support better orientation.

    ii. Color-coded Navigation: Use of subtle, neutral colors to help support navigation is highly recommended. This will be particularly useful to help distinguish between symmetrically identical hallways. A sparing use of color is proposed, in the hallway nodes, the vestibules, the internal walls framing the exit doors and the acoustic fabric panelling in the main halls. Fig. 4 shows the color palette proposed.

DISCUSSION

The application of the Autism ASPECTSS Design Index as a framework for autism design performance generally and specifically as a basis for Post-Occupancy Evaluation is outlined through this paper. The resultant recommendations, when mapped against the index's criteria, provide a range of interventions that can scaled up, replicated and customized in other learning environments for users on the spectrum. The specific examples illustrate the application of the index to real-life design scenarios and provide a catalyst for thought for future projects.

Given that the Lower School Building was only the first phase of the project, lessons learnt from this assessment provided guidance for other buildings across the campus to be completed in subsequent phases. These include the Upper School building that houses a public charter school for grades 9-12 and up to the age of 22 years, a Gymnasium and Cafeteria building and Cultural Arts Pavilion, a Medical and Research Facility as well as an Adult Services Building. The application of such lessons to such a range of diverse building types shows the replicability of design interventions resultant from ASPECTSS criteria assessment.

Further investigation is planned to study the performance of the school post-implementation of these recommendations, and measure the real-time actual impact of the interventions outlined in this paper on the performance of students, the functioning of the school and the general autism friendliness of its design after application of the recommendations outlined here. It is hoped that this will further verify the efficacy of this tool as an important framework for conducive design for autism.
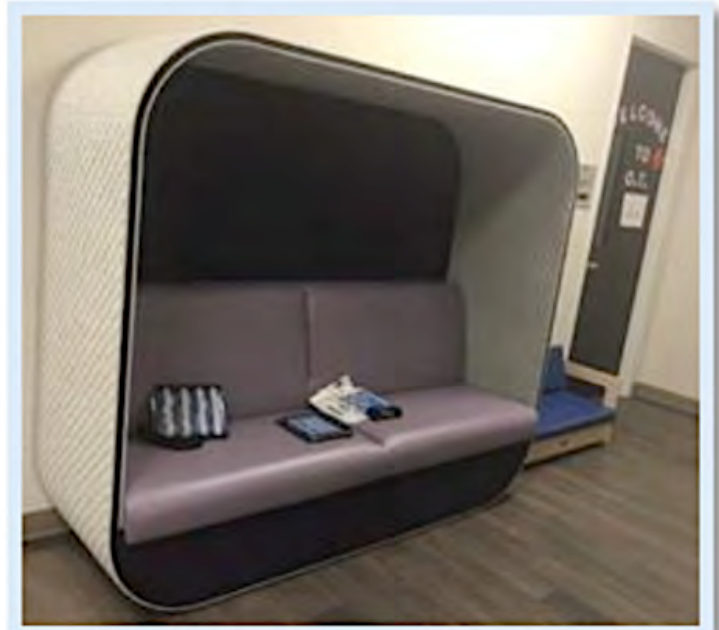
ILLUSTRATIONS

Figure 1. General Plan of the school (Source: Author).

Figure 2. Modular classroom templates proposed (Source: Author).

Figure 3. Proposed acoustical pods (Source: Author).

Figure 4. Proposed colour palette (Source: Authors, based on Asirelli, 2010).

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