ACTS OF SPATIALIZING HEALTHY

The Adolescent Body in Motion

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Abstract. Physical Activity, which is essential for maintaining a healthy condition, is often a non-parallel particular in the curriculum of early adolescent education. Isolated to recess and gym class, or situated as separate extra-curricular activities, its metrics tend to be behavioral and external to cognitive activities. In order to address recent reductions in physical activity for adolescents, which the White House has interpreted as directly related to increased obesity rates in pre-adolescents over the last decade, a series of interventions within learning environments, class space, and facility syntax were developed to introduce activity breaks throughout the class day. This paper posits the findings from hybrid computer aided visualization and simulation tools used in defining adequate space for adolescent physical activity in the classroom. Primarily the research questions the volume of space attributable to each student based on the size of the classroom and number of students per academic year. The findings develop both the hybrid digital systems that map geographies of movement in adolescent bodies and work to facilitate an understanding of physical activity ecologies that can be prescribed to varying components in an educational institution. Additionally the findings contribute to multiple speculative apparatus intent on redefining class space, by situating certain physical activities with specific spatial modifications. In turn, establishing a formal agenda for situating activities in these conditions and determining the plausibility of devices in educational institutions that can encourage movement.

1. Introduction

Recently the United States shifted from the standardized Youth Fitness Test toward a more communal fitness concept, which is presented to students through specialized programs (White House, 2005). The new platforms allow for new mechanisms of demonstration, instruction and assessment, and require new metrics for evaluating the adequacy of facilities in preparation for such activities. Fluctuations annually in population create differing class sizes and make the ability to determine appropriate room configurations that account for all students difficult. In assessing the plausibility of incorporating activity breaks into the classroom this research project first sought mechanisms to prove the validity of predetermining space per child per classroom, and then by spatially mapping movements associated with a select cohort of children limited to between 8 and 11 years of age this research also sought an understanding of the range of displacement associated with the size of adolescent bodies. The representational means of studying movement was through a series of points and lines representing the skeletal frame, and quantified through the use of a contained volume to determine the specific spatial requirements for an individual student.

In this article, we explain how the research metrics posited to a single room provides a mechanism for visual cues and physical performance during physical activity in the classroom. This initial study establishes mappings of the body's movement through puppeteer mechanisms as a basis for studying: (1) the visualization of body displacement during select physical activities; (2) mechanisms of disciplinary specific software in assessing variations in height, dexterity, and range of motion for the study cohort. The use of digital simulation to anticipate the spectrum of performance of the proposed adolescent cohort is intended to provide designers the means to alter differences in: (1) categorizing exercises per classroom and/or class space assessing separately speculative classroom and/or class space elements; (2) the representation of complex human movement; (3) the varied participation typologies and the corresponding size and shape of the proposed classroom and/or class space (HMSO, 1967); and (4) the position of interface points in establishing a basis for interactive surface geometry in classroom and/or class space elements. The physical performances of puppeteers controlling the digital marionette bodies were also recorded separately as the simulations only account for metrics of agility and speed, but were not included in the final speculative proposition as they were only attributable to the puppeteer and not the intended cohort.

2. Literature Review

Compliance by definition can be understood as cooperative adherence whether to law or to a construct, and as such, accessible compliance is the interpretation of intended rules that most satisfies equal provisions for persons with limited ability or a disability, rather than a strict following of guidelines (AIA, 2014). The understanding of compliance is important in establishing the role of this research, as it inconsequentially defines equity of space rather than indemnifies responsibility. Historically, decisions that equalize our social and physical differences are based on the civic interpretation of rules governed by the code and considered equal to the protection of life, while the elevation of spatial experience through architectural reasoning tend to be less specific.

In understanding the means of fulfilling the most efficient means of a particular task it is important to understanding the varied situations of the human form during the working of relative instruments (HMSO, 1967). The utilization of engineering standards for quantifying space attributable to mass production and in particular the visualization techniques employed in the ergonomic studies of heavy industry and military equipment of the mid 1900s (Neufert, 2002) have significantly influenced the rationale used in formulating a scientific approach to architectural metrics used to represent the visual characteristics of space serving as the basis for promoting efficiency in appropriations for range of motion in this study. Comparatively, the singular nature by which compliance defines environments in relationship to the human form, more commonly defined by contemporary codes, reduces to exact measurements and ignores the human body's performance and natural complexity (Wang et al., 2010). This is similar to a reduction of intonation in order to simplify a language, where in doing so reduces the emotional connection to what is being articulated, leaving minimal flexibility for interpretation.

It is from these utilitarian ideals that the multi-axial metric used in quantifying displacement during physical activities is developed. A variety of associative standards for individuals were used in quantifying activity zones, buffers, and topological studies. Most prominent of these studies were when space limitations must resolve acute population increases, and the limitations confine the physical movement of persons within the classroom (HMSO, 1967). Previous studies of parameters for adolescent classroom furnishings served as the foundation for practices regarding modifications to the corresponding physical activity zones and their application. The basic application of which later defines the difference in spatial syntax for the classroom and the modification of class space element locations based on referenced biomechanical studies

(Wiktorin, 1986) for particular physiological body types (Table 1) (NCHS, 2001). The results demonstrate a means for varying the applicability of differing stages of activity in a single classroom or class space based on solitary, parallel, associative, and cooperative participation (Parten, 1932), giving teachers alternatives in arranging students during activities.

TABLE 1 Height Range Data

Lower, Middle, and Upper Height Limits 8-10 (in inches)

	Age 8		Age 9		Age 10	
	Boys	Girls	Boys	Girls	Boys	Girls
Upper	54.5	55.5	56.75	56.5	59	59
Average	50.5	50.5	52.75	52.5	54.75	54.5
Lower	46.75	46.5	49	48.5	50.5	50

Source: National Center for Chronic Disease Prevention and Health Promotion (2000)

Public education's current dilemmas with rising obesity rates (White House, 2016) reflect its continual struggle with the nuances of educational reform. By defining a systems approach to difficulties associated with limited spatial resources for physical activity, centers of early childhood education can focus on methodologies suitable to their specific classroom and class space conditions, and allowing students greater integration of the activities into their daily routine. Supporting the disposition that teachers should maintain conditional control of the classroom flexibility relative to behavioral issues and changing classroom populations, which at best lends itself readily to new organizational structures proposed but not solved within this research.

3. Problem and Methodology

Physical activity in educational environments during the pre-adolescent years is necessary for the development of physical and social behaviors that will influence personal development between students and external to the school. Properly articulating physical activities in class space settings that are confronted with environmental restrictions, serves as a laboratory for understanding how to facilitate the basic needs and interest of children in garnering enough physical activity to remain healthy in isolated settings. At the

same time, studying the structured class space environment provides a setting for investigating the relationship between teacher and student in developing common techniques for guidance on the importance associated with physical movement, which is optimal for the heuristic ownership of personal wellbeing at an early age.

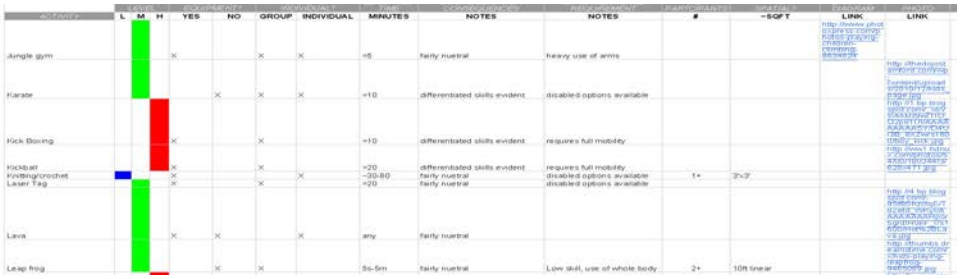
The challenge is in the appropriation of adequate space to formulate the planning of classroom activities and class space environments that encapsulates an understanding of the relatedness between the human body, its movements, and variability in size, shape when locating objects. This research demonstrates the digital testing of ranges in motion associated with levels of physical activity, and the processes of arranging these activities amongst sedentary furnishing arrangements in elementary classrooms. The quantifications garnered from these studies have multiple purposes, the most significant of which is the definition of space to be allocated during each exercise relative to the centroid of the range of motion based on the centre of gravity during each exercise. The measurement of displacement in three axes determines the volume rendered as a single activity zone, therein establishing a basis for determining a metric that when repeated informs the amount of space required in providing multiple physical activity zones per classroom based on the number of students in each classroom and/or class space.

4. The Investigation and Analysis

Derived from the observation of things that twist and turn as a means of avoidance, the formal investigations sought to create a continuance in a place of multiple interactions, from “barnacles” for interaction during play to more formal descriptors of a body moving to avoid another body, ranges of movement are applied to physical territories surrounding select movements. Often this was done unaware of the contextual or conditional needs between larger collaborative references or performance qualities quantifying how the speculative ideas correlated with intended outcomes. Therefore, it is not a factual pursuit of knowledge defined by external references, but rather a pursuit of techniques in forming new knowledge on movement in architecture, engaging physically the intentions of architecture by physically creating the diagrams of use. The caveat being that the research into physical activity, use, and movement happens through an architectural body that evokes movement instead of a preconceived perception of motion as a visual whole.

4.1 CATEGORIZATION OF EXERCISES AND ASSESSMENT OF CLASS SPACE

TABLE 2. Play Activity Matrix



	L	M	H	YES	NO	GROUP	INDIVIDUAL	MINUTES	NOTES	NOTES	#	~SQFT	LINK	LINK
Jungle gym				x		x	x	~5	fairly nuetral	heavy use of arms				
Karate					x	x	x	~10	differentiated skills evident	disabled options available				
Kick Boxing				x		x		~10	differentiated skills evident	requires full mobility				
Kickball				x		x		>20	differentiated skills evident	requires full mobility				
Knitting/crochet				x			x	~30-60	fairly nuetral	disabled options available	1+	3'x3'		
Laser Tag				x		x		>20	fairly nuetral	disabled options available				
Lava				x	x		x	any	fairly nuetral					
Leap frog				x	x			5s-5m	fairly nuetral	Low skill, use of whole body	2+	10ft linear		

Table 2 is a sample of the activities selected for comparative representation, querying available resources for specifics to each exercise and discussing the particulars of relevance to parallel research happening within the School of Public Health. The exercises were recorded using a Microsoft Xbox Kinect whose three-camera configuration captured individual and group skeletal registries (Figure 1). The representations investigated the formal characteristics of multiple exercises happening simultaneously within a confined space against spatial questions of solving for accessible pathways between students during the exercises. The subsequent results were then tested against desk arrangements and seating positions of students (Zacharkow, 1988).

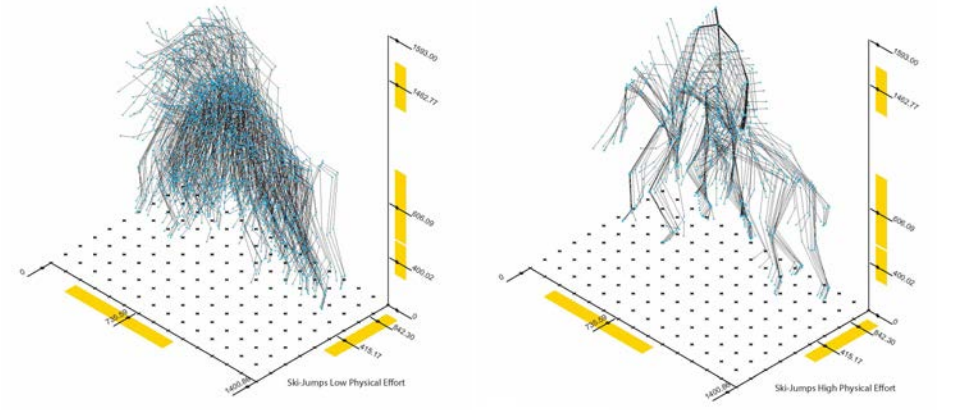


Figure 1. Ski-Jumps Low & High Physical Effort

The results from the initial studies demonstrated an applicability in measuring a variety of small and large movements associated with specific physical behaviors, previously described as low (seated or resting movements), medium (stretching to light walking), and high (climbing, jumping, running), and difficulties in developing objects that engage and encapsulate the body's physical movement when considering varied participatory activities: solitary, parallel, associative and cooperative. Consequently, the first representative simulations demonstrated that the use of puppeteer simulations increased the accuracy in tracking and evaluating the range of motion of non-similar physiological characteristics in differing cohorts as opposed to the control, which was the visual assessment of recorded data video through an analogue method of calculating spatial differences by visual measurement. Along with analysis documenting the existing elements that define a classroom and/or class space, these initial studies define the basis for how work zones and learning zones would be impacted by the introduction of activities zones.

4.2 REPRESENTATION OF COMPLEX HUMAN MOVEMENT

In creating an operative tool for adjusting physical variability in relationship to participant size and capability, modifications to input variables were created in Rhinoceros 3D using the Grasshopper plug-in. Data sets were derived internal to the grasshopper software using the Kangaroo plugin and received from video taken by a Microsoft XBox Kinect device. The Kangaroo plug-in along with script modifications separated the skeletal data into separate body segments; arms, legs, torso, and neck/head (Figure 2) as well as levels of physical activity.

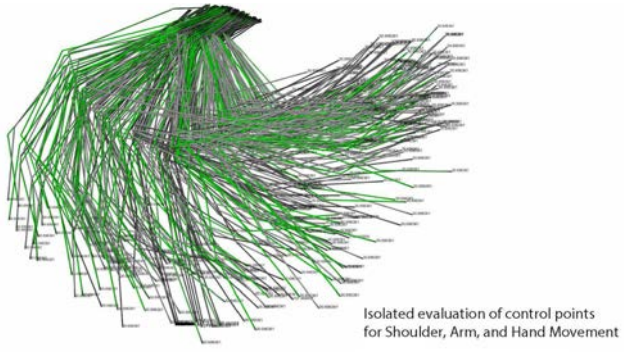


Figure 2. Isolated evaluation of control points for Shoulder, Arm and Hand Movement.

The density of line and point activity respective of the increment of time is based on the frame rate of assessment by the device and reflects the dexterity of the participant irrespective of the study cohort. However, it was observed that when assessing the projected length of study time per participant the model does capture the level of difficultly associated with maintaining an upright body position during such exercises, therein affecting the position of the participants centroid during high intensity exercises. This does have spatial implications for the clear zones around the cohort associated with the higher levels of intensity in the proposition of buffer zones adjacent to activity zones.

4.3 SPECULATIVE CLASSROOM AND/OR CLASS SPACE ELEMENTS

Three prototypes were developed; the composite wall system as a storage system, the system as furnishing, and the point of interface, to initiate studies defining the variety of transitions and territories suitable for modification. The selection of hallway and classroom space that would be utilized for scheduled in class activity breaks related to the isolation of the activities between or around existing furnishings, and is based on simulations conducted as part of this research evaluating the range of motion for particular exercises. The creation of a shelving system carrying interface and controller items served as control points for play, distancing the play surfaces from the chair and desk. What was found through introspective inquiry is that the wall's Cartesian grid worked well in establishing a regularized point of interface (Figure 3), allowing the differences in the controller locations and distortions in controller surfaces to be addressed individually in the structural frame. The geography of controllers offers a variety of hand and body interactions ranging from the notion of a "high five" hand smack, to the surface of the knee in a striking motion, and the tip of the foot in the pressing of a pedal. The higher controllers are all hand slaps, the middle controllers are a combination of hand slaps and knee taps, and the low controllers are foot pedals.

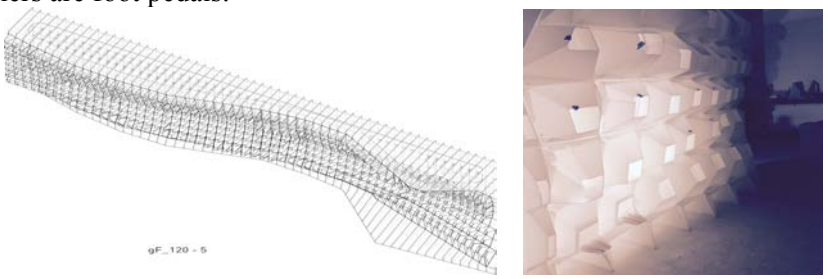


Figure 3. Class Space Wall Shelving Unit

5. Conclusion

Overall it is the testing of a variety of deformations within a specific architectural fragment composed of adjacent and non-adjacent elements, and the applicability of flexibility, resilience, strength and durability in withstanding repetitive activities related to compressive and tensile displacements based on a range of physical activities that defines the scope in relation to its making. The proposition that a practical application of metrics might lead to a more fluid architecture in these siteless settings challenges the pedagogical structure of the traditional design problem. Replacing it is a research-based model, from which proposition and implementation are as much studies on the role of artifacts to achieve variable degrees of performance as they are a discourse on the collaborative role of architects in quantifying their role in defining healthy spaces.

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