Howard Gardner’s theory of multiple intelligences is used to explore activities of architecture students; finding that design needs an adaptable framework of multiple skills.

Revisiting a Vitruvian preface: the value of multiple skills in contemporary architectural pedagogy

Newton D’souza

Recent criticisms in architectural pedagogy suggest that schools of architecture tend to privilege a narrow section of designers with limited skill-sets, neglecting individual differences. In order to encourage architectural pedagogy to become more inclusive, this paper revisits the value of multiple skill-sets in architectural design — following an original suggestion by Vitruvius — exploring it through the framework of multiple intelligences developed by cognitive psychologist Howard Gardner. In the Preface of his Ten Books on Architecture from the first century BCE, Vitruvius suggested that architects develop a generalised skill-set, in the erstwhile role of master builders:

[An architect] should be a good writer, a skillful draftsman, versed in geometry and optics, expert at figures, acquainted with history, informed on the principles of natural and moral philosophy, somewhat of a musician, not ignorant of the law and of physics, nor of the motions, laws, and relations to each other, of the heavenly bodies [...] Those unto whom nature has been so bountiful that they are at once geometers, astronomers, musicians, and skilled in many other arts, go beyond what is required of the architect, and may be properly called polymaths, in the extended sense of that word [...] Since therefore few men are thus gifted, an architect who must strive to be generally well informed in all the arts cannot hope to excel in each. Therefore, I beseech you, O Caesar, and those who read this my work, to pardon and overlook grammatical errors, for I write neither as an accomplished philosopher, an eloquent rhetorician, nor an expert grammarians, but as an architect.

Given the state of flux of the architectural profession today, this paper revisits the notion of a multi-skilled architect and its implication for design pedagogy. Architectural design students in a Midwestern school in the US were studied using Gardner’s multiple intelligence framework. It became evident that students possess and apply a variety of skills during the design process, although these skills are not explicitly taught. Architecture students also showed a balance of several different skills when compared with students from other disciplines. Moreover, understanding not only possessed a variety of skills, but blended these skills and applied them in a meaningful way based on design problems and priorities of the context. The findings of the research indicate that design skills need not be restricted to one set of variables but, rather, should be considered as a multiple intelligence framework which can be seen as an alternative way of empathising with individual differences and affording inclusive tools to tackle the diverse areas of design thinking.

Revisiting the multi-skilled architect
Barrow affirms that current architectural practice involves a re-emergence of the master-builder role, although in a different way: as an ‘integator’ of various skills and knowledge. This professional life demands individuals with a wide array of skill-sets — for example, spatial visualisation, logical thinking, emotional reflection, linguistic ability and interpersonal skills. Hence, recognising architectural design as a composite of skill-sets has several benefits. First, understanding differences in skills can make design learning more inclusive.

Learning to resolve (or accept) individual differences at an appropriate level and capacity could be a formative skill through which strengths and weaknesses of a designer could be identified, enriching the learning experience. Second, the recognition of individual differences and approaches in design could lead to the improvement of teaching. Third, it will allow for an empirical analysis of the nature of architectural design aptitude, the unintelligible nature of which seems to permeate admissions procedures in architecture schools. These procedures might be reviewed, supplanting an overt emphasis on graphical skills and form-making with skills such as problem-solving, spatial sensitivity, kinesthetic skills, interpersonal and linguistic skills which may be much more critical in dealing with real-world design situations.

Multiple skills, representations and intelligences
The construct of ‘skills’, as it refers to architectural design, is complex. Some may even consider the
provocative. Architectural design may be considered subjective and intuitive while skill is commonly viewed as objective and measurable. Hence, many researchers tend to be more comfortable with the term ‘creativity’ to describe inherent abilities of designers. The definition of ‘skill’ in design is compounded when one considers the wide array of activities involved in architectural design. First, design problems vary in content, scale and complexity, and a designer needs to apply a repertoire of skills to solve a design problem. These activities can include visualisation, drawing, measuring, logical and emotional reflection, among others. Second, to that can be added the process of thinking at various scales (macro to micro) and at varied degrees of abstractions (abstract to concrete, symbolic to literal). Third, architects also deal with conflicting architectural issues such as aesthetic judgments (heavy vs light, dark vs bright), functional conflicts (work vs life, movement vs station) and psychological/social issues (community vs privacy, safety vs freedom, etc.).

Thus, given the complex activities involved in design, the term ‘skills’ as it refers to architectural design needs to address both mental constructions and external depictions as architectural representations often lie in an interval where the displacement between the mental conception and its material expression has taken place. Hence, the term ‘skill’ is used in this paper in a loose-fit manner so as to render its meaning more inclusive – overlapping with terms such as ‘aptitude’, ‘competency’, ‘intelligence’ or ‘representation’. For example, spatial skill could indicate both the visualisation of space in the architect’s mind and the graphical articulation of that space in the form of an architectural sketch. Such complexity of design activities calls for an inclusive examination of diverse and multiple skills, and this paper uses an approach borrowed from educational psychology called ‘multiple intelligences’.

Gardner’s use of the term ‘intelligence’ was meant to be provocative rather than literal and is used here in relation to ‘skills’. Gardner suggests that not only do individuals possess numerous mental representations and intellectual languages, but individuals also differ from one another in the forms of these representations, their relative strengths, and the ways in which these representations can be changed. Gardner proposed at least eight discrete mental representations or skills, concerning the ways in which individuals take in information, retain and manipulate that information, and demonstrate their understandings to themselves and others. The eight skills include verbal/linguistic, logical/mathematical, musical, spatial, bodily-kineesthetic, intrapersonal, interpersonal and naturalistic intelligences (Table 1). He critiques the current educational system that focuses on logical and verbal intelligences only and fails to serve the academic and career needs of many students whose strengths lie outside these two intelligences.

Some researchers have already proposed examining architectural design through multiple intelligences, although by regarding it as a separate form of intelligence. According to Cross, architectural design can be regarded as a unique form of intelligence that is different from scientific or scholarly thinking styles, but just as powerful. The purpose of this paper is not so much to relegate design to a unique form of skill or intelligence, but to believe that a more inclusive examination of design skill leads to a more inclusive way of examining design pedagogy (Table 1).

From Vitruvius to Gardner
To further examine the composition of Gardner’s intelligences as it related to design, one can make connections between the discourse of design and aspects of the multiple intelligence framework. By examining design literature, one can derive some parallels to Gardner’s eight intelligences, although one cannot explicitly connect them in a definitive sense. Since architectural design has been influenced by different disciplines such as humanities, sociology, linguistics and so on, different researchers have attended to different forms of skills based on their respective theoretical paradigm and domain knowledge.

To provide some coherence to the connection between architectural design skills and multiple intelligence framework, design skills are organised into four thematic categories in the following sect. These themes include: skills that involve emotions (subjective and creative responses to design); skills that involve the senses (bodily experience in relational design); skills that involve logic (rational and systematic approach to design); and ideational/deductive skills (visualisation and representation of concepts, ideas and spaces). Which follows elaborates these thematic categories in relation to Gardner’s multiple intelligences. 

Skills that involve emotions
A designer relies on emotions and instincts when there is insufficient information to make logical judgments. In architecture, design can sometimes be a completely subjective experience. Skills that involve emotions include intrapersonal skills (personal emotions) and interpersonal skills (social emotions) (Table 1).

Skills that involve the senses
Much in the way that design is associated with emotions, it can also be associated with senses because designers interact constantly with the world around them. Skills associated with such external senses include bodily-kineesthetic skills in which senses are brought about by either visualising or experiencing the movement of the body in relation to the environment, and naturalistic skills, which senses are brought about by visualising and experiencing nature and natural phenomena (Table 2).
INTRAPERSONAL SKILLS

Involving personal experiences and reflection in design. In any design exercise, pure logic doesn’t always suffice. A designer who does not have enough information may rely on emotions and instincts.

Using analogy and metaphor in design. Analogy and metaphor are useful devices in design conceptualisations.

Pursuing purpose and meaning in design. Designers create not just novel solutions but also meaningful ones, turning design into an act of contemplation.

Personal knowledge and efficacy. A designer with high personal efficacy not only brings focus to design but knows design issues that need to be explored.

INTERPERSONAL SKILLS

Social persuasion. As much as design is concerned with individual expression, it is also a part of larger social processes. Design involves action, leadership and diagnosis to solve problems.

Sensitivity to human behaviour and user needs. Understanding user needs, socio-cultural norms and behavioural patterns is vital to creating well-informed design solutions.

BODILY/KINESTHETIC SKILLS

Sensitivity to body movement in space/orientation. Conceptualising body movement in space includes visualising how space unfolds with respect to human movement and exploring space-time relationships.

Sensitivity to human scale. Since buildings are created mainly for people, human scale determines how space should be modulated, exaggerated or understated. Sensitivity to human scale can be aesthetic or pragmatic in terms of universal design, ergonomics and accessibility.

NATURALISTIC SKILLS

Sensitivity to natural features, topography, materials. Architects act upon the natural world. A skilful architect is keenly aware of surrounding landscape, such as trees, water, geological features and movement of the sun, understanding the importance of site history and specificity of a design context.

LOGIC-BASED SKILLS

Sensitivity to the use of numbers or geometry. Numbers and measurements play an important role in design; representations conveying the expressive potential of geometry and rhythm (for example, the number of doors a facade should have) or pragmatic abilities of dimensioning, area estimation, load calculations and so on.

Producing design variations of formal strategies. There is no single solution in design. Designers produce alternatives from which one can be chosen. To produce alternatives, a designer needs to be both analytical and divergent in thinking and to understand relationships between the whole and parts.

Identifying and using design precedents. Design precedents are used to incorporate previous ideas in new situations. The vital part is the ability to understand what fits a problem and what does not. Identifying and using appropriate precedents is a device that reduces time and resources.

Environment-behaviour researchers such as Harry Salling have used participatory design to revitalise a town called Gibson by involving the community as workshop participants.

John Zeisel and colleagues have used programming research, hypothesis testing and post-occupancy evaluation to understand user needs in a project to house twenty seniors in a house-like environment.

In his book, A Scientific Autobiography, architect Le Corbusier describes how a car accident inspired a project for the cemetery at Modena, in which he re-conceived the idea of the cemetery to the structure of the body.

Architect Le Corbusier designed the Villa Savoye as analogous to an oceanliner, in which the main floor of the house is raised above the landscape and the structure is reminiscent of a ship’s deck.

Architects such as Louis Kahn have expressed a heightened state of awareness when thinking about the meaning and purpose of architecture.

Donald Schon observes design as a non-logical thinking process that is made known only by judgment, decision or action – an internal conversation that the designer develops in search of the solution.

For the Parc de la Villette, a site in a working-class suburb on the outskirts of Paris, Bernard Tschumi proposed an urban park for the twenty-first century, designed as much for entertainment and social interaction as for contact with nature.

Le Corbusier’s Modular system is a range of harmonious measurements to suit the human scale that are applicable to architecture and mechanical things. Villa Stein in Garches exemplifies the system, with the inner structure approximating golden rectangles.

Frank Lloyd Wright believed that every building should grow naturally from its environment, reducing the distinction between the built form and nature. In the design of Falling Water, he cantilevered the house from the rock bank in response to a site with a high rock ledge rising beside a waterfall.

Table 1

Table 2

Table 3

Logic-based skills involve understanding of abstract symbols/formulae, formal logical thinking, deciphering codes, numerical calculations and problem solving (Table 3).

In Villa Stein, Le Corbusier intended to define a harmonic measure on a human scale that was applicable to architecture and mechanics. The fundamental concept is a set of ratios proportional to digits, limbs and intervallic divisions of human proportion that form an applicable system by which to divide space.

Peter Eisenman designed eleven houses between the late 1970s and the 1980s that explore the principles of autonomous architecture. Using a generative rule system, each alternative is a response to the last, in which the cube is cut, extended and rotated until the final form is achieved.

In his design of the San Juan Capistrano library, Michael Graves blends his own architectural style with Spanish mission style, merging cloisters, courtyards, garden and bell tower. The product is one of an inward-looking spatial arrangement of a Cartesian monastery.
Multiple skills among architectural designers

While the previous section illustrated some relevance of multiple skills in design, it still does not explain how designers acquire or use such skills, or how they are manifested in the contemporary design process. To investigate this, an exploratory study was conducted among architectural students in the intermediate year design studio at a Midwestern school of architecture in the US. This studio sequence consisted of ninety to one hundred and ten students distributed in six to seven sections. While this sample may not be representative of the entire pedagogical setting, it provides insight into the use and application of multiple skills.

The study was conducted in two parts. The first part consisted of interviews and surveys to understand the basic composition and distribution of multiple skills among architecture students. The second part consisted of a design process documentation to understand how multiple skills were used in specific design tasks. A detailed description of the first part is available in a prior publication and the paper will only summarise the findings here so that the second part can be described in more detail.

In the first part, the following questions were subjected to examination: first, whether there is a hierarchy among multiple skills in design among the multiple skills proposed by Gardner; second, whether there is a diversity among architectural designers in their skills; and third, how architectural designers compare in their skills with other disciplines? These questions were tackled using the MIDAS survey.

Jack of all trades and master of some?
As shown in the bar chart [1], architectural designers ranged as high as 68% for spatial intelligence to as low...
as 50% for musical intelligence. This was expected, given that the architectural domain uses spatial reasoning extensively. However, the relatively low difference of only 18% between spatial intelligence and musical intelligence shows that architecture students used several different skills rather than specialising in one or two.

Moreover, when comparisons were made with other domains (using studies conducted by Shearer), architecture design students were placed at the centre of these groups, suggesting that their scores were neither significantly higher nor lower compared with other domains [2]. In other words, architecture students were in a well-balanced range, indicating the use of several mental representations. But architecture students also outperformed other groups in two specific intelligences - spatial and interpersonal intelligence. This result points out that although architecture on one hand needs multiple skills, it also has enough rigour in two intelligences that need to be given relatively more attention.

**Application of multiple skills in design tasks**

While the foregoing results describe the first part of the study and provide a general description of the students' skills, how they are actually applied in specific design tasks is still in question. This leads to the second part of the study where the following questions are asked: first, how multiple intelligences are used across specific design tasks; second, whether there is a relationship between the possession of skills and nature of design tasks; and third, whether there is a relationship between application of design skills and academic standing.

To answer these questions, the second part of the study consisted of a design process documentation involving a subset of nine design students from the survey participants. Although this sample size is small, considering the exploratory nature of the study and time needed to document the design process for an entire semester compromise was made on the breadth, rather than the depth of the study. The nine students were distributed among six different sections of the design studio so that differences in instruction style were accounted for. Three different design tasks (1: Row Housing, 2: Culture Works and 3: Branch Library) which varied in scale and complexity were examined so as to understand whether students used the same multiple skills in different projects or differed in their strategies. After the design documentation, the design intentions along with their images now had to be matched with the particular characteristics of multiple intelligences to be analysed using a codebook devised by the researcher.

**Individual differences in the design process**

In the final analysis, the results of the coding reveal a wide variety of skills among designers. In the example provided below of a student's row-housing project, one can see the use of spatial, intrapersonal, interpersonal, logical and kinesthetic intelligences [3]. The protocols of the students also revealed individual differences in the manner in which they applied their skills to the three design projects. Three modes of designers emerged: the broad and rigid designers, the narrow and rigid designers, and the broad and adaptive designers.

The broad and rigid designers were very versatile and manoeuvred through most of the intelligences across different projects. They used almost all eight intelligences in different ways across the three projects. They also considered architecture to be highly multidisciplinary and used a high degree of analogy in their design. They were largely consistent in all the three projects, suggesting that they were not making any significant shift in their strategies across the three projects. These students were also older than the average age of the class, suggesting that they may have had more experience and control over different intelligences. This is concurrent with Gardner's assumption that experienced people are more fluid in their use of intelligence than others. Interestingly, these students also had difficulty in time management, perhaps because of their divergent approach.

The narrow and rigid designers used three specific intelligences consistently in their architectural tasks - spatial, logical and natural intelligences. For this group, design was more of a 'practical endeavour' - to get the design done within the limitations of the design studio. This group was also more sensitive to user needs and clients of the design project. The majority of these students did not consider architecture as interdisciplinary, nor did they think architects were generalists. This group of students,
however, got lower grades than others - possibly because they were not seen as rigorous or creative enough in the design studio.

The broad and adaptive designers shifted their strategy for different projects as they changed their multiple intelligences according to the needs of the context. Interestingly, as opposed to the first group of broad and rigid designers, they finished their designs on time, and always seemed ahead in terms of their work in the studio schedule.

When the three groups of students were matched with their studio grades, it revealed that the broad and adaptive designers had the best academic standing (3.5 GPA), indicating that their ability to adapt skills for different contexts was an important asset. In contrast, the broad and rigid designers (3.1 GPA) and the narrow and rigid designers had lower academic standing (2.9 GPA).

The ability of conceptual blending
The success of the broad and adaptive designer indicates that merely possessing multiple skills in architectural design may not be enough. A meaningful blending of these intelligences is also important (as demonstrated by broad and adaptive designers). This phenomenon could be better described as 'conceptual blending' - a popular term in cognitive neuroscience. According to Fauconnier and Turner, elements and relations from diverse scenarios are 'blended' in a subconscious process, which is assumed to be ubiquitous in everyday thought and language. Insights obtained from these blends constitute the products of creative thinking.

One example of a successful conceptual blending in the same design activity is shown in Figs 4a-c, where the designer attempts to blend different architectural strategies through massing. In the first figure, the massing explores the sculptural qualities of the units in terms of proportion, hierarchy, and geometry. In the second example, massing serves to clarify functional zoning (work space vs. residence, community vs. privacy), and in the third example, massing is used on a purely aesthetic basis to understand visual weight (heavy vs. light). Hence, in one design activity, different skills are used: logical, spatial and interpersonal. This example illustrates that it may be more plausible to think of design as a domain that consists of interplay of various skills rather than as a separate form of intelligence.

Reciprocal priority based on design context
Another characteristic of the broad and adaptive designers was that they adapted their skills according to the needs of specific projects. This change in strategy demonstrated that the successful designers are cognisant of the changing nature of design problems. This could be better described through the concept of reciprocal priority [5].

'Reciprocal priority' is a phrase used to explain that multiple worldviews can (and do) exist simultaneously, and that there is no one view that may be true or right. One approach can be prior to another at any given time or based on a given context. An example of reciprocal priority can be illustrated by the following example. In Figs 5a-c, for the first project of a row house, the designer's intention was to use a generative module and exploit its formal logic for design (logical intelligence). She then changed the strategy in the second project of a museum, where she was influenced by her personal experience of a museum she visited in her childhood (intraperial/interpersonal intelligence), and in
In revisiting the value of multiple skill-sets in design, originally suggested by Vitruvius, this paper has proposed a multiple-intelligence approach to design pedagogy. The study leads to four distinct findings. First, design situations need multiple intelligences in the design studio, whether explicitly taught or not. Second, individual differences exist among designers in terms of how skills are applied and should be given due acknowledgement in teaching. Third, possessing different skills in architectural design itself is not enough, but a conceptual blending is important. And finally, successful design solutions require reciprocal priority for contextualising skills to specific design situations.

In reference to architectural design, the concept of ‘skills’ is a complex one. As the study has pointed out, design skills cannot be restricted to one set of variables, but rather should be considered as a flexible framework consisting of multiple skills that can be adapted to produce desired outcomes. This loose-fit definition of skills helps us to understand that architectural design problems can be solved in a variety of ways, and thereby through alternative viewpoints.

If instructors are aware of the complexity of multiple intelligences, they can intervene on the student’s behalf. Students can also be asked to identify their own competencies. Multiple-intelligence questionnaires such as the MIDAS and ABDAS could be partly helpful to achieve this and only provide a snapshot. The larger question is to recognise the individual strengths and differences in which students operate and provide the necessary flexibility. Rather than being antithetical to the traditional studio system, the multiple intelligence framework, then, could be seen as an alternative way of affording inclusive tools to tackle diverse areas of design thinking. Moreover, instead of making abstract references to skills, skills have to be dealt with in their context, for example by using concrete examples of design precedents and their relevance to individual students’ needs. Currently, the use of precedents in design studios is restricted only to understanding typological and formal principles rather than the skills that made them happen.

The other challenge is about conceptual blending. Currently in North America, most architecture schools are structured sequentially; that is, ‘architecture fundamentals’ in the first year, ‘basic architectural design’ in the intermediate year, and ‘advanced architectural design’ in the final year. The initial years are hence often stripped of all complexity and reduced to exercises on lines and planes. While there is some benefit in this approach, it assumes that complexity of design problems can be dealt sequentially. But the downside of this approach is that students may regard architectural complexity as something external rather than an integral part of the design problem. A multiple intelligence approach to beginning design studios may be one way to address architectural complexity early. The challenge then, is to devise architectural problems that afford the use of multiple

The (re)education of an architect

Marvin Minsky writes that:

> It can make sense to think there exists, inside your brain, a society of different minds [e.g., intuition, analysis, emotion]. Like members of a family, the different minds can work together to help each other, each still having its own mental experiences that the others never know about [...] The power of intelligence stems from our vast [internal] diversity.”
intelligences, yet maintaining the appropriate degree of difficulty for a specific undergraduate level.

While the measurement of multiple intelligences in this paper is primarily conducted in an academic setting, the framework of multiple intelligences also has implications for practice, as mentioned by Vitruvius, although the goals and challenges are very different. In the context of a dynamically networked team of specialists, practitioners use a high degree of interpersonal intelligence (in the form of client interaction, communication skills) and associated skills to fit into the process of the larger community of practice. Further, practitioners have greater power in redefining their tasks, while students are bound more rigidly to the studio system. Indeed, practice involves collaborative design and seldom focuses only on the individual. Evidence also points out that experts approach design problems differently from novices, in that experts are more fluid in their integration of knowledge than novices. While professional capacities need to be diagnosed perhaps in a different way, multiple intelligences seem to be important where building design and construction have increased in complexity, products and project participants. Within all these limitations and challenges outlined in this paper, the multiple intelligence framework could be seen as an alternative way of making architectural pedagogy and practice more inclusive and empathetic.

Notes
8. Literature on architectural design skills is fragmented and dispersed, from studies conducted among the architecture design research community; the writings of architectural practitioners; psychological studies conducted on architectural designers; stretching out to the worldviews that have influenced architectural design from other domains and disciplines. A brief review reveals that ‘design skills’ as a subject matter has not been explicitly discussed in the literature, although it has been addressed implicitly within studies that have examined personality traits of architects (Cross and Matheson, 1981; Newland et al., 1987), or studies conducted on design process and methods (Jones, 1970; Lawson, 1997; Schon, 1983; Downing, 1989) or the nature of design (Cross, 1986; Archer, 1984).
30. MIDA stands for Multiple.
Intelligences Development Assessment Scale, a scale created by developmental psychologist Branton Shearer, mainly to assess the multiple intelligences theory of Gardner. While several researchers have attempted to develop scales to assess multiple intelligences, MIDAS is the only instrument endorsed by Gardner. MIDAS is administered through a paper-and-pencil questionnaire or interview and consists of 119 questions for the eight intelligences. In the current study, the MIDAS questionnaire was administered to a random sample of thirty-six architecture students of which eighteen were from an intermediate level studio and eighteen from a senior level studio. However, during the questionnaire construction process a total sample of 140 students participated.

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arq gratefully acknowledges the student works depicted in Figures 3, 4 and 5 from the intermediate studio of the University of Wisconsin-Milwaukee whose specific names are kept anonymous for ethical purposes. arq also acknowledges the permission to reprint Figures 1 and 2 from the International Journal of Architectural Research, ed. by Ashraf Salama, MIT Press July (2007).

Biography

Newton D'Souza is an Assistant Professor of Architectural Studies at the University of Missouri, Columbia where he teaches design studio and Environment Behaviour/Design Research. He received his PhD from the University of Wisconsin-Milwaukee and has an academic and practical background as an architect and design researcher in the US, Singapore and India.

Author's address

Newton D'Souza
Architectural Studies
133 Stanley Hall
Columbia
MO 65211, USA
dsouzanie@missouri.edu