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.[1] 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 geometricians, 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 grammarian, but as an architect.*[2]

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,

standing 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 'integrator' of various skills and knowledge.[3] 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.[4] 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, formal logic 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 static) 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.[5] 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'.[6]

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-kinesthetic, 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 separa[te] form of intelligence.[7] According to Cross, architectural design can be regarded as a unique form of intelligence that is different from scientif[ic] 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, b[ut] belief that a more inclusive examination of desig[n] 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. B[y] examining design literature, one can derive some parallels to Gardner's eight intelligences, althoug[h] one cannot explicitly connect them in a definitiv[e] sense.[8] 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 theoretic[al] paradigm and domain knowledge.

To provide some coherence to the connection between architectural design skills and multiple intelligence framework, design skills are organise[d] into four thematic categories in the following sect[ion]. These themes include: skills that involve *emotions* (subjective and creative responses to design); skills that involve the *senses* (bodily experience in relatio[n to] the design world); skills that involve *logic* (rational and systematic approach to design); and ideational/depictive skills (visualisation and representation of concepts, ideas and spaces). Wha[t] follows elaborates these thematic categories in relation to Gardner's multiple intelligences. Howe[ver] it must be acknowledged that they are personal interpretations specific to architectural design an[d] in several instances, they may push the boundarie[s] from Gardner's original description of the multip[le] intelligences. These examples are also supplemen[ted] with descriptors from architectural theories.

Skills that involve emotions

A designer relies on emotions and instincts when there is insufficient information to make logical judgments. In architecture, design can sometime[s be] a completely subjective experience. Skills that involve emotions include *intrapersonal* skills (personal emotions) and *interpersonal* skills (anot[her's] 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 bec[ause] designers interact constantly with the world arou[nd] them. Skills associated with such external senses include *bodily-kinesthetic* skills in which senses are brought about by either visualising or experienci[ng] the movement of the body in relation to the exter[nal] environment, and *naturalistic* skills, in which sens[es] are brought about by visualising and experiencin[g] 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.	In his book, *A Scientific Autobiography*, architect Aldo Rossi describes how a car accident inspired a project for the cemetery at Modena, in which he reconceived the idea of the cemetery to the structure of the body.[9]
Using analogy and metaphor in design. Analogy and metaphor are useful devices in design conceptualisations.	Architect Le Corbusier designed the Villa Savoye as analogous to an ocean liner, in which the main floor of the house is raised above the landscape and the structure is reminiscent of a ship's deck.[10]
Pursuing purpose and meaning in design. Designers create not just novel solutions but also meaningful ones, turning design into an act of contemplation.	Architects such as Louis Kahn have expressed a heightened state of awareness when thinking about the meaning and purpose of architecture.[11]
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.	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.[12]
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.	Environment-behaviour researchers such as Henry Sanoff have used participatory design to revitalise a town called Gibson by involving the community as workshop participants.[13]
Sensitivity to human behaviour and user needs. Understanding user needs, socio-cultural norms and behavioural patterns is vital to creating well-informed design solutions.	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.[14]

Table 1

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.	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.[15]
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.	Le Corbusier's Modulor 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.[16]
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.	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.[17]

Table 2

Logic-based skills

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

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 bays a facade should have) or pragmatic abilities of dimensioning, area estimation, load calculations and so on.	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 agreeable system by which to divide space.[18]
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.	Peter Eisenman designed eleven houses between the late 1960s and the 1970s 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.[19]
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.	In his design of the San Juan Capistrano library, Michael Graves blends his own architectural style with Spanish missionary style, merging cloisters, courtyards, gardens and bell tower. The product is one of an inward-looking spatial arrangement of a Cartesian monastery.[20]

Table 3

Ideational/depictive skills

Ideational/depictive skills such as *spatial* and *verbal skills* in design allow for visualisation and representation of concepts, ideas and spaces. These may have the strongest connections to design because they involve both the medium and the message of designing. Spatial skills include the ability to perceive the visual world accurately and to perform transformations and modifications upon one's own initial perceptions via mental imagery. Verbal skills involve the ability to use words effectively or expressively to articulate design ideas [Table 4].

SPATIAL SKILLS	
Spatial choreography. Spatial choreography involves physical placement of space in a way that conveys mood and ambience of the context.	In the Shrine of the Book, architects Frederick Kiesler and Armand Bartos choreograph spaces from a compressed lit space into an open dark space, terminating into a spiral, where the most precious artifact, the Dead Sea Scrolls, are housed.[21]
Sensitivity to spatial transparency, enclosure and the play of light. Transparency in architecture can be achieved through sensitivity to texture, visual weight and material density, not physical characteristics of materials alone.	In their analysis of Villa Garches, Colin Rowe and Robert Slutzky show Le Corbusier's mastery with the planar qualities of glass and window framing that pass behind the wall surface, creating a spatial stratification of separation and stratification.[22]
Sensitivity to spatial transition. Spatial strategies need not be focused just on major spaces as objects but also on transition zones, i.e. from private to public, large to small etc.	Christopher Alexander uses the terminology 'entrance transition', the difference between the user's psychological state on the street and that inside a house has a spatial form.[23]
Clarity in spatial organisation. Clarity in spatial organisation leads to better design communication and visualisation of different systems of architecture.	In the Bauhaus at Dessau, décor is kept to a minimum, and the independent wings are expressive of their internal function, such as arts, library and administration, demonstrating Walter Gropius' clarity in spatial organisation.[24]
Thinking in different scales in space. A designer must handle macro and micro scales of information, assimilating design ideas at differing scales.	In Le Corbusier's La Tourette, monastic simplicity is manifested at a large scale in the concrete superstructure and topography and on a micro scale in the setting of glass panels into concrete and the modularity of the interior.[25]
Aesthetic cognition. Aesthetic cognition is both logical and sensory, evoking craftsmanship and sculptural qualities of design.	In Barcelona's multi-storey dwelling block, Casa Mila, architect Antonio Gaudí synthesises a sculptural form for a functional building, including circular windows, curvilinear balconies, parabolic vaults, inclined columns and a curved chimney.[26]
VERBAL/LINGUISTIC INTELLIGENCE	
Articulating design ideas. A designer with good verbal ability uses words with elegance and parsimony.	In the design competition for the Vietnam Veterans Memorial, the jury was persuaded as much by Maya Lin's poetic description of her concept as it was by her design.[27]
Using verbal tools such as riddles, quotes and narratives in design. Design can be used as an analogy to the act of language narration.	The fictional quality of design is expressed in Daniel Libeskind's Jewish Museum in overlapping layers of axis, icons and musical compositions.[28]

Table 4

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 survey 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. [29]

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.[30]

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
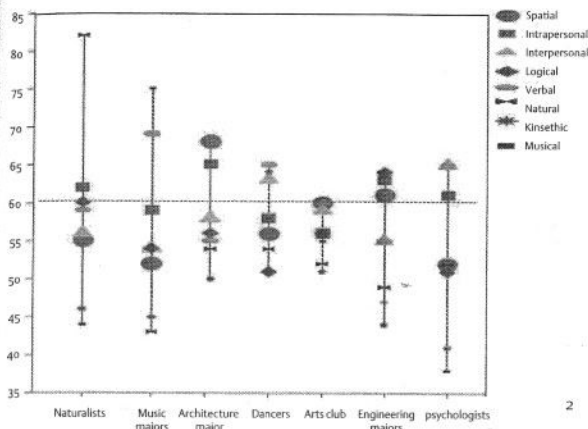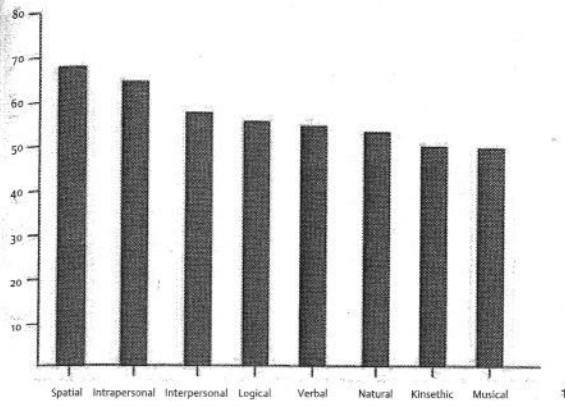
as 50% for *musical intelligence*. This was expected, given that the architectural domain uses spatial reasoning extensively. However, the relatively low difference (of only 18%) between spatial intelligence and musical intelligence shows that architecture students used several different skills rather than specialising in one or two.

Moreover, when comparisons were made with other domains (using studies conducted by Shearer),[31] 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 *intrapersonal* 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.[32] 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.[33]

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 manoeuvered 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,

3

4a

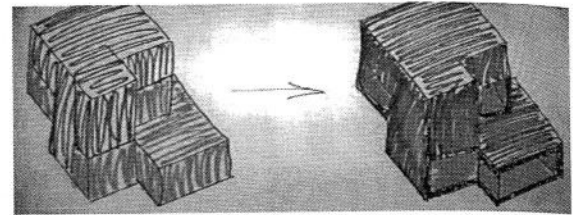4b

4c
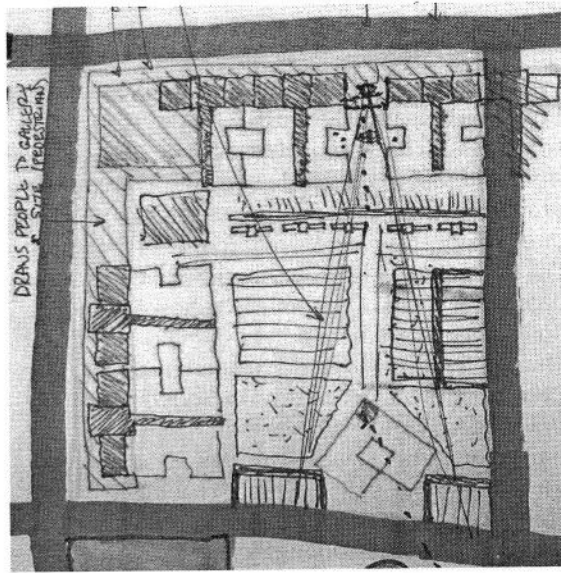
3 Use of multiple
   intelligences in a
   design of row
   housing

4 Conceptual blending
   through massing
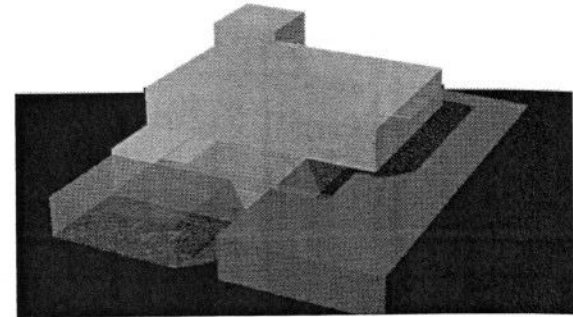
5 Reciprocal priority
   for different design
   situations
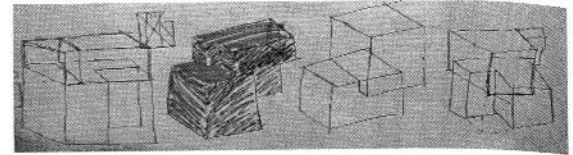
however, got lower grades than others – possibly because they were not seen as rigorous or creative enough in the design studio.

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 vital relations from diverse scenarios are 'blended' in a subconscious process, which is assumed to be ubiquitous in everyday thought and language.[34] 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.[35] 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 (intrapersonal/interpersonal intelligence), and in
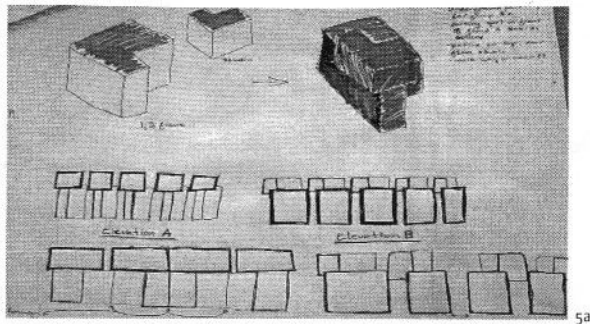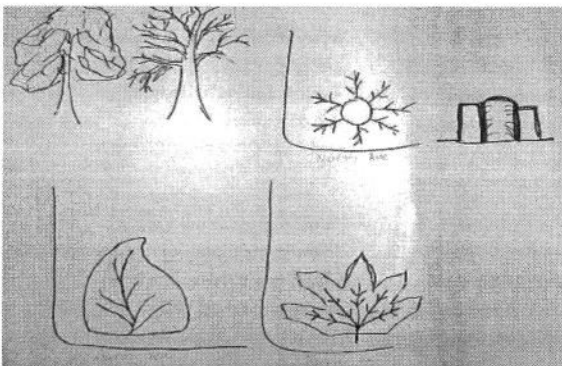
the third library project, the designer used the analogy of trees found in the site as a form generator (naturalistic/intrapersonal). These three strategies are very different but all spring from the same designer, demonstrating that successful designers use different skills for different projects and create a representational hierarchy based on the specificity of the situation. Given that design issues are context-specific, situational issues ultimately determine which skills are valuable and which are not. When design intelligences are considered as a combination of different intelligences, they allow for flexibility in action and afford space for creativity.

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.[36]

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 ADIAS[37] 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

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.[38] 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

1. Garry Stevens, 'Struggle in the Studio: A Bourdivin Look at Architectural Pedagogy', *Journal of Architectural Education* 49.2 (1984), 105–22.
2. Vitruvius, 'de Architectura', *The Architecture of Marcus Vitruvius Pollio*, trans. by Joseph Gwilt (London: Priestley & Weale, 1826), I (1), 1–18, pp. 3, 4, 8, 9.
3. Larry R. Barrow, *Cybernetic Architecture – Process and Form: The Impact of Information Technology*, unpublished Doctor of Design Dissertation, Harvard Design School, Massachusetts (2000).
4. Donald MacKinnon, *In Search of Human Effectiveness: Identifying and Developing Creativity* (New York: Creative Education Foundation, 1978).
5. Alper S. Alkan, *Framing the 'Invisible': Section as a Spatial Frame for a Reconsideration of Architectural Representation*, unpublished Master's Thesis, Middle East Technical University (2004), p. 18.
6. Howard Gardner, *Frames of Mind: The Theory of Multiple Intelligences* (New York: Basic Books, 1983).
7. Nigel Cross, 'Designerly Ways of Knowing', *Design Studies*, 3.4 (1982), 221–27 and Anita Cross, 'Design Intelligence: the Use of Codes and Language Systems in Design', *Design Studies*, 7 (1986), 14–19.
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 Nathenson, 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). Design skills are also found implicitly in the writings of architectural practitioners (Wright, 1975; Tschumi, 1994; Kahn, 1944). Besides designers, some psychologists have also studied design skills (MacKinnon, 1978; Balchin and Coleman, 1965).
9. Aldo Rossi, *A Scientific Autobiography* (Cambridge MA: MIT Press, 1981).
10. Willy Boesiger, *Le Corbusier – Complete Works: 1946–1952*, vol. 5 (Basel: Birkhäuser, 1995).
11. Louis I. Kahn, 'Monumentality', in *New Architecture and City Planning. A Symposium*, ed. by Paul Zucker (New York: Philosophical Library, 1944), pp. 577–88.
12. Donald A. Schon, *The Reflective Practitioner: How Professionals Think in Action* (Hampshire: Arena Ashgate, 1983).
13. Henry Sanoff, 'Participatory Design in Focus', *Architecture and Behavior*, 4.1 (1988), 27–42.
14. John Zeisel, 'Space Design and Management for People with Dementia', in *Proceedings of Environment Design Research Association*, 28 (Oklahoma City, Oklahoma, 1997), pp. 18–22.
15. Bernard Tschumi, *Architecture and Disjunction* (Cambridge MA: MIT Press, 1994).
16. Boesiger, *Le Corbusier*.
17. Frank L. Wright, *An American Architecture*, ed. by Edgar Kaufmann (New York: Horizon Press, 1955).
18. Boesiger, *Le Corbusier*.
19. Peter Eisenman and Jacques Derrida, *Chora L Works*, ed. by Jeffrey Kipnis and Thomas Leeser (New York: Monacelli Press, 1997).
20. Janet Abrams, *Michael Graves: Buildings and Projects, 1990–1994*, ed. by Karen Nichols and Lisa Burke (Cambridge MA: Rizzoli, 1995).
21. Frederick J. Kiesler and Armand P. Bartos, 'The Shrine of the Book', in *Ariel: A Review of the Arts and Sciences in Israel*, ed. by Isaac Halevy-Levin, Israel Museum Issue, Cultural Relations Department, Ministry for Foreign Affairs Jerusalem, no.10 (1965).
22. Colin Rowe and Robert Slutzky, 'Transparency: Literal and Phenomenal', in *The Mathematics of the Ideal Villa and Other Essays*, ed. by C. Rowe (Cambridge, MA: MIT Press, 1971), pp. 45–54.
23. Christopher Alexander, Sara Ishikawa, Murray Silverstein, *A Pattern Language: Towns, Buildings, Construction* (New York: Oxford University Press, 1977).
24. Walter Gropius, *The New Architecture and the Bauhaus*, trans. by P. Morton Shand (London: Faber & Faber, 1935).
25. Boesiger, *Le Corbusier*.
26. Joan N. Bassegoda, *Gaudí: The Entire Works* (Sant Lluis, Minorca: Triangle Postals, 2007).
27. David Smit, conference presentation, 'Words and Images: Writing and Thinking in Architectural Design', at the Design Communication Association conference, Ball State Indiana (2007). Based on David Smit's personal communication with a jury member of the Vietnam Memorial, Hideo Sasaki.
28. Daniel Libeskind, 'Between the Lines', in *Daniel Libeskind: Erweiterung des Berlin Museums mit Abteilung Jüdisches Museum*, ed. by Kristin Feireiss (Berlin: Springer, 1992).
29. Newton D'souza, 'Design Intelligences: A Case for Multiple Intelligences in Architectural Design', *International Journal of Architectural Research*, July (2007), 15–34.
30. MIDAS 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 104 students participated.

31. Branton C. Shearer, *The MIDAS: A Professional Manual* (Kent, OH: MI Research and Consulting, 1996).

32. Each design project lasted for approximately one month, and documentation was carried out at least twice a week, in sessions lasting five to twenty minutes. Verbal information was collected in the form of *design intentions*, defined as a coherent design idea generated towards a purposeful end. Although no audio recording was made because the researcher wanted to reduce student inhibition, verbal information was supplemented by design images recorded with a digital camera consisting of drawings, sketches and doodles. Students were also asked to keep a logbook to record informal sketches and provided with the final version of their documented data for verification. During the documentation, students were first asked to explain their design scheme, and then asked to clarify their intentions. A comprehensive survey was also done after each of the three projects was completed. Since a large quantity of data was anticipated, only those intentions were retained which could be sufficiently backed up with drawing images as evidence. The number of intentions per student per project ranged from twelve to forty-five, and an exhaustive collection of about 1,100 images was gathered from the nine students. Although the documentation of the design process was recorded in a sequential order, the sequencing of the design process in an exact manner was not as important as organising the data to reveal multiple ways of thinking.

33. Since specific design skills were to be matched with the multiple intelligences framework, several sources were considered to create the codebook. These included substantive descriptors from the data collected in the first part of the study, and design issues identified in the survey of architectural theories. This codebook was considered as merely a tentative guide to the researcher and external coders, the content of which could be developed and changed based on further examination and interpretations. In the first round of the coding task, some common design activities emerged. Hence, standardisation for repeated design activities was done to keep the coding consistent throughout the process. Three external referees checked for reliability, and three reports for the three design tasks with the accompanying codebook were provided for each. The referees were primarily architects who were better equipped to read architectural drawings and understand design intentions. To come to some sort of consensus, a discussion session was organised with the referees on a one-to-one basis, before and after the coding process. These discussions focused on why certain intentions were placed in certain intelligence categories and whether or not certain descriptors were sufficient to describe specific intelligences.

34. Gilles Fauconnier and Mark Turner, 'Conceptual Integration Networks', *Cognitive Science* 22.2 (1998), 133–87.

35. Walter Watson, *The Architectonics of Meaning: Foundations of the New Pluralism* (Chicago: The University of Chicago Press, 1985).

36. Marvin Minsky, *The Society of Mind* (New York: Simon & Schuster, 1985), p. 308.

37. At the end of the first part of the study, a new scale called ADIAS (Architecture Design Intelligence Assessment Scale) was developed by the author as an offshoot from MIDAS specifically to test design skills. For more information refer to Newton D'souza, *Design Intelligence: A Case for Multiple Intelligences in Design*, unpublished doctoral dissertation, University of Wisconsin-Milwaukee (2006).

38. Frances Downing, *Image Banks: The Purpose, Function, and Meaning of Environmental Imagery for Architectural Designers*, unpublished doctoral dissertation, University of Wisconsin-Milwaukee (1999).

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 practice 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
dsouzan@missouri.edu