Journal of Science and Technology, Vol. 31, No. 3 (2011), pp 77-85 77

http://dx.doi.org/10.4314/just.v31i3.9

REVIEW PAPER

CONTRASTING THE PRINCIPLES BEHIND THE ORIENTATION OF BUILDING FORMS AND LOCATION OF SPATIAL COMPONENTS AROUND THE GLOBE

C. Koranteng and B. Simons
Department of Architecture, Kwame Nkrumah University of Science and Technology, Private Mail Bag, Kumasi, Ghana
Corresponding E-mail: christiankoranteng@yahoo.co.uk

ABSTRACT:
Building designers are advised to use sustainable design measures in order to make spaces comfortable, before applying mechanical systems. An important aspect of sustainable design is orientation, specifically the rule to orient buildings to the north and south. However, in an attempt to employ this sustainable principle, various cultures resort to different myths as means of justification. The paper presents historical and modern views and theories on orientation of building forms, spatial components, and the surrounding myths worldwide. The results showed that even though the recommended orientation is mostly the north-south, the myths around this measure are sometimes rooted in the culture of places. For instance, the Chinese, many of whom practice the Feng Shui theory, support design recommendations that follow the flow and balance of positive (yang) and negative (yin) energies. Furthermore, room heights between 3 and 3.5 metres, centrally placed dining spaces and main entrance to buildings in the South are common principles worldwide.

Keywords: *Orientation, Sustainability, Design, Architecture, Feng Shui*

INTRODUCTION

Building form, orientation and installed systems are key issues to be considered in the sustainable design of the built environment. It has been observed that as humans, we are losing control of our environment through unsustainable behaviour and design principles. Our ancestors however have adopted intelligent principles with regard to the built environment (urban planning, architectural forms, spatial orientation of building components, etc). For instance, in the layout of towns and cities, a recommendation to design and live with the sun has been the main factor. Further, the ancient Greeks and Romans oriented their buildings to the south to take advantage of the winter sun. Their buildings also functioned well in summer, when temperatures could reach tropical levels, as they provided cool and comfortable conditions (Lechner, 2001).

In China, Taiwan, Singapore, Hongkong and Japan (and recently in Europe and the Americas), the practice of Feng Shui forms the core factor in design and decision making in various aspects of life. According to Too (2000), Feng Shui is a traditional science which was reserved for and practiced by the royal family (Tang

dynasty) in China over 3500 years ago. Globalisation and improved technology have promoted its spread. The Feng Shui theory promotes life in harmony with nature. It is based on 5 basic elements (fire, metal, earth, wood and water) embodying positive energy (yang-chi) and negative energy (yin-chi). The yang is related to life, activity, movement and growth, whereas the yin is associated with silence, quietness and death. A balance between these elements (fire, metal, earth, wood and water) and energies (yang and yin) results in happiness, luck and prosperity in all areas of life.

In building design, the trigram (spread out in Table 1) is used in the orientation of spaces. The trigram is a distribution of the five elements (fire, metal, earth, wood and water) to the various cardinal points (Too, 2000). Each of them has a specific meaning which could have a positive or a negative impact on building occupants. For instance, the north is related to winter (cold water) and symbolises a dangerous and unlucky situation. Concurrently, the south orientation is linked to fire (summer) and means increasing energy and good luck. These cultural beliefs (myths) are the main reasons for enticing people to use sustainable design principles in the placement of buildings and spaces.

In Europe and North America, the recommendations for people to adopt sustainable design principles are less mythological when compared to those of the eastern cultures (China, Taiwan, etc). In the pattern language, Alexander (1977) believes that in designing a sustainable settlement (house), one has to follow a systematic pattern which will result in an efficient dwelling. The patterns are based on long term observations and some of them are issues related to common sense. For instance, Alexander (1977) believes that bedrooms should be placed to the east so that people wake up with the sun and a view through available windows should inform occupants of the weather situation for the day. Furthermore, common areas in a house are to be placed centrally, thus making them equally accessible to everyone. Besides, Alexander noticed that generally, terraces and gardens oriented to the north are hardly used because of the lack of sunlight. Therefore, he suggests gardens and terraces to be placed to the south, southwest or to the west whereas storage areas are to be placed to the north.

Other researchers have also reported on subjects relating to sustainable design principles of orientation and its association to thermal comfort and energy efficiency. Wagner *et al.* (1980) suggests a southern orientation of buildings to save 30% energy. Salmon (1999) propagates equipping buildings with the necessary systems to maintain comfort but he does not recommend a specific orientation. Lauber (2005), Szokolay (2004) and Ferstl (2003) recommend orientation of buildings to the north and south for a better performance.

In warm and humid countries, the design advice has been to use elongated buildings with orientation towards the north and south. The direction of spaces towards the prevailing wind is

Table 1: The basic meaning of cardinal points in relation to beliefs and symbols

Orientation	South East	South	South West	East	Centre of earth	West	North East	North	North West
Symbol	Wood	Fire	Earth	Wood	Earth	Small Metal	Earth	Water	Big Metal
Meaning	Prosperity	Increasing energy and good luck	Fertility	Stormy situations	Harmony and good luck	Luck for children	Growth in wisdom	Danger and bad luck	Brightness, energy and enduring

also paramount (Koranteng and Mahdavi, 2011; Koranteng and Abaitey, 2010 and 2009; Lauber, 2005; Szokolay, 2004; Watson *et al*., 1983; Givoni, 1981; Koenigsberger *et al*., 1974). Bedrooms are to be located towards the east, since less thermal loads are expected during the evening (sleeping time), whereas sanitary areas and stores are to be located on the western side to serve as a radiant barrier to common spaces in the centre of a building (Gut and Ackerknecht, 1993).

The study looks at the myths and theories surrounding the recommendations on orientation of buildings around the globe. In detail, the work compares the practices of some eastern cultures (Feng Shui in China, Taiwan and Singapore), Europe, the Americas, and design proposals for tropical countries. The main objective of contrasting the principles behind the orientation of building forms and placement of spatial components is to contribute to the debate on differences in design theories around the world.

APPROACH

The study compared historical and modern interpretations on orientation of buildings and spatial components around the globe (cold, temperate and tropical climates). Specifically, the practice of Feng Shui in the eastern cultures (China, Taiwan, Singapore, etc.) was grounded on Too (2000), the illustrated encyclopaedia of Feng Shui. With regards to design recommendations in Europe, the Americas and tropical regions (warm and humid), the scientific works of researchers (Koranteng and Mahdavi, 2011; Koranteng and Abaitey, 2010 and 2009; Lauber, 2005; Szokolay, 2004; Watson *et al*., 1983; Givoni, 1981; Koenigsberger *et al*., 1974; etc) have been the underlying principle.

The pattern language of Alexander (1977) also formed a core of the comparative study. The reason for choosing the pattern language is that it provides analysis, synthesis, and describes detailed outlines of building and planning towns, neighbourhoods, houses, gardens, rooms, etc. In the notes on the synthesis of form, Alexander (1964) illustrates design as matching programme requirements with corresponding diagrams, which will eventually lead to a positive form.

While the recommendations of spaces in connection to Feng Shui are mythological (interpretive-historical approach (Groat and Wang, 2002)) and rooted in the culture of the Chinese for the past 3500 years (now spreading around the globe), those in relation to the other parts of the world are based on scientific studies and long term observations.

RESULTS

The general aspects and the design recommendations on the placement of various components of the building have been structured and presented in Tables 2 and 3. The structured information being presented on the design recommendations however does not demonstrate the extent of the application of the design suggestions and its influences in the various regions. This was because of the fact that the suggestions are not rules, and for practical reasons, the study was not aimed at reporting their application in the regions.

Table 2 shows factors relating to site planning, building form, orientation, depth, window to door ratios and colours. Table 3 illustrates parameters of spaces in a building (living area, sleeping spaces, dining, etc). Furthermore, the results have been grouped under the main topics of Feng Shui, pattern language and tropical architecture recommendations, mainly in relation to spatial orientation.

DISCUSSION

Feng Shui, which means living in harmony with nature, could be compared to the general concept of sustainability, thus not compromising on future generations with regards to the use of resources. The architectural principles of the discipline are compared with the scientific knowledge of other parts of the world (Europe, America and tropical countries).

Table 2: General aspects of design recommendations

Parameter	Feng shui	Pattern language	Tropical (warm and humid)
Site planning	Avoid the following: the creation of building plots at T and Y junctions, triangular plots, streets on all four sides of a building, a curved street in front of a plot, and a curved street or L – shaped street in front of a building plot.	North – south plots	Spread out and staggered (Szokolay, 2004; Givoni, 1981; Koenigsberger, 1974; Gut and Ackerknect, 1993)
Building form	Whole shapes (squares and rectangles) and those that increase in size in relation to the entrance.	Rectangular (east:south = 1:1.7 to 3.0) Spreading forms to take advantage of lighting and ventilation	Rectangular (east: south = 1:1.3 to 2.0) (Koranteng and Abaitey, 2009 and 2010)
Orientation of form	If waste pipe has a flow direction of left to right, then building should be oriented towards the main cardinal points. If flow direction is from right to left then orientation to the minor axes.	South	South (Lauber, 2005 and Ferstl, 2003)
Depth of form	3 to 6 rooms (squared shapes preferred)	Thin (≤ 7.62 metres)	Thin, ≤ 6 metres (linear arrangement) (Salmon, 1999)
Building/room height	3 to 3.5 metres	To vary (common spaces to be higher than private rooms)	≤ 3 meters (Koenigsberger, 1974)
Ratios	1:3 (door to window)	N.A. but attention to more natural light	50% to 80% window to wall ratio (Koenigsberger, 1974)
Colours	Avoid the following: Red on west and northwest walls, black and blue on south walls, white and metallic colours on east and southeast walls, and green on southwest and northwest walls. Promote the following: Green with blue, black and white with green, red with yellow and, white with blue	N.A.	Reflective (white, but attention to glare problems) (Lauber, 2005 and Szokolay, 2004)
Distance between Building and fence wall	≥ 2.5 metres	As far as possible, site building very close to the north fence wall	Generally ≥ 3 metres (Koenigsberger, 1974)

N.A. = Not Applicable

Table 3: Design recommendations on the placement of building components

Parameter	Feng shui	Pattern language	Tropical (warm and humid)
Main entrance	South with a solid wooden door	South, doors to have a glazing component	South (Koranteng and Abaitey, 2009 and 2010)
Living area	South	South or central	Central (Salmon, 1999)
Master bedroom	Northwest (man) and southwest (woman)	East	East* (Gut and Ackerknecht, 1993)
Child's bedroom (eldest son)	East	East	East* (Gut and Ackerknecht, 1993)
Child's bedroom (youngest daughter)	West	East	East* (Koenigsberger, 1974)
Child's bedroom (middle daughter)	South	East	East* (Lauber, 2005)
Child's bedroom (middle son)	North	East	East* (Salmon, 1999)
Child's bedroom (eldest daughter)	Southeast	East	East* (Szokolay, 2004)
Child's bedroom (youngest son)	Northeast	East	East* (Koenigsberger, 1974)
Dining	Central position in house	Central	Central (Szokolay, 2004)
Kitchen	Not central and not northwest	Central but worktop to face south	North or detached (attention to prevailing wind direction) (Szokolay, 2004)
Sanitary	Avoid main cardinal points and should not be visible from the main entrance door	East (to be large and sandwiched between master bedroom and other bedrooms)	West (Koenigsberger, 1974 and Lauber, 2005)
Storage	North	North	West (Salmon, 1999)
Garage	North (when free standing: east or southeast)	North	West (Salmon, 1999)
Porch	South	Southwest	North or South (shaded) (Lauber, 2005)
Garden/trees	Should not be near children's bedrooms	South	East and west (Koranteng and Mahdavi, 2011)
Circulation	Space to be serpentine	South to west (to be tangential to common areas)	Avoid corridor types (double banking and borrowed ventilation) (Szokolay, 2004 and Koenigsberger, 1974)
Stairway	Should not be straight and have a higher gradient	Central and visual (flared at the bottom)	Generally to the West (attention to building length) (Lauber, 2005)

* *In hybrid constructions, place bedrooms on the first floor (construction to be with a light weight material)*

Settlement planning is the initial step in designing an efficient town or city. Feng Shui recommends avoiding building plots at T and Y junctions (see Table 2). Triangular plots are also to be avoided since they all result in bad luck for the building occupants. The sense in these guidelines could be linked to the possibility of defective coaches driving into houses and causing harm to the occupants. The principle strongly disapproves of sites facing sloping T and Y junctions (Too, 2000). The pattern language, however, propagates building blocks to be oriented towards the north and south to make use of the sun (Alexander, 1977). In warm and humid regions, one ought to spread out and stagger the buildings in order to make good use of ventilation (Szokolay, 2004; Gut and Ackerknect, 1993; Givoni, 1981; Koenigsberger, 1974).

On the appropriate building form to be employed, Feng Shui recommends the use of squares and rectangular shapes. Other shapes that increase in size in relation to the entrance are also suggested, since they bring luck and can contain fortune. Forms that spread out (L, T and U shaped) and those that are triangular and serpentine restrict the flow of positive energy. Moreover, spiky shapes, like triangular ones, have the potential to cause disputes with neighbours and are to be avoided (Too, 2000).

Therefore, for a peaceful co-habitation, people are supposed to use regular shapes for their houses. In addition to the use of regular shapes alone, Alexander (1977) urges designers to spread out buildings to take advantage of lighting and ventilation. A form aspect ratio is also provided for rectangular shapes (east:south = 1:1.7 to 3.0). In warm and humid regions, rectangular shapes are recommended with aspect ratios of 1:1.3 to 2.0 (Koranteng and Abaitey, 2009 and 2010). These form ratios are known to be efficient with regards to the use of energy and ventilation (Watson and Labs, 1983; Koranteng and Mahdavi, 2011).

The proposal on the orientation of the building form is south in the pattern language and for tropical regions. Further, the prevailing wind direction is an important factor when placing buildings in warm and humid countries. Conversely, the orientation of building forms depends on the flow direction of the waste pipes in Feng Shui (China, Singapore, Taiwan, etc.). If the main liquid waste flow direction of a settlement is from the left to the right, then designers ought to orient their buildings to the main cardinal points, and if the flow direction is right to the left, to the minor points (NE, SE, SW and NW). Those who follow this principle of orientation are awarded with fortune, health and good luck. In addition, the distance of a building block to its fence wall is supposed to be more than 2.5 metres in Feng Shui and in tropical regions. Alexander (1977) proposes shifting the building block to the north wall as far as possible to make space for the southern and sunny area, since spaces on the northern sides are less used because of the low solar exposure.

The suggestion on the depth of forms employed varies in Feng Shui and other parts of the world. Feng Shui proposes the depth of buildings to be 3 to 6 rooms whilst the pattern language and tropical regions use values less than 8 metres. The arrangement of rooms is to be linear in tropical countries to take advantage of ventilation. The advice on room height was however similar in all countries (3 to 3.5 metres). The pattern language further recommends the use of varying room heights in a building. A building in which the ceiling heights are all the same is virtually incapable of making people comfortable (Alexander, 1977). Alexander further relates this argument with the work of Palladio (1508 – 1580) in relation to room proportions, that the height of a room should be an intermediate between length and breadth (Rybczynski, 2003). In Japanese architecture, room height is related to the number of tatami mats used for the floor (room height = 1.91 metres + the number of mats in the room) (Alexander, 1977).

The door to window ratio being practiced in

Feng Shui is 1:3 (Table 2). In warm and humid regions, 50% to 80% window to wall ratio is recommended (Koenigsberger, 1974). This is to aid in ventilation (Koranteng and Mahdavi, 2011), whereas in China, too many windows mean that the yang (positive) energy will flee or cannot be contained in a space.

While the use of reflective colours is promoted in tropical regions, Feng Shui promotes avoiding the use of red colours on west and northwestern walls, black and blue on south walls, etc (Table 2) since those colours in combination with the orientations are associated with bad luck.

The main entrance to a house should be placed towards the south and the living area is also to take a southern orientation or to be centrally placed (see Table 3). The only difference is that in Feng Shui, the entrance door should be solid (wooden) and not have a glazing component (bad luck when broken) whereas the pattern language recommends a glazing component to serve as a view towards incoming visitors. The Chinese believe that in the seventh month, angry spirits come to the earth through the north east to cause harm and therefore, main doors or openings to the north (especially the north east) should be avoided. Cold winds from Mongolia also come from the north and consequently, openings to the north ought to be minimum (Too, 2000). This practice is seen in cold countries of Europe and America where the northern facades of buildings have only minor openings to aid in heat retention.

The pattern language and tropical climates have an eastern orientation for bedrooms (Alexander, 1977; Gut and Ackerknecht, 1993). The reasons are that building occupants should be able to wake up with the sun and get a feeling of the prevailing weather situation for the day. In tropical countries, spaces with an eastern orientation receive less radiation after midday and therefore bedrooms should be placed eastwards.

The solar radiation received during the mornings would have been transferred to other spaces by bedtime. The use of light weight constructions is also advised, especially in hybrid constructions. In Feng Shui, the recommendations are different for all bedrooms for children (6 in number, see Table 2). By following these placement principles, children will grow up healthily, be successful at school and be fortunate in life. While trees are not supposed to be near children's bedrooms, since they would block the positive energy, in tropical countries, trees serve as shades and are even supposed to be planted around buildings (Koranteng and Mahdavi, 2011).

The dining area is recommended to be centrally placed in all three regions. However, different opinions are given on the placement of the kitchen. In Feng Shui, the kitchen should not be placed centrally and not to the northwest. Alexander (1977) proposes a centrally located kitchen, but the worktops are to face south (natural light). In warm and humid countries, kitchens are advised to be detached, because of the humidity produced by the activities in such spaces. Already the humidity levels are high (most time of the year) and this is known to be a major factor in thermal comfort (Szokolay, 2004).

Storage and garage spaces are to be placed to the north (except in tropical regions) because the north is usually cool/cold and common spaces located to the north are less used. By placing these spaces to the west or east, one could use them as a buffer against solar radiation in tropical countries. Sanitary spaces should not be oriented towards the main cardinal points in Feng Shui, since they are associated with bad luck, whereas in the pattern language, bathrooms should be designed to serve as a place for comfort. Alexander (1977) quoted Rudofsky (1965) who did a lot of scientific work in many countries as saying "the motions we call bathing are mere ablutions which formerly preceded the bath. The place where they are performed, though adequate for the routine, does not deserve to be called a

bathroom." Alexander (1977) is of the opinion that a bath is far more than a basic activity, for it has therapeutic and pleasurable aspects. Therefore, bathrooms should be designed to be generous in space, full of light and views. This is contrary to the Chinese perception and practice in Feng Shui (Too, 2000).

Staircases, circulation spaces and porches received different orientations in all regions (Table 3). While in Feng Shui, circulation spaces are to be serpentine to allow the positive energy to flow gradually, the pattern language advocates a sunny orientation (south, southwest or west) and further states that those spaces are to be placed tangentially to common areas, so that people passing by could have a view of activities going on in the space and partake. In tropical regions, centrally placed circulation spaces may lead to dark corridors and hinder the flow of ventilation into rear spaces (borrowed ventilation).

CONCLUSION

The worldwide comparative study on the orientation of buildings and spaces showed common traits and divergent views between countries where Feng Shui is mainly practiced (China, Taiwan, Singapore, etc.), the pattern language which reflects architectural practice in Europe and North America, and warm and humid countries. Common traits recommended in all three regions were the centrally placed dining and the southwards facing main entrance. In cold countries, the north sides of buildings are colder in winter and therefore supporting spaces (stairs, storage, etc) are placed to the north to serve as a barrier. The northern spaces are also characterised by smaller openings in order not to lose heat. While the recommendations are clear, understandable and sometimes supported with scientific studies or long term observations, the Chinese who mainly practice Feng Shui (living in harmony with nature) resort to all kinds of myths to ensure the practice of sustainable principles in architecture. The placement and orientation of spaces in tropical regions were rather based on climatic conditions.

REFERENCES

Alexander, C. (1964). Notes on the Synthesis of Form, Harvard University Press, Cambridge.

Alexander, C. (1977). A Pattern Language, Oxford University Press, New York.

Ferstl, K. J. (2003). Energy Conserving Concepts in Building Design and Construction, Cooling your Home Naturally,Workshop Proceedings, Accra/Ghana (3rd to 7th November 2003).

Givoni, B. (1981). Man, Climate and Architecture, Second Edition, Van Nostrand Reinhold Company, New York, USA.

Groat, L. and Wang, D. (2002). Architectural Research Methods, First Edition, John Wiley and Sons Publishers, New York, USA.

Gut, P. and Ackerknecht, D. (1993). Climate Responsive Building, First Edition, SKAT – Swiss Centre for Develop ment and Cooperation in Technology and Management, Switzerland.

Koenigsberger, O. H., Ingersoll, T. G., Mayhew, A. and Szokolay, S. V. (1974). Manual of Tropical Housing and Building: Part One, Climatic Design, First Edition, Longman Inc., New York.

Koranteng, C. and Abaitey, G. E. (2009). Simulation Based Analysis on the Effects of Orientation on Energy Performance of Residential Buildings in Ghana, *Journal of Science and Technology 29 (3): 86-101.*

Koranteng, C. and Abaitey, G. E. (2010). The Effects of Form and Orientation on Energy Performance of Residential Buildings in Ghana, *Journal of Science and Technology 30 (1): 71-81.*

Koranteng, C. and Mahdavi, A. (2011). An In-

vestigation into the Thermal Performance of Office Buildings in Ghana, *Energy and Buildings 43: 555–563.*

Lauber, W. (2005). Tropical Architecture, First Edition, Prestel Verlag, Munich, Germany.

Lechner, N. (2001). Heating, Cooling, Lighting: Design Methods for Architects, Second Edition, John Wiley and Sons, Inc., New York, USA.

Rudofsky, B. (1965). Architecture without Architects, First Edition, University of New Mexico Press, New Mexico.

Rybczynski, W. (2003). The Perfect House: A Journey with the Renaissance Master, First Edition, Simon and Schuster Publishers, UK.

Salmon, C. (1999). Architectural Design for Tropical Regions, First Edition, John Wiley and Sons, Inc., New York, USA.

Szokolay, S. (2004). Introduction to Architectural Science: The Basis of Sustainable Design, First Edition, Architectural Press, Oxford.

Too, L. (2000). The Illustrated Encyclopedia of Feng Shui, Koeneman Verlag, Germany.

Wagner, W., Robi nson, J. and Markert, P. (1980). Energy-Efficient Buildings, First Edition, McGraw-Hill Book Company, New York, USA.

Watson, D. and Labs, K. (1983). Climatic Design: Energy-Efficient Building Principles and Practices, First Edition, McGraw-Hill Book Company, New York, USA.