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Sky courts as transitional space: Using Space syntax as a predictive theory

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Biography

Jason is an Associate Director of International multi-disciplinary practice, Broadway Malyan. He joined in 2005 to support the cause of progressive tall building design and vertical urbanism and is currently employing these skills in the Middle – East, South-East Asia and the lecture theatre. His research at Cambridge considered the sky court within the tall building typology, and whether it could be a viable alternative civic space for the 21st century: in the vein of the 18th century hotel court and the 19th century arcade. His research culminated in a thesis that formulated a toolkit that acted as a series of prompts for creating better sky court design. This was featured in the Winter 2008 issue of the CTBUH journal.

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Abstract

With inner city densification and population increase, tall buildings will require Sky courts as part of the programme. Sky courts are managed, semi - public places that serve as both destination and transition space - retained within the tall building typology. As a destination, they can provide a convivial environment for social interaction, (like the court); and as a transitional space it provides an ease of movement (like the arcade). Given the greater complexity of multi level circulation systems and the need for alternative simultaneous evacuation strategies post 9/11, the transitional Sky court will provide civil society the same freedom and choice of movement in the sky as does its counterpart (open space) on the ground. Space syntax could be used as a predictive theory to model pedestrian movement behaviour through Sky courts and improve integration, intelligibility, and footfall through spatial re-configuration. This paper finds that Sky courts bear similarities with multi layer buildings in their low intelligibility and poor integration with the main integrating axis in the urban environment. It proposes further quantitative analysis, employing modified Space syntax software to evaluate case studies and provide an opportunity for better Sky court, and therefore tall building design, in the future.

Keywords: Sky courts, Space syntax, Axial mapping

Introduction: The Sky court in the built environment

'Public space has become a derivative of movement...the erasure of a live public space contains an even more perverse idea – that of making space contingent upon motion,'

(Sennett, 1976).

The built environment and its spaces permit motion. When correctly planned, the spaces provide civil society the ability to traverse from origin to destination with ease - be that by mechanised means, such as the automobile or naturally, by walking. It allows us to move freely, for which civil society assumes is an absolute right. Anxiety arises when such freedoms are denied, either through geographical, topographical or urban constraint, or the reduction of visual legibility caused by urban incongruity. Paradoxically, it is the very mechanisms that often allow movement to take place (i.e the automobile, and its' respective highways and arteries) that creates congestion and imbues frustration in the individual's inability to move freely. Increased densification of inner city centres through population increase and inner city migration further hinders flow. It has forced many cities to adopt integrated circulation systems and three-dimensional dispositions of urban land uses through super - surface, surface and sub-surface space utilisation. Circulation systems, incorporated into multi-functional complexes have become more complex

and unintelligible in terms of way finding performance and spatial configuration (Chang and Penn, 1997).

When inner cities become denser and pedestrian movement increases, the two dimensional plane of the city reaches its elastic limit. It forces the city to move to a second stage of development whereby it can take no more growth without incorporating auxiliary systems and layers, such as transit, parking and subways, to facilitate choice and freedom of movement (Siksna, 1997). This inevitably thrusts itself into the third dimension in order to cater for increased density and movement. A city like Seattle, with its myriad of skyways, cannot reach such a threshold of movement needed to expand into the third dimension unless it has the prerequisite urban density of its centre to sustain an increase in population. Without such infrastructure, the compact city would run the risk of accessibility suffocation due to its own success (Gabay and Aravot, 2003).

Similarly, the tall building typology cannot reach its threshold needed to expand skywards into the third dimension unless it has the prerequisite Sky courts and auxiliary systems (i.e the deployment of underground trains, parking structures, sky bridges and other technical facilities) to sustain an increase in pedestrian flow. Without such infrastructure, the compact city (of towers) would similarly run the risk of accessibility suffocation.

The need for improved circulatory methods to facilitate an ease of pedestrian movement, coupled with revised evacuation procedures post 9/11 is as pertinent in the tall building typology as it is to the urban environment at grade. It needs to be considered more

quantifiably if it is to adapt to the rigours of increasing densification and with it greater pedestrian footfall. This is particularly important, as tall buildings are increasingly becoming mixed-use, vertical extrapolations of the city with more complex programmes and circulation systems that interlink with neighbouring buildings and their spaces. With such fluid connections that are creating more diverse pedestrian flow in the upper realms of tall buildings should we not be considering quantitative methods of assessing movement patterns that can help the design of Sky courts in tall buildings.

The Sky court as destination space

Sky courts are recreational social spaces in the sky that can also act as a circulatory interchange in tall buildings. Unlike its recreational open space counterparts on the ground, (which are public and governed by state), the courts in the sky are often semi – public and governed by private entities. They may bear public domain characteristics that allow the user a particular freedom of movement or the ability to appropriate the space as a place of recreation, amenity and social interaction. They're nevertheless managed spaces that are physically constrained by the very structure that retains them and are controlled by the institution, company, association or group that governs the tall building.

The notion of Sky courts is not an alien phenomenon. Diodorus Siculus in the 6th century B.C. recorded the ancient gardens of Babylon as a series of planted terraces supported on stone arches 23 metres above ground and mechanically irrigated by the Euphrates River. Vignola's Villa Giulia in Rome manipulated levels to afford high-level views from raised terraces from where Julius III could enjoy an evening's entertainment. Le Corbusier's Fourieresque social condensers in Marseilles and Berlin also captured an element of recreational open space for amenity, health and well being for the occupants of his Unite d'habitations.

More recently, Sky courts can be found to adorn the worlds' tallest buildings. Like its past precedents, they are spaces that provide a forum for social interaction through chance or planned meetings with others. They allow the occupant or visitor the ability to pause and orientate themselves within both building and urban context. When located midpoint within the building (such as MVRDV's Mirador, Spain), they can be a useful source of convenience, recreation and amenity that can negate the need to travel ground-wards for the grocery run, gymnasium visit or relaxation in open space. Sky courts at the pinnacle of tall buildings can provide the opportunity to observe memorable skylines and panoramic views and in so doing, potentially be a source of income as a viewing gallery, such as in the Umeda Sky Building, Osaka. In addition to the socio-economic draws are the environmental benefits. Planted winter gardens spiraling up through the tall building, like those employed in Foster's Commerzbank, Frankfurt can

provide natural light and ventilation while counteracting carbon dioxide emissions.

For their successful mimicry in the sky of those socio - economic and environmental attributes commonly found in successful open spaces on the ground, Sky courts can act as the spatial gel that integrates the disparate vertical land uses of the mixed use tower to establish a new network of semi-public spaces. These can embody public domain characteristics more commonly associated with the street and square. The Sky court, however, is by no means a replacement to the traditional public realm at grade; merely an alternative that aims to replenish the loss of open space for civil society to enjoy and appropriate. It is a space analogous to the court of the 18th century Hotel – a managed, semi-public place for social interaction as well as the provider of light and ventilation within the confines of private development; created at a time of increased inner city densification and socio – economic, political and cultural change (Figure 1). Like the Hotel court, the Sky court defines the figurative (semi – public) void within the poché of the (private) tall building object. It forms part of a hierarchical order of recreational spaces in the sky that can complement the larger, more civic orientated open space programmes on the ground (Pomeroy, 2007). This creates the opportunity for better social connectivity between the tall buildings' occupants and the surrounding community. It also establishes a spatial relationship with the ground that starts to vertically balance open space to built up area ratios within the tall building - just as one normally finds a proportion of open space to built up area in ground scraping mixed use developments, for the greater good of civil society. It finally leads us to a more cohesive integration of pedestrian movement from the fabric of the city, through the tower and beyond.



Figure 1: Hotel Corzat, off Place Vendome, Paris, France.

The figurative (semi-public) void within the urban infill of the hotel is a microcosmic analogy of the Sky court and an attempt to recapture open space for the greater good of civil society (Dennis, 1988).

The Sky court as transition space

While Sky courts undoubtedly provide certain socio - economic and environmental benefits through the provision of semi-public open space within the private

object, little has been done to consider their circulatory potential through quantifiable modeling of pedestrian behaviour. In their current guise, they are primarily destinations for the very reasons demonstrated above. Their function as a transitional space tend to be the reserve of the super tall building typology (80 storeys and over) whereby lift car capacities, waiting times and floor plate efficiencies necessitate the stacking of local lift cores and the consequent incorporation of sky lobbies for onward transition from one part of the tall building to another (Barney, 2002).

Yet in many respects their *raison d'être*, in and above that of being a recreational destination, is also one of a transition space. It is analogous of the 19th century arcade, a building typology that incorporated a semi-public transitional thoroughfare within the confines of its private curtilage (Figure 2). This covered space would link primary (public) circulatory axes (as London's Burlington arcade links Vigo street and Piccadilly) outside of its jurisdiction and provide pedestrians ease of movement through the broader urban fabric (Geist, 1983). The Sky court acts as a pseudo vertical arcade by its ability to link primary, secondary and tertiary modes of vertical circulation and, through the incorporation of retail, compounds the analogy further - the Sky court being the (vertical) arcade; the lifts, escalators, staircases, ramps and other (vertical) circulation means being the hierarchical orders of boulevard, streets, paths and so on. Using the Sky court as a transitional space that links the disparate vertical circulation modes provides not only connectivity to the upper levels of the tower but also the potential to link with other tall buildings' and their Sky courts. This will increase footfall through the space - encouraging activity, chance meetings and social interaction as well as provide an alternative means of ingress and egress.

In light of the World Trade Centre Towers' collapse in 2001, the conventional phased evacuation strategy of tall buildings (whereby sections of the building are evacuated one at a time) has also come under close scrutiny (Barber, 2003). Post 9/11, there is a general reluctance towards employing this conventional means of escape and alternatives are being studied to evacuate occupants simultaneously. The incorporation of larger escape stairs at a greater frequency, in order to cater for increased human traffic in an emergency, can mitigate such a problem. This can prove to be a costly exercise in terms of the tall buildings' net to gross efficiency. However, the incorporation of sky courts and their sky bridges that can connect with adjacent tall buildings enables a simultaneous evacuation strategy that need not compromise net to gross floor plate efficiencies (Wood, 2003). It also provides a protected route in the event that the tall buildings' own vertical evacuation method should be obstructed either beneath the sky court or at ground level.

The Sky court potentially improves the integration of the tall building with the infrastructure of the compact

city, placing circulation and ease of movement at the heart of the design and the opportunity for a discourse regarding spatial configuration and movement. Just as civil society is provided with both choice of route and mode of transport on the ground (the ability to walk, cycle, drive, or take public transport through a variety of axes), the occupant or visitor to the tower will be faced with a multiplicity of circulation routes and modes in the sky, stemming from and activating the court as a transitional space that is integrated with the pedestrian movement of the city.



Figure 2: Galleria Vittorio Emanuele II, Milan, Italy

Industrial capitalism was the catalyst for the creation of the arcade as an object of private speculation. It also demonstrates how a public - private interface can create semi-public domains for the benefit of civil society (Geist, 1983).

Spatial configuration, movement and Space syntax
Creating spaces that have a sense of place is a relatively intangible concept - a qualitative approach that is subjective and reflects the experience of the individual as propagated by Lynch et al. The design of Sky courts and its spatial requirements can however be further defined and substantiated by using Space syntax as a quantitative means of predicting patterns of pedestrian movement, from urban and architectural morphology. Sky courts can then be created that are both functional transitional spaces and pleasant recreational destinations.

Space syntax has proven that spatial configuration correlates powerfully with aggregate pedestrian movement and can explain its variance in different locations, be that in urban or building spaces (Hillier et al 1993, 1987, 1983; Peponis et al, 1989; Read, 1999). It quantifies aspects of social pattern without reference to the individual's motivation, origin / destination, land use or density, scale, height and massing or other prompts that may bear influence. In so doing, it provides a mechanism for a predictive theory of mass movement based on rational choices of the individuals' spatial cognition.

Pedestrian movement has similarly been found to correlate with spatial integration (i.e an area's predictability), which in itself is correlated to the degree of intelligibility of an area. Hillier identified the intelligibility of space as the correlation between global and local spatial measures (i.e the integration of primary and secondary routes and the pedestrians' cognitive understanding of the space). The greater the spatial

integration, the greater the potential for main integrating axes to be frequented by pedestrians; and in turn the more intelligible the spaces / axes. Conversely, as spaces / axes become less intelligible; the correlation between spatial integration and movement is compromised, resulting in the axes potentially being sparsely frequented by pedestrians.

Space syntax has been employed extensively in two dimensions to assess horizontal pedestrian movement through urban centres in order to improve flow. The use of Space syntax was found to greatly improve movement through Trafalgar Square in London – diagnosed as a poorly integrated space that was under utilised by pedestrians. It has also been applied to multi level buildings, notably by Chang and Penn's research into integrated multi level circulation systems (IMCS) in dense urban areas. However, changes in level, coupled with attractors and generators of movement (the cineplex and food court; the underground metro system for example) that draw high volumes of pedestrians through multi tiers of space, have made it more difficult to model and therefore predict pedestrian movement behaviour. This has necessitated studies that are able to describe and quantify such circulation and the effects certain variables (time of day, land use, visual factors, effects of grade separation) have over the multi level space.

Chang developed a method to assess movement behaviour in multi level structures by disaggregating variables (such as stairways, changes of level, changes of direction and visibility, in addition to spatial configuration) that influence the way people move through spaces. The Barbican and South Bank were used as case studies in the research, with the following conclusions being drawn:

- 1) The general trend is for pedestrians to choose the shortest and axially simplest routes.
- 2) Pedestrians have a direction in mind and set their directions as soon as possible when embarking on a route.
- 3) Pedestrian decision behaviour in route choice is affected by familiarity with an area - with footfall increasing by those familiar with the area. The remainder have to rely on their field of vision, sign posting and a cognitive understanding of the space. Therefore, an area of low intelligibility will have lower footfall and pedestrian movement as the spatial configuration / one's field of vision / sign posting may be more compromised.
- 4) Axial depth from integrating routes (i.e the area with most footfall) and major attractors and generators (i.e the theatre, the metro respectively) is key.
- 5) Grade transition / vertical level change has little effect provided they are on globally integrated axis (Chang and Penn, 1997).

Multi layer buildings were found to have a poor correlation between spatial integration and movement –

their intelligibility breaking down over a series of multiple layers (Figure 3). Way-finding problems and failure to establish orientation were also evident in multi level spaces, as their vertical circulation methods were often removed from the main integrating axis (the most pedestrian trafficked route), poorly sign posted, and the space visually illegible. It did, however, demonstrate that even highly unintelligible places were able to have predictable movement patterns.

Sky courts and their tall buildings often face similar problems to the multi layer building. The position of the vertical access, be that lift, ramp, stairs or elevator are usually deep plan - several steps removed from the main integrating (and therefore highly trafficked) axis. This leads to lower levels of visual accessibility and intelligibility of the space. Sky courts may not always provide the opportunity to pause, observe and orientate. In terms of floor plate configuration, the repetitive tall building typology also negates the visual diversity that often helps people orientate themselves within the streetscape. The repetitive nature of tall building floor plates should aid the cognitive understanding of the spaces, as one mentally maps the other floors within the building, based on assumptions of the floor experienced



at first hand. However, different subdivisions within an otherwise repetitive floor plate that, from the outside, appear to have a homogenous skin can similarly confuse and disorientate.

Figure 3: Barbican (left), South Bank (right)

Axial maps of pedestrian movement through the Barbican and South Bank, documented by Penn and Chang illustrate poor integration and lower intelligibility to multi layer urban environments (Chang and Penn, 1997).

If intelligible urban spaces are those which correlate spatial configuration with movement and forward visibility, Sky courts should be similarly configured spatially to facilitate an ease of movement in order to release its potential as a transitional urban space in the sky and increase its intelligibility. This would be achieved by using the Sky court as a conduit to vertical, horizontal and diagonal modes of circulation that integrate surrounding tall buildings, their Sky courts, roof lines, and the ground plane of the city - just as the arcade is capable of linking primary axes on the ground. It also allows us to question the precept of designing tall buildings as non-contiguous, free standing private objects from outside-in, by placing space and its associated freedom of movement and choice at the heart of the

design process. This will allow us to consider the tall building as less of an object but more of a diverse mix of components stabilised by the Sky courts and its circulatory spaces and axes. In so doing, the object becomes integrated with the city as piece of vertical urbanism.

Applying Space syntax to the design of Sky courts

The research by Chang, Penn et al suggests that Space syntax can be used as a predictive theory of mapping pedestrian behaviour and a quantitative tool to diagnose spatial / movement deficiencies in Sky courts and their tall buildings. Consequently, it provides the opportunity to improve its intelligibility. Shaping the Sky courts' spatial configuration to optimise freedom of pedestrian movement through Space syntax study also facilitates the design process by identifying 'supporting' spaces within the Sky court that could be used for rest and recuperation, observation, refreshment, events, meetings and social interaction.

To date, little has been done by way of quantitative analysis into the Sky court as a vertical pseudo urban space within the tall building, let alone employing Space syntax. One explanation, as we see in the case of Trafalgar Square, is that it has been used primarily to improve movement, and therefore spatial configuration, within the urban environment. Another related aspect is that the Sky court within the tall building typology has not necessitated such studies, which is further reflected in the lack of reference to axial mapping in UK planning legislation and published guidance for tall building design. This is further compounded by the Sky courts' predominant use as a destination space. In addition, the city of towers has yet to evolve into Sant Elias' (1) vision of the future that allows for multiple connections via Sky courts with other structures at high level to warrant such analysis. Currently, when multi layer research is undertaken, as in the case of the Barbican, it often applies two dimensional methodologies as one normally explores the ground plane by stacking plans and linking the vertical circulation (Figure 4). This, however, will likely change in the future as more super high-rise schemes are developed over 80 storeys that will require advanced lift strategies and their respective sky transfer lobbies (Fortune, 1995). With it will come the opportunities to link with other towers for structural / simultaneous evacuation strategies and the potential employment of Space syntax.

Using Space syntax will require a similar process to that undergone by Chang and Penn, and software that can consider a range of variables to axially map the spatial configuration and its movement three dimensionally. This would suggest that for Space syntax to be a useful predictive tool, the vertical, horizontal and diagonal means of circulation (the travellers, lifts, ramps, staircases) will need to be included in the calculation, but weighted to reflect its public, semi-public or private designation along with the passenger capacity

of any mechanical mode of transport (the lift car for example).

Just as Ida and Nishibori found that they needed to study the Tokyo metro system to understand pedestrian movement through Metropolitan Tokyo, so too should the sky train and lift cars be included in the model to ascertain similar pedestrian flows from grade to and from the Sky court and beyond. Ramps and successive escalators, such as at the Centre Pompidou can be calculated as a normal continuous axis inspecting the sight line spatially rather than on a plane, particularly if there are no alterations to the direction (Gabay and Aravot, 2003). Stairs, escalators, travellers can also be calculated as one axis, provided there is visual connectivity at any one time between levels (Pushkarev and Zupan, 1975). Given the compact city, and therefore the tall buildings' connectivity with skyway or concourse systems, it would also seem imperative to model parking structures, the metro and other auxiliary systems (not normally considered part of the urban grid in axial models) if one is to truly understand movement patterns through the public and semi-public spaces on the ground and through to the Sky courts within their respective tall buildings. Once these mechanised means of circulation are incorporated into the model and the obstacle of floor plate separation is overcome, a rethinking of how to assess movement vertically by employing Space syntax through three dimensions will be necessary, as two dimensional axial mapping will no longer be sufficient.

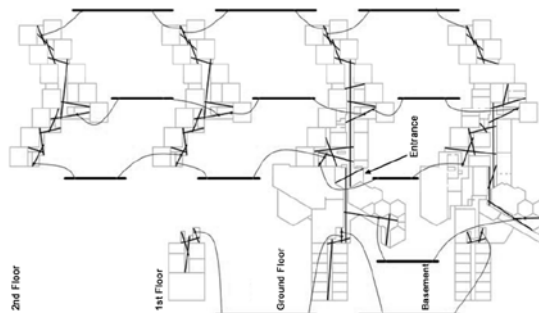


Figure 4: The Heinrich-Lübke Haus conference centre

A multi layer building that Holscher et al studied using two dimensional Space syntax methodologies over a series of levels - linking the vertical circulation (Holscher, C.; Brosamle, M.; Vrachiliotis, G., 2005)

Conclusion – why do it and what next?

With 54 % of the worlds' 200 tallest buildings completed this last decade (Emporis, 2007), the trend to build increasingly high may suggest San Gimignano - like (2) competition amongst developing countries, economies and institutions, in their quest to overtly express their power and dominance through such edifices. This is in and above an architect or engineers desire to innovate and push the technological boundaries. Yet the proliferation of tall buildings similarly reinforces inner city densification. As half of the world's population will

be living in cities and urban centres by 2008 (UNFPA, 2007), land prices are set to rise and open space become more scarce as cities adapt to the growing tendency towards multi layer, mixed use high density development. The tall building typology will need to similarly adapt to such change in order to improve its integration into the city and will necessitate the need for Sky courts as spaces of transition between buildings as well as socially focused destination.

If the city of towers continues to extrapolate, becomes more dense and incorporates multi level auxiliary transport infrastructure systems; and if tall buildings reach heights necessitating Sky courts that create horizontal / diagonal high level connections to other vertical transitional spaces in the sky to improve ingress and egress through city and tower alike, then Space syntax can be a useful quantitative tool and predictive theory to map out aggregate pedestrian movement and improve integration. It will help inform the spatial configuration, position and internal planning of the Sky courts relative to the city as well as the tall building that retains it. This will become particularly opportune for simultaneous evacuation post 9/ 11. It will also capitalize on the movement economy (Hillier, 1996) through the potential incorporation of income generators activated by footfall, and create better integrated routes that will provide an ease of movement as well as a heightened chance of social interaction and chance meeting.

Nollis' plan of Rome in 1748 revolutionised the way we map cities and its open spaces. It clearly identified a hierarchy of 'outdoor rooms' as the spaces left over after the urban 'infill' of buildings was blackened out. Such a mapping exercise can clearly demonstrate the fundamental shift in precedence of space over object in the 18th century to the object over space by the 20th century. Whilst this has as much to do with slum clearance as it does with technological advancements in transport infrastructure at the turn of the century (Hall, 2002) it also highlights the increasing privatisation of space and the decline of the public realm (Sennett, 1976).

The Sky court can therefore provide an opportunity within the private tall building object to replenish and integrate those spaces that are so critical for movement and social interaction – and if not on the ground, *in the sky*. Undertaking Space syntax analysis to facilitate the design of Sky courts places movement and space at the core of the design process. Modelling in three dimensions the vertical, diagonal and horizontal circulation (the pedestrian movement) allows for the shaping of the spaces (the spatial configuration) to facilitate the same freedom of movement in the sky, as society believes is its inherent right, on the ground. Just as the spatial configuration of primary figurative voids permits movement in the city and, in the past, took precedence over urban 'infill', so too can the spatial configuration of the secondary figurative voids in the Sky courts take precedence over the tall building, in the future. The tall

building therefore needs to be reconsidered as a disparate series of land use components, glued together by the spatial gel that are the Sky courts, which in turn are spatially configured to optimise movement, improve intelligibility by its users and its integration into the broader city fabric. Such an approach challenges the preconception of the tall building as a stand-alone object designed from the outside-in, and establishes the mixed-use tall building as a 'vertical city' designed inside-out (*Figure 5*). If, through two dimensional studies of the built environment, Nollis was able to identify hierarchies of open space through figure-ground, and Hillier was able to predict pedestrian movement through Space syntax, it is imperative to consider developing software that explores space and movement through the tall building in the third dimension.

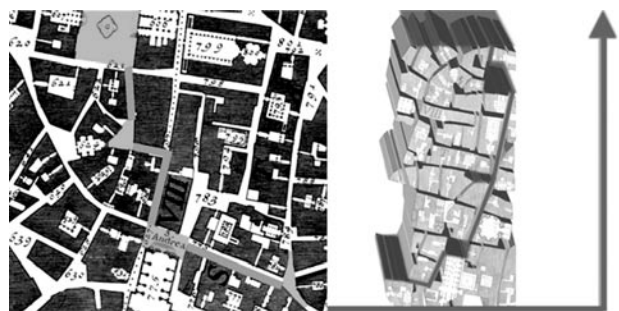


Figure 5: Nollis's figure ground of Rome in 1748

We need to view the tall building as a piece of urbanism extrapolated vertically. Such an approach places space and movement at the heart of the design process and allows the tall building to be designed inside-out (Pomeroy, 2007)

Further research

This paper, through qualitative research, has highlighted the need for further quantitative analysis into the design of Sky courts using Space syntax theory and its software to be able to understand pedestrian movement through the mixed use tall building and its integration within the city. To facilitate this, appropriate mixed-use tall buildings with Sky courts need to be sought as case studies to consider the following:

- 1) Can Space syntax software be developed or modified to model in three dimensions the Sky courts, its means of vertical, horizontal and diagonal axes; and its integration with the city?
- 2) Can the modified Space syntax software successfully model Sky court spaces to establish its degree of intelligibility?
- 3) Can Space syntax assist in the design process through modifications of the spaces analysed?

Notes

- 1) Antonio Sant'Elia (April 30th 1888-October 10 1916). Italian architect who, after being influenced by the growth of industrial cities and

the works of Loos and Wagner, became involved with the Futurist movement and, purportedly wrote the manifesto *Futurist architecture*. His vision was of a mechanised city of the future that was a multi level, integrated and interconnected urban conurbation.

- 2) San Gimignano. A small medieval hill top town in Tuscany, Italy. During its golden era of the 12th century, rival rich families competed in the erection of towers in a show of wealth, power and prosperity

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