REACHING FOR THE SKY: ALEXANDRA SINICKAS

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In an exclusive interview, Alexandra Sinickas, research leader at Arup Australasia, shares with us key insights regarding the design and construction of skyscraper buildings and how data that is now available can influence not only the construction and design of buildings, but also their sustainability.

By 2036 Sydney's population is projected to be 7.5 million (ABS, series 3 projection), while Melbourne's is expected to have grown to 7 million (ABS, series 3 projection). Such rises are not confined to Australia of course, with similar stories in capital cities across the planet. By 2050 it's projected that nearly 70 percent of the world's population will live in cities (World Health Organisation).

The overwhelming global conversation then revolves around the accommodation of all these extra people. How will they travel? Where will they work? Where will they play? And, above all, where will they live? Further, how can we take the opportunity to reduce the environmental impact of the associated construction to house those people?

With space at ever-increasing premiums, many developed and developing countries believe one solution is to go up.

How can high-rise living address the needs of the future to support a truly viable and sustainable way of life?

Alexandra Sinickas is research lead in the Foresight, Research and Innovation team at Arup Australasia, a global engineering design firm. In addition to engineers, Arup employs designers, planners and technical specialists who together cover every aspect of building physical infrastructure, including its surrounding environment.

One of its most recent projects, One Central Park in Sydney, was voted one of the best tall building developments due to Arup's approach to designing for sustainability and community.

Given Arup’s area of expertise in designing smart and sustainable buildings, precincts and cities, it’s no surprise Alexandra was a keynote speaker at this year’s Smart Skyscrapers Summit, held in Sydney. Through the research program, Alexandra works with Arup engineers and designers to explore innovative ways to integrate technology and architecture to enhance the way people live, work and play, while also ensuring smart buildings have sustainability front and centre.

“One way to do this is to design for flexibility, reconstruction and reuse. With changes already in demographics and expectations of citizens, and advancements in technology such as autonomous vehicles and smart cities more broadly, it’s important to incorporate flexibility in the design phase of our buildings, precincts and cities to allow for significant change in how we live in the future.”

Arup commissions research that identifies ways to improve the design of high-rise buildings to resolve issues such as heat island effects, community isolation and energy consumption. “We are moving away from designing tall buildings as a unit to designing tall buildings as a contributing part and changing part of their environment – meaning the precinct and the social environment that they’re in.”

Arup’s research so far indicates two important considerations when designing smart and sustainable tall buildings and skyscrapers: how do people experience their cities, and how can buildings, precincts and cities be designed with social cohesion in mind?

The Foresight, Research and Innovation team suggest that one way to do this is to design with children as the main focus, as it reveals in its ‘Cities Alive – Designing for Urban Childhoods report’.

Alexandra believes if you design for children, then you are automatically designing for families. “Families have different needs to a single person living alone. They need space that is safe, open and clean and, with more people moving to apartment living within cities, this category of dwellers must not be overlooked.” In fact, future design needs to consider bringing together different types of people. “There is research that shows if you put people together from different classes, different ages and different backgrounds, you actually get increased social cohesion. And increased tolerance.”

And if whole communities are living in high-rises, this also means that the infrastructure needs to reflect their needs. “We’ve been investing in research into vertical schools and other critical amenities for people. You need to be able to create a community within and near your high-rise, so it feels like a vertical community, rather than just a whole lot of rooms.”

Alongside the design for the quality of the spaces for communities, technological advances are having a tremendous impact on the way high-rise buildings can be constructed and operated, particularly in how adaptable they will be for future change of use.

An example is incorporating flexibility in the design of apartment block car parks. With the advent of autonomous vehicles and car parking requirements likely to decline, by raising the height of roofs in car parks they could potentially be used for something different in the future, including more apartments.

It’s not just car parks – workspaces and living spaces too can be designed with flexibility, so that they can be adapted or deconstructed later. “Timber is a great example of a material that allows for flexibility, because it can be easier to erect and deconstruct than other materials. It also brings in the benefits of off-site quality construction, reduced wastage, improved environmental impact through lower embodied energy and health benefits to occupants.”

Good examples of its use are RMIT’s Garden Building, where both the timber and concrete floor were prefabricated and assembled quickly on-site, and Arup’s Circular Building, prototyped and installed for the London Design Festival, which tested how different construction materials lend themselves to deconstruction and reuse in support of a circular economy.

Another way to reduce waste is to explore different methods of construction. The MX3D team, of which Arup was a part, has recently been awarded a European Union innovation prize for a bridge project over a canal in Amsterdam. “It was 3D printing,” says Alexandra, “but it was 3D printing on steroids because it’s printing structural steel. The reason this is so exciting is that by being able to print steel in layers (called additive manufacturing), we can create structures that couldn’t be built before using the least amount of material as possible.

“Normally steel connections are created by welding and bolting steel beams and flanges together. At these connection points there are internal forces running through the steel (tension, compression, torsion and shear). Depending on the connection type, those forces run along different paths within the steel. In a traditional connection, some parts of the steel are more stressed or strained than other parts, but because of manufacturing constraints (flat steel bolted and welded together) it is faster, cheaper and to standard code to use a bulkier, but repeatable system even though there’s more waste.

“With additive manufacturing, because we are only printing one grain at a time, we can print shapes that we would be able to build with traditional methods, and we can print steel only where we need it – reducing waste.”

The Amsterdam Canal project is one of the latest in a series of research projects into digital fabrication using construction materials. In 2014, Arup researchers in Amsterdam and Melbourne set about printing steel nodes for tensile structures again using the least amount of steel as possible to cut waste and cost. The project required steel nodes that were designed in a totally innovative way. “We wanted to see what a node would look like if it only had steel where it really needed it… and when you look at the modelling for that and the final printed components, some of them look like human joints.

“Perhaps this shows that evolution is actually an efficient building form. Maybe we’ll start seeing more biomimicry in building design in the future,” says Alexandra. Arup is currently exploring this idea of building urban structures that resemble the natural structures seen in our environment with Computational Design Architecture students at UNSW Built Environment.

The other major development in the design of tall buildings stems from the data that is now available and how that can influence not only the construction of the buildings, but also their sustainability. “Data means that you can now understand so much more about your buildings, and therefore there’s a lot of opportunity for improvement in energy efficiency and the experience of people within the building because of that,” says Alexandra.

“For example, architects and engineers have been designing buildings for a certain thermal comfort and energy use based on empirical evidence or modelling of physical processes. But now that we have so many sensors, we can actually look back on that, apply machine learning or other analysis to the data and improve the building’s systems (mechanical, shading, building orientation and glazing etc) to provide what is needed at an exact point in time, and thus reduce energy consumption and improve the environment for the people in it.”