Global Journal of Science Frontier Research: H
Environment & Earth Science
Volume 21 Issue 2 Version 1.0 Year 2021
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Reimagining Indian Urbanism and Design

By A. K. Jain

Abstract- Urban India is passing through the Anthropocene, where humans have permeated everywhere and shape everything. The approaches of sustainable development focus largely on socio-economic and technical aspects, over-riding the human and cultural values. The architectural design, urban planning and environment impact assessment often ignore the social and cultural aspects, leading to increasing carbon footprints.

It needs relooking at cross-cultural realities, underpinning the socio-economic and cultural dimensions and adoption of circular concepts of the resources and development. The trend of walk to work and work from home need reimagining the process of planning and design.

Keywords: covid 19, migrants, SDG, 4th industrial revolution, digitisation.

GJSFR-H Classification: FOR Code: 050299

REIMAGININGINDIANURBANISMANDDESIGN

Strictly as per the compliance and regulations of:

Reimagining Indian Urbanism and Design

A.K. Jain

Abstract- Urban India is passing through the Anthropocene, where humans have permeated everywhere and shape everything. The approaches of sustainable development focus largely on socio-economic and technical aspects, over-riding the human and cultural values. The architectural design, urban planning and environment impact assessment often ignore the social and cultural aspects, leading to increasing carbon footprints.

It needs relooking at cross-cultural realities, underpinning the socio-economic and cultural dimensions and adoption of circular concepts of the resources and development. The trend of walk to work and work from home need reimagining the process of planning and design.

In this context, the urbanism must shift from predigital, fossil fuel era to renewables, digital and circular systems. This needs leapfrogging in the areas of combinatorial and discrete optimisation by algorithms, 4D mapping, downloading, networking, presencing, artificial intelligence, big data analytics, the ubiquitous cloud and robotics. The setools aim to address the impending issues of pollution, energy and water shortages and make the buildings and cities green and carbon negative.

Keywords: covid 19, migrants, SDG, 4th industrial revolution, digitisation.

I. Introduction

With Covid 19 pandemic, social instability, climate change and political conflicts along with rapid changes in technology, environmental sustainability, jobs, energy, water, and food are emerging as the key issues of urban development. Whereas the businesses and industries have transformed by fourth industrial revolution and new technologies, such as combinatorial and discrete optimisation, algorithms, complexity theory, artificial intelligence, big data, and the ubiquitous cloud, the architecture and urbanism are still inhibited by predigital era thinking.

The construction is still one of the most inefficient and fragmented industries. The design process is often compartmentalised with limited interactions among engineers, architects, contractors, and financiers. The emerging technologies, such as Automatic Guided Vehicles (AGVs), Robotics Drive Units (RDUs) and adaptive environment-reconfiguring machines have shaken the foundation of urban design and architecture. Mega projects, such as SEZ, industrial hubs, highways, railway corridors and infrastructure projects ongoing all over the country have hefty carbon footprints. These foreclose the possibilities of questioning whether so much of development is even necessary. The new computation simulation methods favour the emergence of efficient carbon neutral and flexible building blocks, which are efficient, economical and unwasteful. It needs a transition from fossil fuel pollution to green, carbon negative buildings and cities by digital and parametric techniques.

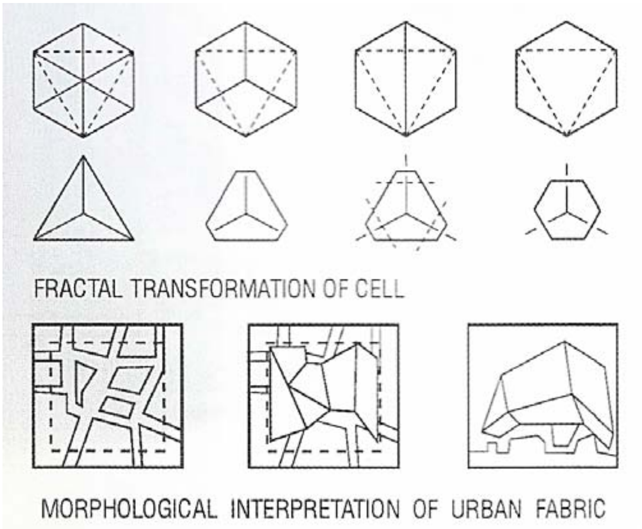
The built environment comprises the urban environment, infrastructure and buildings and interactions among the functions, economy, culture, information, citizens and government. These involve complex systems that address and integrate the diverse issues of jobs, economy, social welfare, culture, equality, gender, children, elderly, lifeline services, housing, climate change, air quality, water, energy, mobility, affordability, and governance.

The electronic era is manifesting a dramatic effect on design, its complexity, and dynamic simulations. During the 1980s there was a breakthrough in parametric design inspired by the plants and organic morphology. This gave birth to a new 'organicity'. Learning from the nature's structural systems of nuanced complexity, it was applied to buildings and urban patterns. The biological forms (morphogenesis) are analysed and reconstructed using parametric design models.The term parametric originates from mathematics (parametric equation) and refers to the use of certain parameters or variables that can be edited to manipulate or alter the end result of an equation or a system. By morphological simulations, the shared concepts, computational techniques, formal repertoires, and tectonic logics are developed, which *expand the repertoire and freedom with non-linear curvilinearity and gradient swarm formations.*

According to Patrick Schumacher, by parametricism urban and architectural environments receive an inbuilt kinetic capacity that allows those environments to reconfigure and adapt themselves. The real time registration of use-patterns drives the real time kinetic adaptation. The systematic modulation of morphologies produces the mutually accentuating correlation of multiple urban systems: fabric modulation, street systems, system of open spaces, etc. This implies

Author: A. K. Jain worked as Commissioner (Planning), Delhi Development Authority. He was a member of the Committee of the Ministry of Housing and Urban Affairs on the DDA (2015), and UN Habitat (2007-12). A member of Editorial Board of International Journal of Environmental Studies (UK), and author of several books, he is visiting faculty in planning and architecture. He was awarded 2nd Urban Professional Award 2014 at World Urban Forum in Medellin, Colombia and IBC Lifetime Achievement Award (2016).
e-mail: ak.jain6@gmail.com

that the fabric modulation extends to the tectonic articulation, fenestration and orientation.



Source: Carlo, Aiello (ed), Evolo Skyscrapers (2012)

Fig. 1: Fractal and Morphological Interpretation of Cells and Urban Fabric

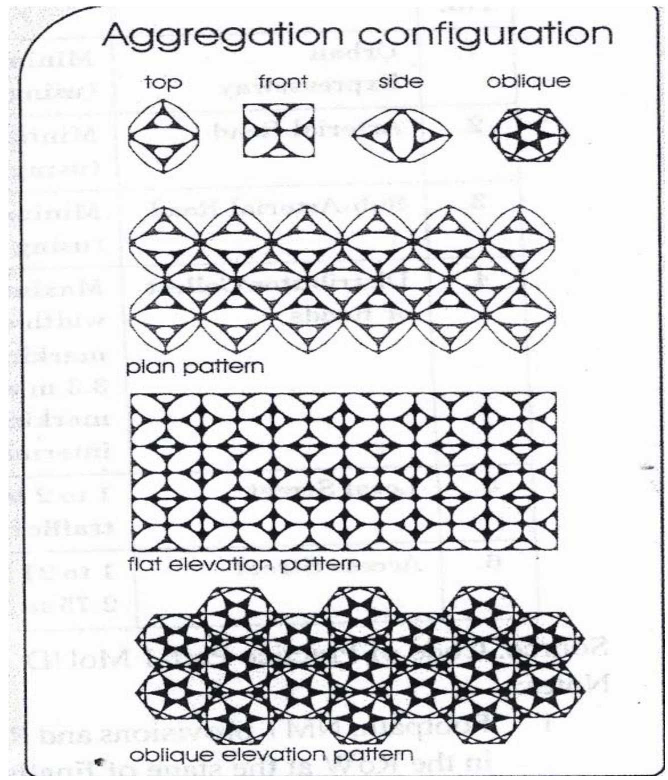
Computer technology provides the tools to analyse and simulate the complexity observed in nature and apply it to building shapes and spatial patterns by use of moving picture and animate forms. Parametric programs, algorithms, and computers can manipulate the elements of design as a self-referential system, in which all the elements are interlinked.

Parametricism aims to achieve spatial complexity while maintaining legibility and adapt to contexts. It uses tools and engines of digital animation software and advanced computational processes. Parametric design is built around the intersection of three areas of knowledge: cognitive models, digital models of design, and parametric tools and scripts. The flow of digital information can be applied for performance-based, generative design from conception to production.

Traditional visual and geometrical representation of the design can be transformed by the 3D Rhino modelling, Grasshopper system and other tools. These enablesa parametric relationship among the topological structures, mathematics, and associative geometry. The parametric process comprises six taxonomies: morphogenetic, geometry and natural system, mathematical algorithms, computation, digital fabrication and production. Parametric design involves thinking with abstraction, thinking mathematically, and thinking algorithmically. This is a new way of relating tangible and intangible systems into a design proposal, integrating topological patterns within generic typologies.

II. Morphogenetic, Geometry and Biomimetics

Morphogenetic is derived from the Greek terms 'morphe' (shape/form) and genesis (creation), used in the biological sciences. It refers to 'the logic of form generation and pattern-making in an organism through processes of growth and differentiation'. Morphogenetic form is not predefined but emerges from the rules that define it.



Source: Architecture+ Design, Horizontal Skyscraper in Carlo, Aiello (ed), Evolo Skyscrapers (2012)

Fig. 3: Aggregation Configuration

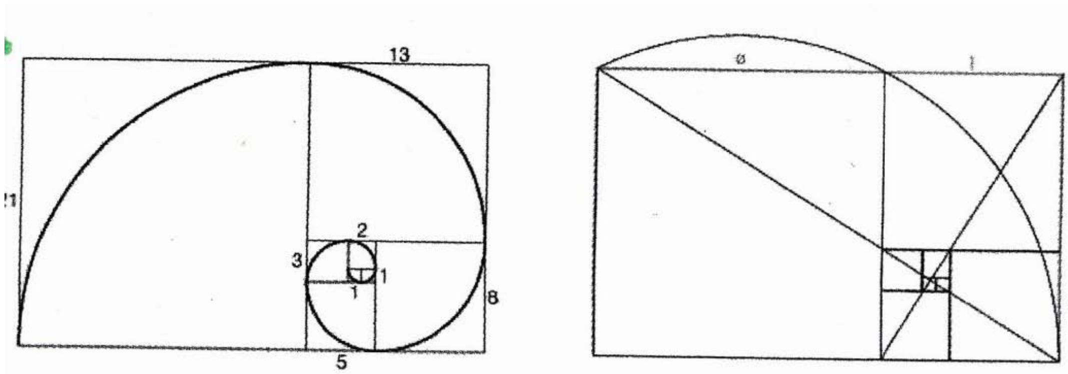


Fig. 3: Fibonacci Sequence and Golden Ratio

Biomimetics or biomimicry is the imitation of the models, systems, and elements of nature for the purpose of solving complex human problems. It has emerged as an important field of research and is having particular resonance in morphogenetic architecture. Nature has always been an inspiration, as the works of Frank Lloyd Wright and Antonio Gaudídemonstrate.

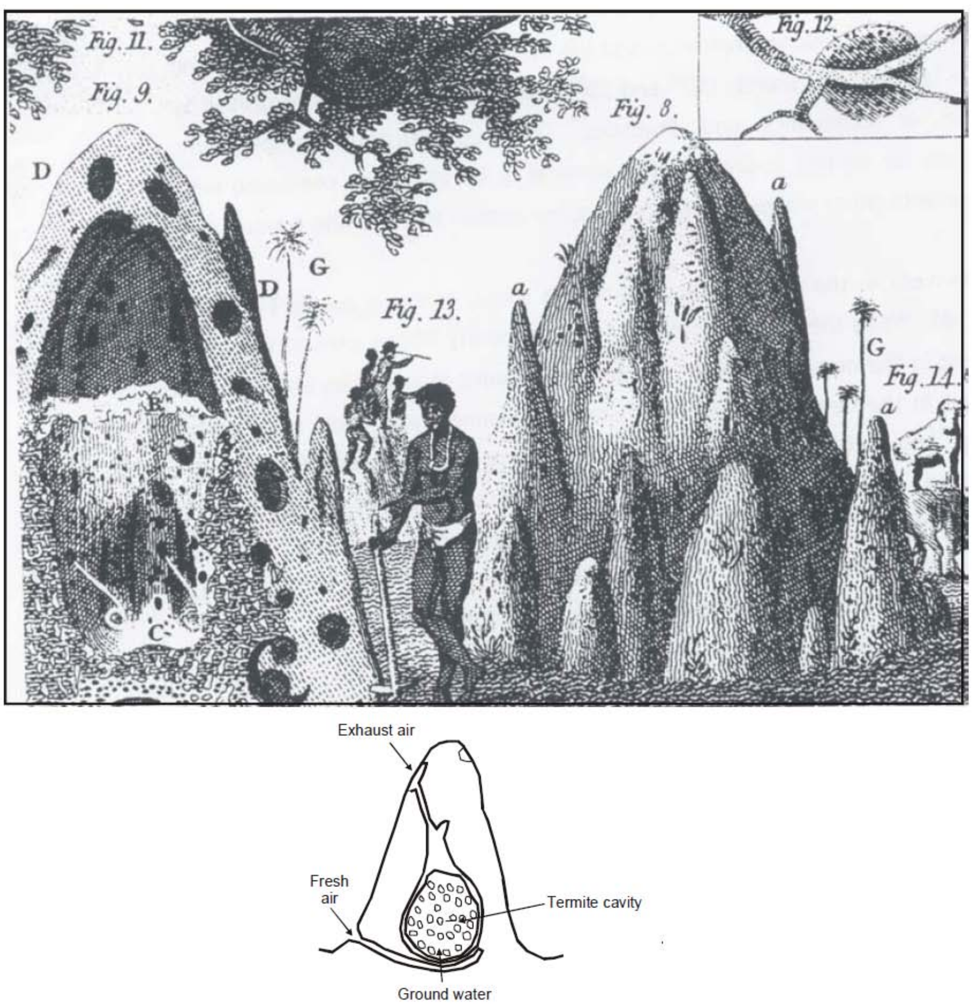


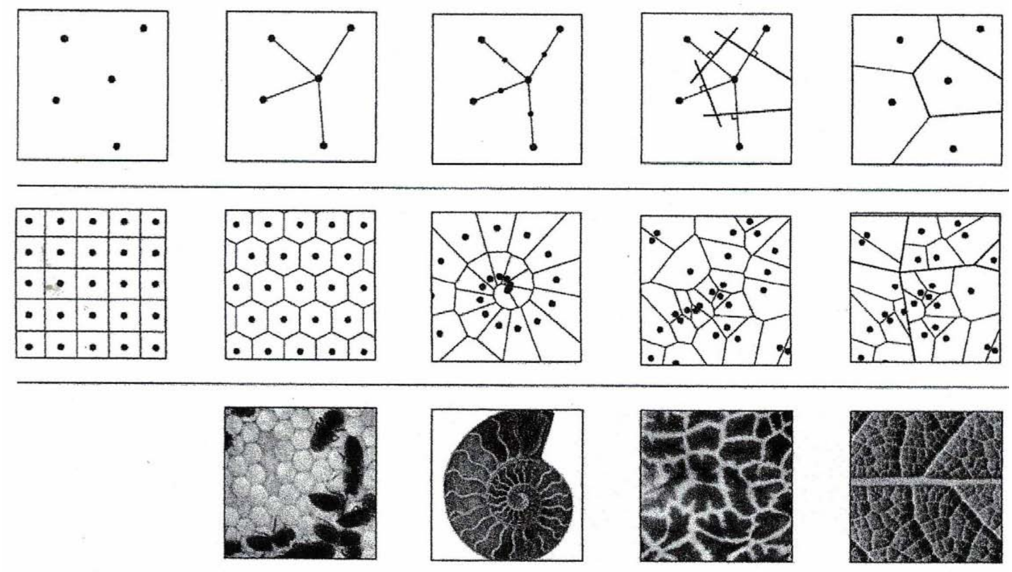
Fig. 4: Termites Nestby Henry Seathman(1781) shows within it miniature streets, bridges, canals, food stores, nurseries, guard rooms, and a royal palace. Termites construct their structures with natural ventilation, thermal storage and evaporative cooling. Through orientation, the nests are protected from overheating in hot climate. Each nest is separated from the outer walls and stands on columns. Spaces are connected and ventilated via vertical tubes and the porous walls.

a) Complex Adaptive Systems

Complex Adaptive Systems (CAS) depend on extensive interactions, the aggregation of diverse elements, and adaptations. These can be seen in the collective intelligence of biological systems, such as a colony of ants, termites' nest, slime mould, flocking birds or a school of fish. Termites' nest is an excellent example of natural ventilation, thermal storage and evaporative cooling. The morphology of traditional cities like Jaipur is an example of community living, occupations, organisation and climatization. Although unpredictable outcomes may emerge, the results are intrinsically connected through the rules that govern them.

b) Voronoi

Named after Georgy Voronoi, a Voronoi diagram is a partitioning of a plane into regions based on distance to points in a specific subset of the plane. A set of points (called seeds, sites, or generators) is specified beforehand, and for each seed there is a corresponding region consisting of all points closer to that seed than to any other. These regions are called Voronoi cells.



Source: Burry, Jane & Mark (2012) The New Mathematics of Architecture, Thames and Hudson, London

Fig. 5: Voronoi Diagrams

c) Mathematical Algorithm

An algorithm is a process of addressing a problem in a finite number of steps. It can be an articulation of either a strategic plan for solving a known problem or a stochastic search towards possible solutions to a partially known problem. Algorithms are expressed in terms of mathematical equations which define the rules of the model.

d) Parametric Modelling

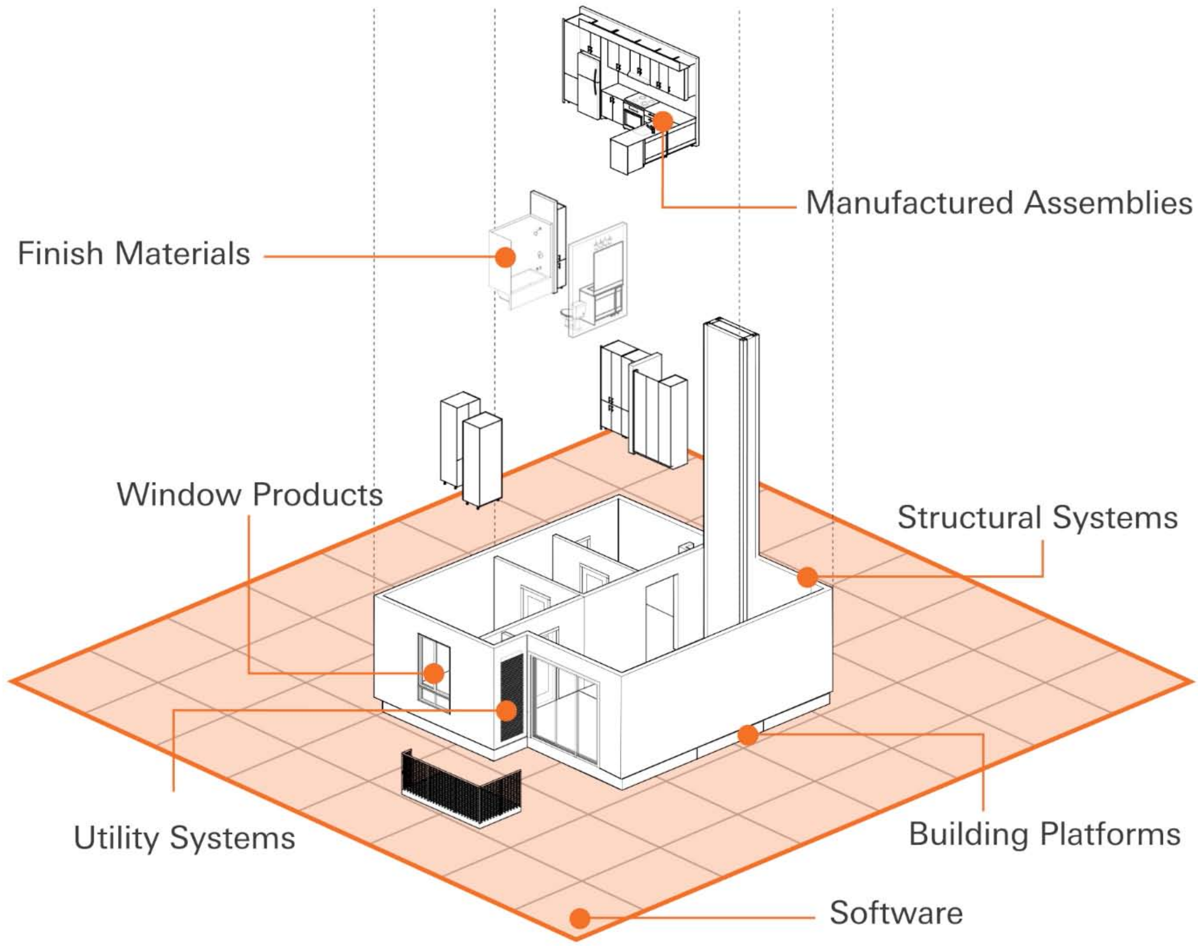
Parametric modelling is based on a series of pre-programmed rules or algorithms known as 'parameter'. The model or elements of it are generated automatically rather than by being manual manipulation. Typically, parametric rules create relationships between different elements of the design. For example, a rule might be created to ensure that walls must start at floor level and reach the underside of the ceiling. Then if the floor to ceiling height is changed, the walls will automatically adjust.

Soft modelling focuses on the control of flexible materials aiming to automate the creation of a discrete line-based structural frame from a membrane. Parametric model engages directly with the BIM to generate, extract and manipulate data. It can also be used to perform analyses and embed the results into the building/planning model.

e) Digital Robotics, Fabrication and Production Process

Digital fabrication uses design-to-fabrication workflows to enable a faster construction process, minimise resources, and material-specific design solutions. It integrates design, simulation, and digital fabrication to create complex, customized products using ubiquitous manufacturing hardware. Digital manufacturing has facilitated opportunities of surface patterning and the fabrication of offsite special building components, removing the constraints of standardisa-tion in the construction industry.

Material feedback allows adjusting the digital fabrication in order to negotiate material properties and to calibrate a precise relation between the whole and the individual units of construction.



Source: Kattera, Key Assemblies, and Curtis, Craig (2020) Architecture at Scale: Reimagining One-Off Projects as Building Platforms Architectural Design

Fig. 6: End-to-end control of building design, manufacturing, construction, and operations achieve targets at lower cost and time

III. Reimagining the City

Cities have become sources of extreme inequality and environmental degradation, which are threatening their physical social and economic integration. Urban planning has long been governed by the classification of human activities-work, residence, leisure and transport. However, this approach is ill-suited to address the pressing environmental, economic and equity concerns. There is a need to adopt a new ecosystem, which addresses the challenges of the environment and urban complexities. The new perspective is mediated by the ecology, technology, connectivity, producing its own energy, transport, food, shelter and recycling of wastes.

It is necessary to overcome the visual chaos of *laissez faire* urbanisation, and focus more upon identity, local culture, topography and climate. The cities and buildings must be not only smart and sustainable but also act as urban nebulisers and transducers in order to detox the air, and function as bioreactor and energy generators. They should enable waste recycling, urban farming and provide green loops which integrate building resources, non-linear geometry and nanotechnology.

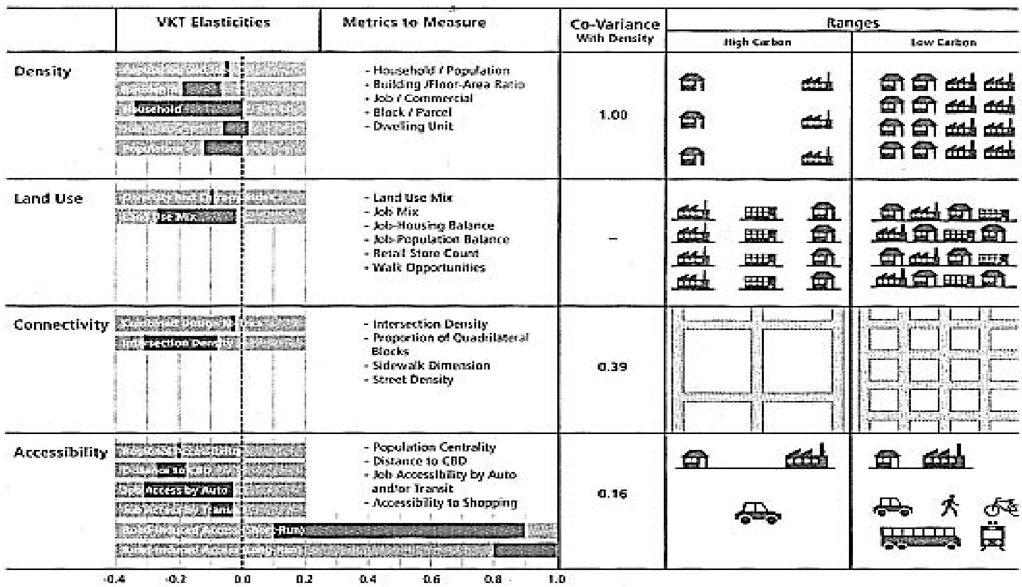
With the sustainability at the centre-stage, it is necessary to work out the approaches that can respond to the needs of 600 million urban population in India by 2031, as well as meet the SDG targets of sustainable cities and communities. These challenges need a new ethics and process of planning and development, which is low carbon and climate resilient.

According to the Intergovernmental Panel on Climate Change (2014 WG III), urban areas account for 67 to 76% of global energy use and 71 to 76% CO_2 emissions. According to the IPCC, the critical aspects of spatial planning for clean air comprise:

- Density and Floor Area Ratio for optimizing land use
- Land use and job mix, walkability

- Connectivity, intersections, block size
- Accessibility to facilities by streets, public transport, cycles and walk.

The mitigation and adaptation to climate change, disasters and risk management and the safety of women, old persons, children and other vulnerable sections of the society need a comprehensive approach in compliance to NDMA guidelines and Hyogo framework.



Source: IPCC, 2014

Fig. 7: Critical components of Sustainable Spatial Planning

a) Land, Zoning and Jobs

Land is a key resource for sustainability and should be used optimally. It should not put a large footprint, while providing space for jobs, infrastructure services and housing. A major focus area has to be local economic promotion and poverty reduction. A large number of the unemployed are forced to take on informal, illegal or uncertain jobs, and their entrepreneurial potential and development opportunities lie untapped. This needs rethinking the concept of land use zoning, whereby the work centres(zero polluting industries and commercial) can co-exist with residential use. At least 50% of the workers should be provided with their residences within a walkable distance from their workplace. At least 10 per cent of commercial and industrial areas may be reserved for the informal sector, including Janta markets, workshops, shops, small offices, kiosks, fruit and vegetable stalls, etc. Just 1 to 2 sm of space can create one livelihood for informal sector against 3 to 6 sm of space per formal shop. As such, by informal sector jobs and mixed land use, it is possible to expand access to livelihoods and reducing poverty.

Writing about home-based enterprises and hawkers in Delhi, Surbaya and Pretoria, Graham Tipple of the University of Newcastle upon Tyne, concludes that *"they should be accorded more attention by policy makers – not to control them, but to find ways of cooperating with entrepreneurs to assist them to be effective and efficient. Other reason why cities need vendors on streets and not designated food courts, is because hawkers are the eyes of the street and prevent violent crime. Our city roads are safer because of them."*

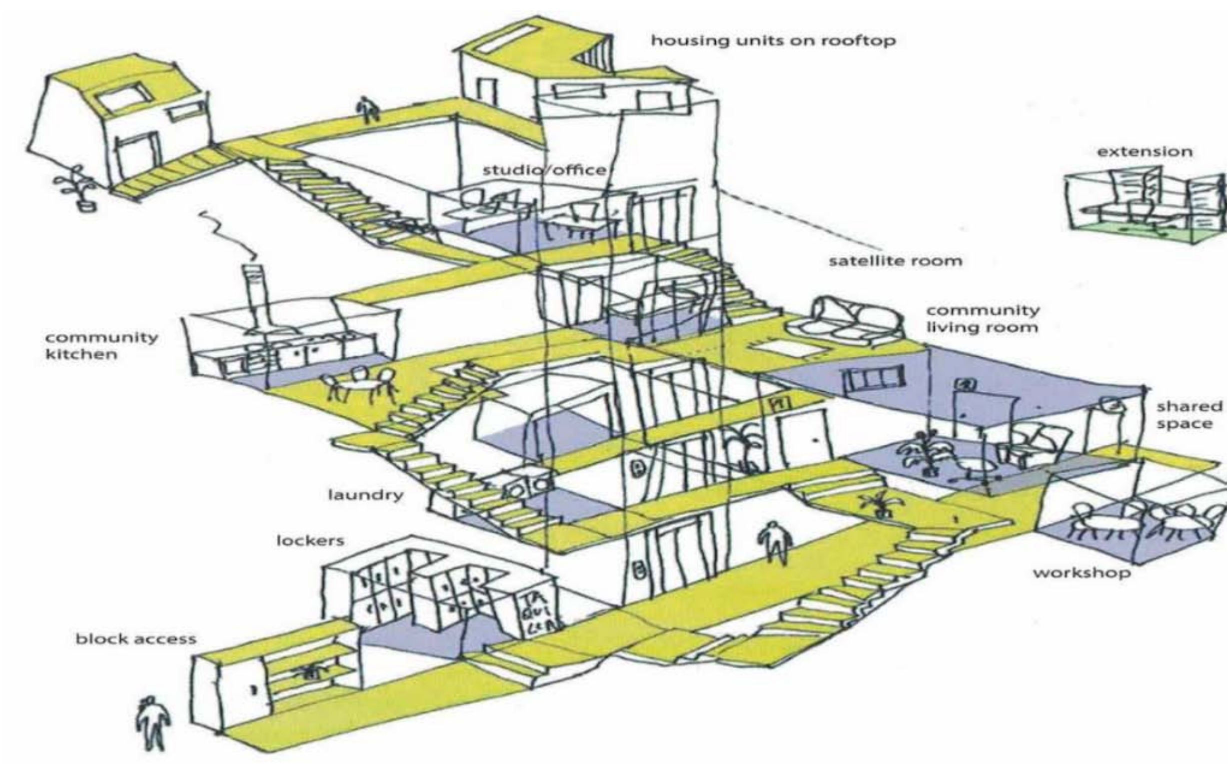
This implies that to establish closer links between shelter and poverty reduction, it is necessary to revise the concepts of land use zoning and building regulations. There is a need to rethink and review the planning paradigm and norms, such as land use, FAR and densities, which are equitous, compact and promote affordable housing. The densification can lead to travel reduction, economy of services and conservation of agricultural areas. Although there are objections to the idea of high-density planning, empirical data indicates correlation of urban density with less transport energy and car use. The compact and smart growth supports a high transit-share and makes walking and cycling attractive. The Indian cities have an overall density of 100 to 240 PPHa, which can be selectively doubled along public transit corridors, excluding the archaeological, heritage and conservation zones.

There is a simultaneous need for strengthening the services, greens and amenities. The private owners and developers can be made to provide part of their land/ built-up area for public greens and social facilities. While higher density and FAR, may reduce the cost of land per unit area, the cost of construction increases beyond the walk ups (15 m height), owing to lifts, foundation, fire sprinkler system, services, generator, etc. There are also implications with respect to safety of women, elderly and children, home based occupations, community interaction and communications. As such, a pyramidical structure can be worked out in terms of height. For those at the base of the pyramid, the walk-ups, low rise –high density development patterns can be adopted. For the middle-income group people mid-rise (up to 12 storeys) and for those who are rich, high rise development can be encouraged.

The urban design and planning have to be open ended having flexible spaces for multiple cultures, synthesising universal values, local climate and technology. In hot climate the objective of site planning and building form is to minimize solar gain and to reduce the need of cooling, thus reducing the demand for energy. As such, it is necessary to adopt compact and dense forms with mixed uses. Landscaping can enhance the ecology and aesthetics and cool the buildings. Apart from ground planting, vertical landscaping, patios and roofs can be landscaped.

The parametric model can be a tool for redevelopment of brown fields, where large number of trees are existing. As a basic principle, no tree should be cut. The parametric model of allows for their conservation by adjustments in road alignment and building footprint as per site condition.

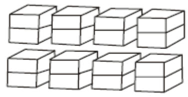
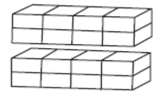
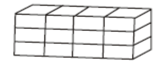
The service networks and transportation can also be parameterised to reduce their carbon footprint. Against the Data Model which deals with the performance of urban environment, the parametric model is crucial tool for integrated planning and smart built environment. As a pre-requisite, it is essential to computerise /digitise land records, allow formation of small cooperatives of the residents, and encourage the engagement of the professional groups and private sector to act as a catalyst and facilitate implementation of redevelopment schemes.



Source: NPR, (www.npr.org)

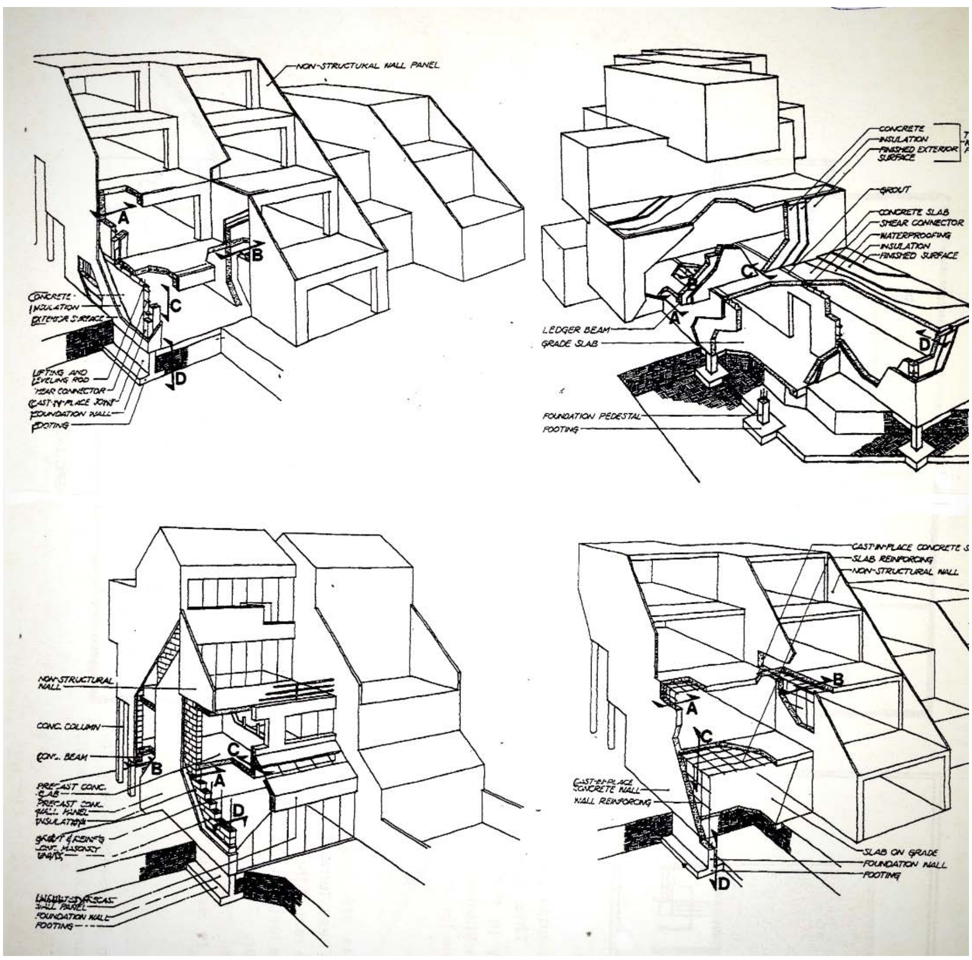
Fig. 8: Mixed Land Use for Work-Life Integration

The concentration of activities enables the reduction of energy consumption, optimization of land costs, while meeting the locational preferences of the occupants. The following figure indicates the options, so as to select the building form with minimum footprint and envelope without reducing the overall floor area.

Building form	 *8 separate houses (ground floor plus basement)*	 *2 terraces of 4 house} (ground floor plus basement)*	 *block of 8 flats (2 storeys plus basement)*
Site area	100 %	70 %	34%
Envelope surface area	100%	74 %	35%
Heating energy	100 %	89 %	68 %
Construction costs	100%	87%	58 %

Source: Presig H. R, et al (1999) Okologische Baukampetenz, Zurich

Fig. 9: Comparison of the surface area, energy consumed and construction costs for eight building unit in different configurations. The lower the footprint and envelope area, more energy efficient is the building.



Source: Community architect daily.blogspot.com

Fig. 10: High density -low rise housing options for Coldspring New Town: crisscross panel systems placed at right angles to one another, optimum conventional construction and large panel system (Architect Moshe Safdie)

Local climate has a significant connection to the energy use, climate resilience and urban heat island mitigation. For example, areas with cooler mean temperatures and more cloudy days would have less energy savings compared to the areas with reduced cloud cover and rain and higher temperatures. Also, the effect of wind in dispersing pollutants may improve the air quality. Trade–offs between roofing types and insulation are influenced by the local climate. Passive design strategies such as day-lighting and natural ventilation, should be integrated with the design and construction. Some low energy passive techniques are given in Box 1.

Box 1: Some Low Energy Passive Techniques

Insulation

The heat-transfer through the building skin is reduced: the heat loss from the building is reduced in winter and heat penetrations is prevented in the summer

Mass

Mass stores heat to stablise room air temperature: for heating in winter, solar heat is absorbed in day time and released at night. For cooling in summer, mass is cooled at night time to keep rooms cool in the day time.

Air Lock

Air lock prevents the heat loss by air leakage to make the building air-tight.

Solar Glazing, Solar Passive Devices

The solar window or solar-collector uses solar heat positively.

Air-Circulation, Wind Related Orientation

Air is circulator to supply the heat and homogenize the air temperature distribution in the room.

Sun Space, Sky Courts, Atria

Sun spaces are attaches to the building in order to collect solar heat positivelty like greenhouses, conservatories, sun rooms, etc.

Shading, Sensor Controlled Fenestration

Solar insolation in the summer is blocked and heat penetration into the building is prevented.

Cross-Ventilation

Air ventilator lets fresh air in and exhausts hot room air out. Air movement promotes heat emission from the human body surface and gives a fresh feeling.

Night Flushing

Mass of cooled air in the night time is vented through the cuildfing to cool it. It is effective to store 'coolness'

Earth, Bio-Climatic Design

The stable temperature of the earth can be utilised for the purpose of heating and cooling. Earth berming on the room has the same effect.

Water Spray

Water sprayed on the building to promote evaporation, evaporation cooling is effective in dry climates.

Dehumidification

This expells the damped room air and/or intentionally condensed water. The building material which works as aspitator of humidity is also effective.

Top-Lighting

Light is introduced into the spaces at all seasons but solar control in necessary in summer.

Side-Lighting

High side-lighting is effective in distributing the illuminance homogeneously. Solar control is necessary depending on the window orientation.

Light Guide

Special devices transfer the light to the deep interior of the building.

Light Shelf

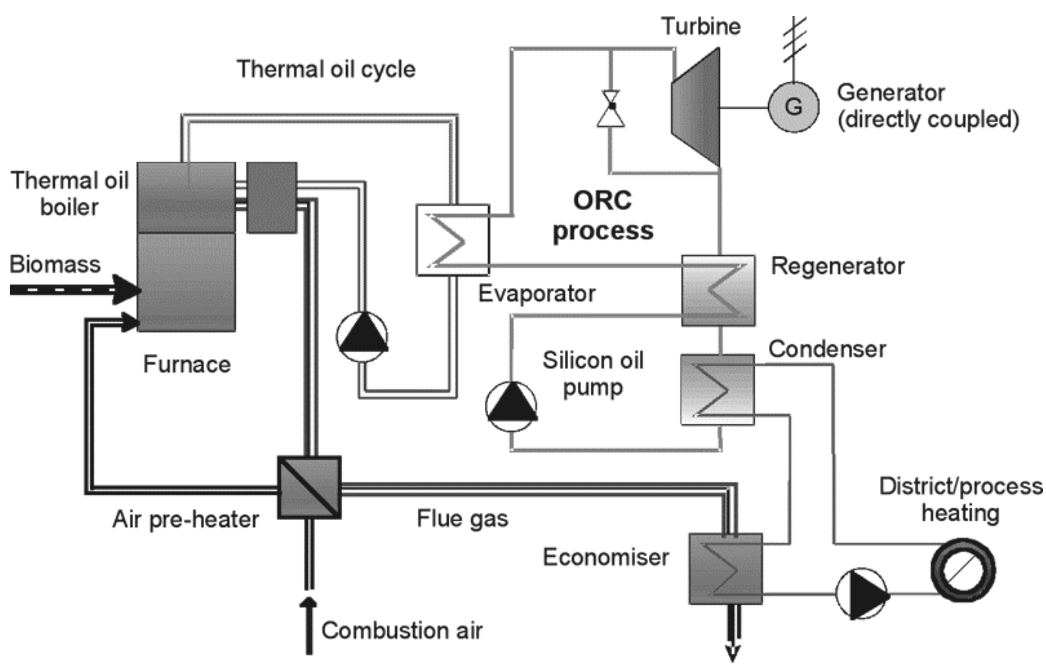
The shelf which is installed at the glazing reflects and diffuses the direct beam and the light can reach into the deep interior.

Source: PLEA (Passive and Low Energy Architecture, 1991) Process Architecture No. 98, Tokyo Japan *b) Smart Utilities and Services*

Smart utilities aim at sustainable and renewable energy, water supply, drainage, sewerage, recycling and waste management. For water supply, the ICT solutions, such as SCADA system, enable enhanced efficiency. Similar benefits are available in respect of solid waste management and other utilities. RFID controlled three bins recycling, blockchains and micro-irrigation system can make the utilities efficient. Smart utilities can give energy saving up to 30%, reduce carbon emissions and provide higher efficiency and comfort. Information technology can be used for better services, high-speed communication and data management, carbon-emission accounting and performance objectives. The buildings can be designed as energy bio-reactors, urban nebulisers and detox towers. Innovative systems can convert bio-mass and noise into energy, conserve and recycle water and promote urban agriculture.

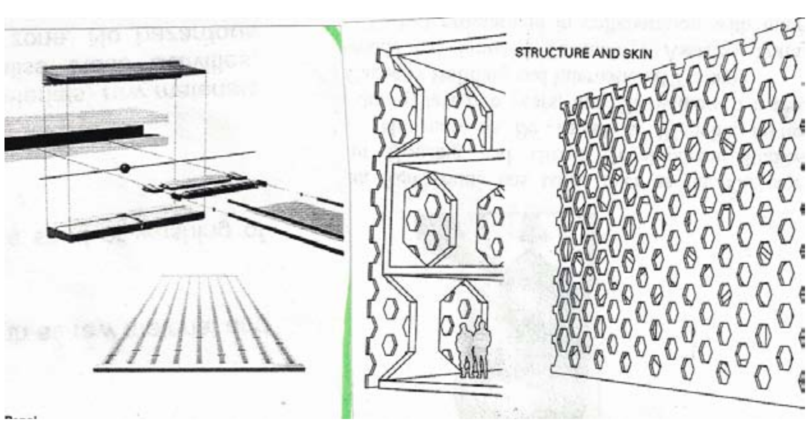
c) Building as an Energy Bioreactor

Noise and heat insulating panels, made of carbon fibre and cyanobacteria create a closed autonomous system of air circulation within a building, protecting it from outer pollution by providing fresh ionized oxygen. The exterior should be able to open and close. Within these modules, the cyanobacteria grow. The modules are filled with a special water solution that reacts with carbon dioxide to produce oxygen by photosynthesis process.



Source: David Constable, 2012, Trashscraper

Fig. 11: Gasification Process: Electricity from Bio-mass



Source: Ryan Browne, Nathaniel Dunn, Daniel Nelson & B. Scholten, Urban Transducer, and Amandine Quillent, F Zaini, Urban Coral Reef, in Evolo Skyscrapers, 2012

Fig. 12: Acoustic Panel and Urban Coral Reef Skin for Energy from Noise

Global Journal of Science Frontier Research (H) Volume XXI Issue II Version I Year 2021

d) Buildings as Respirational System

Buildings can be designed as huge air-purifiers, which transform the polluted air and exhaust fumes into clean air by water algae and sea sponge. These contain organisms that convert greenhouse gases and exhaust fumes into oxygen.

Urban Nebulizer is a device to aid breath for an asthmatic. It takes temperature inversion, smog and polluted air of atmosphere and diffuses it by smokestack, combined with water vapour. The structure can also function as a botanical garden, mostly with acicular trees for air purification.

Detox Tower: A building can double as a detox tower which cleans air through its outer skin and internal detox loop. The detox tube has three layers-the first is Voronoi/ aerodynamic adaptable structure, the next is a nano-hydrophobic membrane layer with venturi that uses lichen and algae for purification purposes. Finally, the air passes through layer three, which comprises a flexible aerogel. The building can be designed to give the chimney effect, which cools the air entering at its base and flows out at the top. The building skin can also collect solar energy.

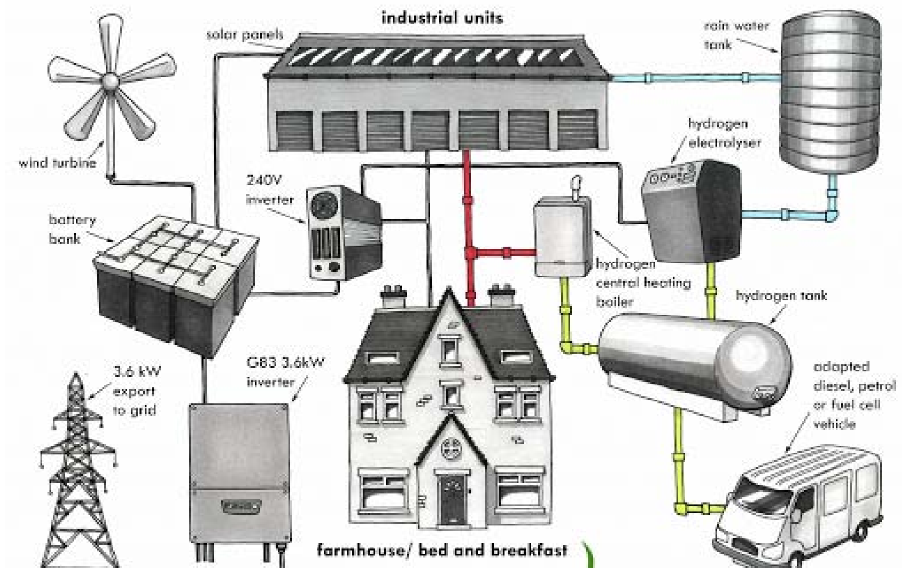


Fig. 13: Wind Turbines, Solar Parabolic and Microgrid

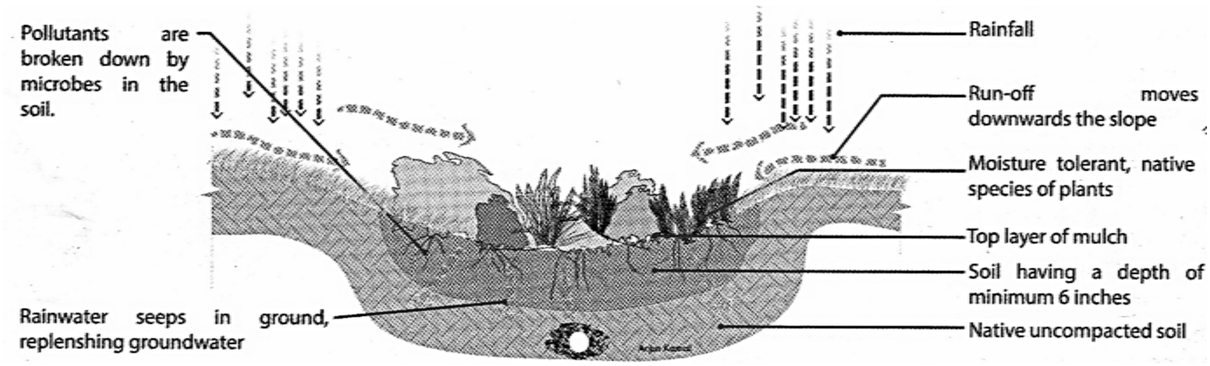
e) Converting Noise into Energy

The urban transducer captures airborne sound converting it into energy by using acoustic panels that perceive frequencies and wavelengths. The acoustic panels on the exterior of the building contain multiple bands with tuners which resonate at a specific frequency. They can slide to the desired locations, changing the band frequency. The bands change the magnetic field by electrostriction and transform noise into electrical current by a piezoelectric transducer. The urban transducer has ability to remember the frequencies and their locations. It can also be combined with the wind energy produced by miniature turbines. The acoustic panels that envelope urban transducer is made up of multiple metal bands with individual tuners and sensors that sense frequencies.

f) Water Conservation and Evo-transpiration

Grey water treatment by root zone system using urban forestry and nutrients can produce evaporation-transpiration. The irrigation system is 1 m below ground to reduce evaporation losses, pollution and to prevent odour. The vegetation cools the environment. An adult beech (Fagus Sylvatica) has a cooling power of 1,000 mega-joules per day. Each litre of water evaporated by a tree produces 2,300 kilo joules (0.64 kwh) of cooling. By proper design, we can use this energy to cool buildings, in addition restoring the nature. The plants species for cooling should be suitable for suction of particulate, evapo-transpiration and wastewater treatment.

Water reservoirs in the form of funnels, rain gardens, swales and reed fields serve as a hydro-botanic treatment unit. The rainfall stored in a reservoir and treated wastewater can be used for flushing toilets, washing machines, watering plants, cleaning floors and other domestic applications.



Source: Jain, A.K. (2015) The Idea of Green Building, Khanna Publishers, New Delhi.

Fig. 14: Bio-swale Captures Rainwater and Recharges Groundwater

g) Urban Agriculture

For urban agriculture multi-level platforms can be created along with micro-irrigation and humidifying mechanisms. Methanisation of organic wastes, air supply and photovoltaic systems provide supports to the idea of urban farming and artificial urban biotope. This can help in availability of organic produce locally, reduce haulage and wastage of agriculture produce and bring greenery in midst of concrete jungle.

h) Building Resources and Sustainable Construction

The idea of circular economy is based on the continuity of raw materials, products and waste streams in a closed circular loop. It involves an energy centered approach towards design, materials and construction. Adoption of circular models for the building design and construction requires formulating guidelines, calculating resources, labour and material flows, their environmental footprint and impact and lifetime scenarios. The basic approach of circular construction is zero emissions and wastes by on-site recycling to save the environment.

i) Construction and Demolition (C & D) Waste Recycling

Construction involves generation of construction and demolition wastes. These need to be disposed of and recycled as per the Construction and Demolition Waste Management Rules, 2016.Recycled products reduce the demand for new materials. Such materials include reused brick, steel, concrete, gypsum, sulphur, wood alternatives, reconstituted wood, straw, bamboo, wood waste pallets and panels for construction.

j) The Breathing and Green Facade

Facades are the building envelope forming the outer skin of a building and express its image and creative intent. They are also important environmental moderators. A thoughtfully designed skin can make a building work more effectively for its users and the environment. It can effectively control the physical environmental factors such as heat, light and sound, thus improving the occupant comfort within a building. The location and climate are crucial factors in selecting appropriate façade materials and deciding on design strategies for sustainable façade. As the materials of façade are exposed to mechanical, weather and maintenance, the use of high-performance materials such as titanium and high alloy special steel (ferrite austenite steel) assumes an economic and ecological relevance.

The breathing and green facade aims to create green spaces closer to the users. The openable windows allow fresh breeze and facade planting creates a microclimate, which is less prone to heat gain from solar radiation. Wind resistant plant scan also act as wind breakers. This idea has been pursued by the architectKen Yeang with his "green" facades, on the Menara Boustead Tower in Kuala Lumpur. The green wall and vertical garden with deciduous plants can reduce the solar gain inside the building, reduce the street noise and reduce energy load. It also produces a stack effect between the planted facade and the building exterior, channelling the heat away from the building. It has been designed keeping in view architectural and functional requirements, thermal performance, flexibility, HVAC system and maintenance costs.

Fig. 15: The Opus Business Bay, Dubai (UAE), Architect Zaha Hadid. Materials used for facade and fenestration include aluminium unitized curtain wall system, steel and aluminium skylight system, carbon fibre composite stick system curtain wall and high-performance mirror fritted and blue body tinted double curved glass. The glazing comprises complex 3-D forms especially manufactured for the facade.

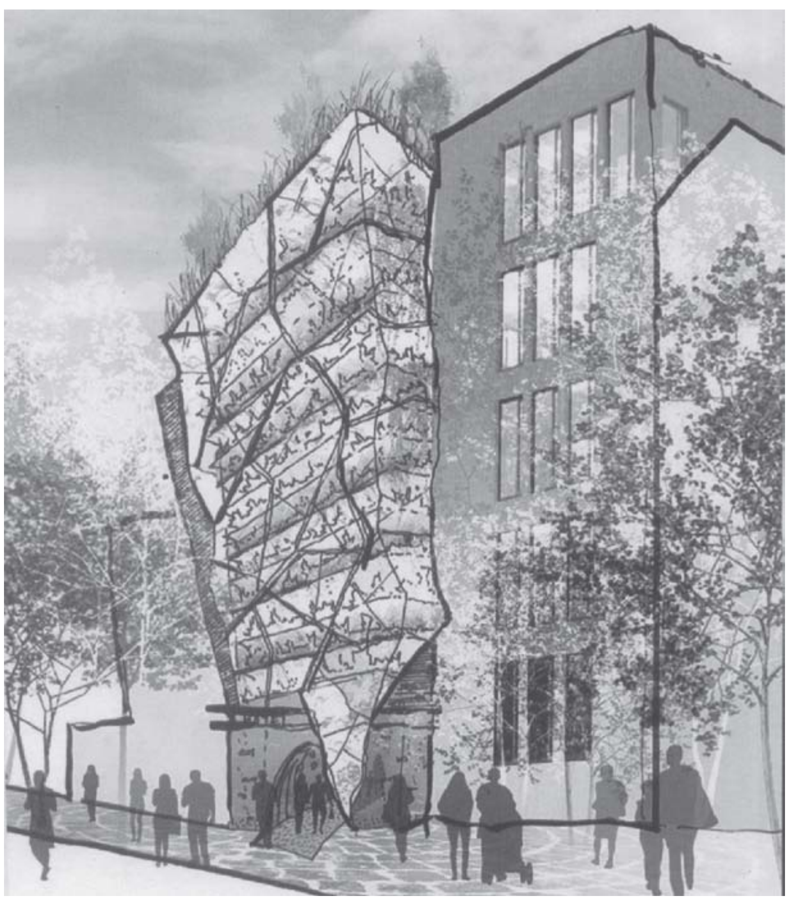


Fig. 16: Green facade of proposed Edible Hotel, London, Dexter Moren, Architects

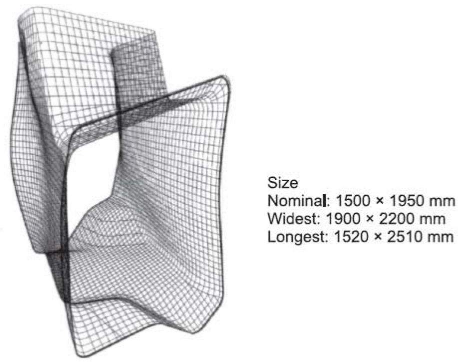
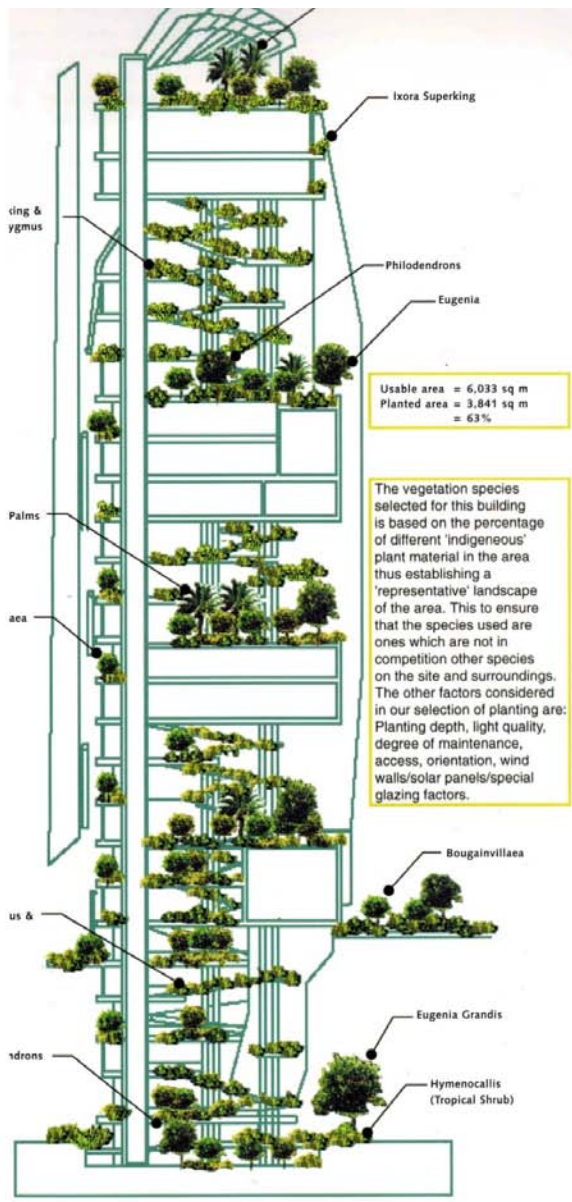
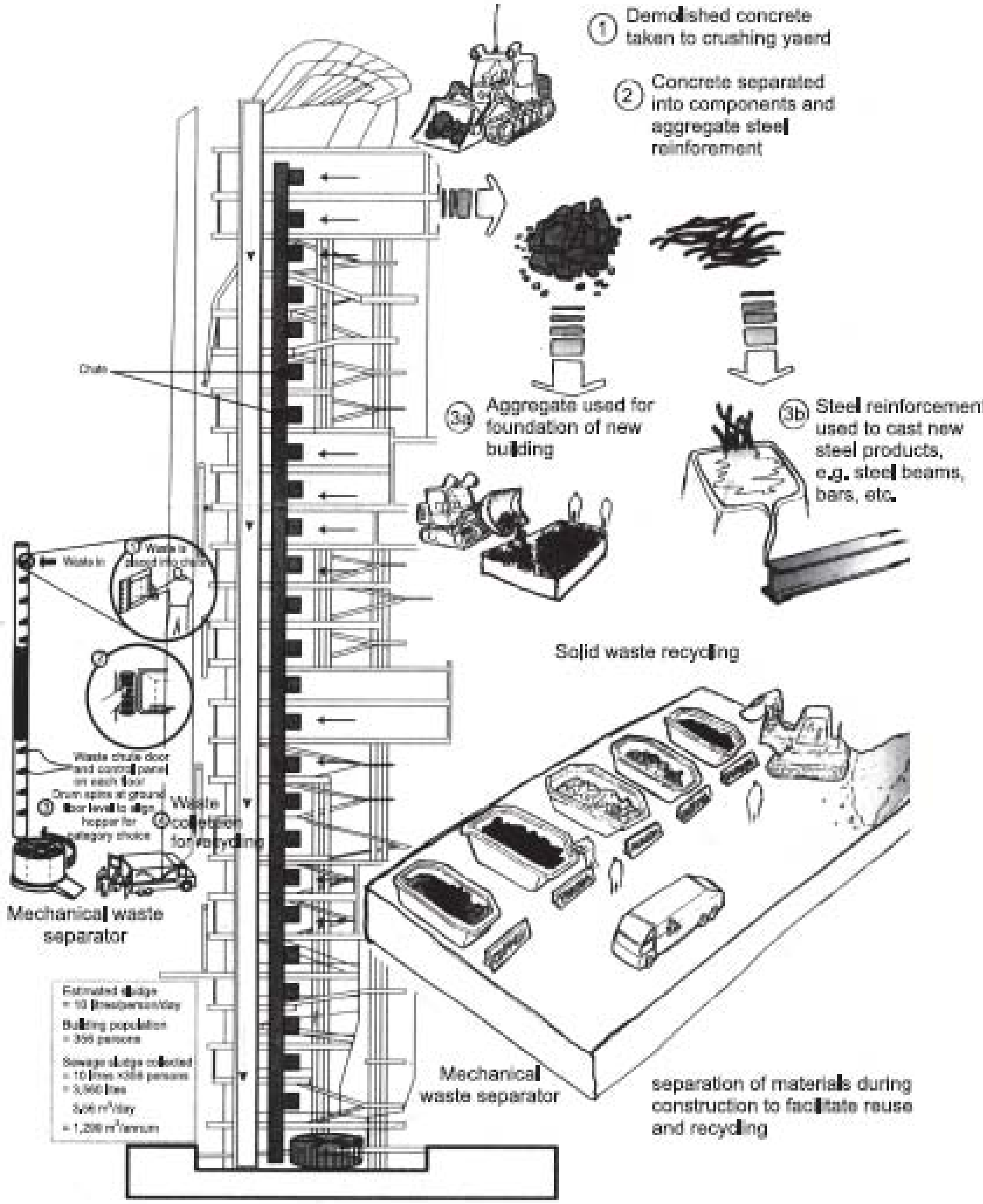


Fig. 17: Void surface quadrilateral modules are all unique in shape and size, Architect Zaha Hadid



Source: Yeang Kenneth (1999) The Green Skyscraper, the Basis for Designing Sustainable Intensive Buildings, Prestel , New York

Fig. 18: Bio-climatic skyscraper: Climate zone and precipitation determine the building design, its fabric and features. Vertical, spiral/ hanging gardens, terraces, courts, atriums, louvers, sun shades and shaded envelope are combined with bionic controls and intelligent systems. Architect Ken Yeang



Source: Hamzah TR and Yeang, Ken, Ecology of the Skyscraper (2001)

Fig. 19: Concrete recycling by Bawttle McCarthy, Consulting Engineers, Editt Tower, Singapore

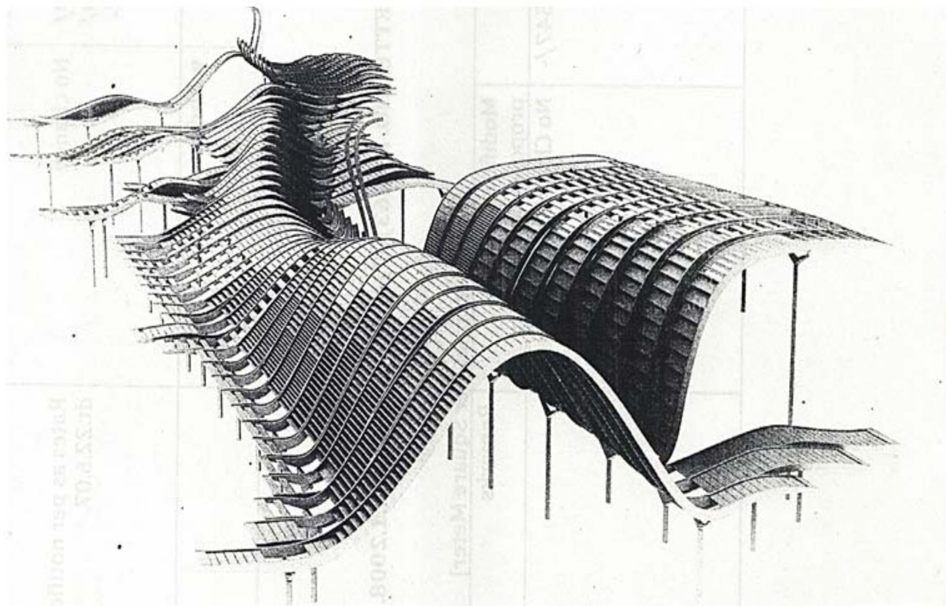


Fig. 20: The architecture, engineering and construction industry are increasingly operating within the physical and digital era of connectivity, that merge social, ecological and technological complexities

Source: Zaha Hadid Architects, Galaxy Soho, 2012

Fig. 21: Galaxy Soho

The heuristics of parametric urban design include the avoidance of rigid forms, functional stereotypes and segregated zoning. This implies the use of the intelligent information, rich deformation of soft forms, differentiation of all systems through gradients, thresholds and singularities and interdependent correlation of all systems. This produces a combination of complexity, rigor and elegance as manifested in the works of Peter Eisenman, Frank Gehry, Zaha Hadid, Rem Koolhaas, Wolf D. Prix, Bernard Tschumi, Daniel Libeskind and others.

Fig. 22: Frei Paul Otto used lightweight tensile and membrane structures in the roof of the Olympic Stadium in Munich for the 1972 Summer Olympics

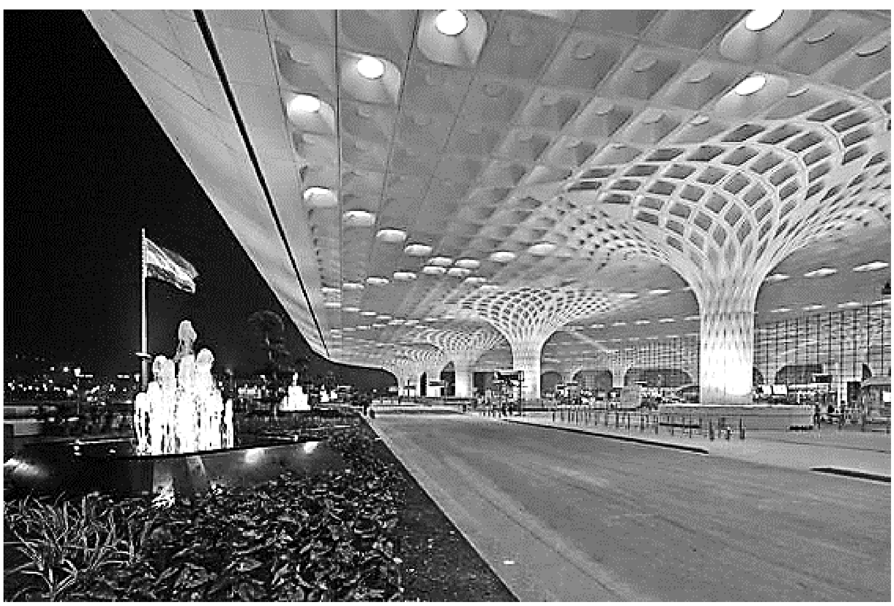


Fig. 23: Chhatrapati Shivaji International Airport Terminal 2 in Mumbai, India, designed by Skidmore Owings and Merrill (2014)

Chhatrapati Shivaji International Airport Terminal 2 in Mumbai, India, by Skidmore Owings and Merrill (2014)has been designed to accommodate traditional Indian departure and arrival ceremonies, and the complex variegated patterns.

Other projects, such as Google's California Headquarters by Bjarke Ingles (BIG) and Thomas Heatherwick, Beijing, New Airport Terminal Building in Beijing, China by Zaha Hadid Architects , Harbin Cultural Center in Harbin, Heilongjiang, China by MAD Studio, and Earthly Pond Service Center International Horticultural Exposition by HHD-FUN, canherald a new phase of parametric urbanism, digital architecture, andurban design.

References Références Referencias

1. Aiello, Carlo (ed) et al (2012) Evolo Skyscrapers, Vol. 1 & 2, Evolo Inc., Los Angeles, USA.
2. Burry, Jane & Mark (2012) The New Mathematics of Architecture, Thames and Hudson, London.

3. Cinark, Kdak (2019) Circular Construction Materials, Architecture and Tectonics, Unwelt, Udgivet, Copenhagen, Denmark.
4. Curtis, Craig (2020) Architecture at Scale: Reimagining One-Off Projects as Building Platforms Architectural Design.
5. Hamzah TR & Yeang, Ken (2001), Ecology of the Skyscrapers, Mulgrave, Victoria.
6. IPCC, (2014) Working Group III, Intergovernmental Panel on Climate Change, Geneva.
7. Jain, A.K. (2015) The Idea of Green Building, Khanna Publishers, New Delhi.
8. Jain, A.K. (2015) Smart Cities: Vision and Action, Discovery Publishing House, New Delhi.
9. Jain, A.K. (2021) Architecture- Past, Present and Future, Delta Books House, New Delhi.
10. Jain, A.K. (2020) Tall Buildings and Vertical Urbanism, Discovery Publishing House, New Delhi
11. Jain, A K. (2020) Housing and Community Planning, Discovery Publishing House, New Delhi.
12. Patrick Schumacher, (2016) Parametricism, Rethinking Architecture's Agenda for the 21st Century John Wiley and Sons, London, UK.
13. PLEA (Passive and Low Energy Architecture) (1991) Process Architecture No. 98, Tokyo, Japan.
14. Presig H. R, et al (1999) Okologische Baukam-petenz, Zurich.
15. Ryan Browne, Nathaniel Dunn, Daniel Nelson & B. Scholten, Urban Transducer, and Amandine Quillent, F Zaini, Urban Coral Reef, in Evolo Skyscrapers, 2012.
16. Safdie, Moshe, High Density-Low Rise Housing for Coldspring New Town, in Community Architect Daily, Blogspot.com.
17. Tipple, A.G. (1991)Self-help transformations of low cost housing: an introductory study, Newcastle upon Tyne, CARDO for H. M. Overseas Development Administration (ODA). (ISBN 1 872811 01 9).
18. UN-Habitat (2011) Cities and Climate Change, Global Report on Human Settlements, Earthscan, UK/USA/Nairobi.
19. Yeang Kenneth (1999) The Green Skyscraper, the Basis for Designing Sustainable Intensive Buildings, Prestel, New York.
20. Zaha Hadid Architects, Galaxy Soho, 2012.