



PREFAB AGENDA

sustainable dwelling design for the 21st century

R. J. MENDEL

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Photo courtesy NASA

intro

the global landscape

We are living in the midst of a paradigm shift. A revolution is underway in the design and construction of dwellings in response to a global crisis. This crisis consists of a complex of issues; depletion of natural resources, increasing demand on energy supplies, population growth, poverty and migration to the world's cities.

Initially labelled 'green building,' it is led by architects, designers and builders exploring and exploiting the use of prefabrication to obtain two advantages; production efficiencies and sustainable values.

leveraging prefabrication

Prefabrication refers to the use of housing parts and systems manufactured in a production facility and trans-

ported to the building site for assembly. Inherent in prefabrication are sustainable values derived from the use of alternative building materials, less material waste in the production process, less impact on the building site and precision fabrication including improved quality control.

On the experimental edge of architectural design, new software providing computer-generated structural analysis promises to produce new ways of designing and design/build options by tapping new materials and new combinations of building systems.

While the public is aware of the global issues at play a review of the trends shaping the global landscape from here forward will help define the tools and approaches needed to address them.

supply/demand nexus

Global Trends 2025 is the fourth installment in the National Intelligence Council-led effort to identify key drivers and developments likely to shape world events a decade or more into the future. It is compiled from input supplied by the U.S. intelligence community, other elements of the U.S. government, members of the academic community, other experts via seminars on six continents and use of the Internet.

The report predicts a multi-polar global power system with the rise of India, China, Russia and Brazil among the leaders, together with an increase in the power of non-state actors such as businesses, tribes, religious groups and even criminal networks. This is accompanied by a major shift in economic

The modular box section translated seamlessly to the style known as modernism with its preference for rectilinear minimalism, industrial materials and extensive use of glass.

section one

prefab modern

Prefabrication has played an important role in home building since the post-World War II era, providing low-cost housing and an evolving set of alternatives to conventional site construction. In 1973 a total of 2.625 million homes were built in the United States and of that number, 1.475 million were prefab, i.e. modular, mobile/manufactured, panelized or kit housing.

As the prefab building industry developed it generally followed two paths in marketing to the public; producing affordable housing with a no-frills approach to design and amenities and imitating traditional, regional architectural styles.

Modular and manufactured housing firms began offering product lines tailored to regional tastes, while the flexibility and speed provided by computer-assisted design (CAD) software allowed them to customize floor plans within their existing product lines or design custom homes from the ground up.

Meanwhile modular housing found greater acceptance among informed home buyers who recognized builders could match any architectural style while offering a high level of structural quality. Gradually architects and designers recognized the advantages prefab offered as software design programs and factory efficiencies combined to offer intriguing creative possibilities.

For one, the modular box section translated seamlessly to the style known as modernism with its preferences for rectilinear minimalism, industrial

materials and extensive use of glass.

As public awareness turned to environmental challenges – elimination of toxic materials, energy efficiency and conservation of natural resources – these issues impacted home building in a significant way. Alternative construction materials and aftermarket products were developed to address the problems of toxicity, indoor air quality and energy conservation.

Over time the concept of sustainable building practices evolved in response to demand for a more responsible use of natural resources. The linkage of modular fabrication with the sustainability movement has produced a synergy attractive to both builder and home buyer. Since homes are typically rectangular, the modular section is a design sub-assembly which can be juxtaposed or stacked to meet design parameters and site conditions.



For architects who favor modern design, the modular section is a natural choice though by no means the only one. Various panel systems offer similar benefits although they require more on-site work. Panels can be shipped flat and erected without the use of cranes, an advantage in some

site locations.

Meanwhile, a range of other prefab building methods such as steel framing of various kinds, aluminum framing, panel systems, concrete forms, kit and hybrid systems have become popular with designers and architects.

Hive Modular, X-Line



Blue Sky Homes

In some cases the interaction between architect and client is simple; just match the lifestyle needs with a preference for architectural design. In the case of the Blue Sky Home prototype a synergy developed between the client/builder, the architect and a framing system

expert whose product had never been used in residential construction before.

When David McAdam and his business partner left careers in top management at a health care company they took a step into the unknown by entering the residential building

business. They called their venture Blue Sky Homes in recognition of the environmental goal they hoped to achieve. Today Blue Sky Homes is offering a proprietary building system that promises better, faster, more economical, sustainable home building.

McAdam explains, “We think the way houses are built in the U.S. often makes no sense. Particularly when it’s wood. Wood construction is prone to errors because wood is not an engineered material and the quality of lumber being harvested is diminishing. Traditional

**We need environmental improvement
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wood construction is very wasteful. We need environmental improvement and we need to consider the lifetime of the home. Our system offers a more ‘perfect’ building, tighter structure, uses less energy and it’s relocatable and reusable – the only thing you can’t reuse is the drywall and the concrete floor.

“Blue Sky Homes was created to speed the evolution of home building. We think homes can be and should be built more efficiently and sustainably.

To meet that goal the Blue Sky Homes Building System allows us to build a high-quality, custom home in about six weeks.”

While working for the health care company in San Francisco McAdam found he missed the Southern California environment where he grew up and the desert in particular. He bought acreage in the high desert and decided to build a home. He knew he didn’t want wood in the desert because the climate accelerates the problems associated with it and he didn’t want to bring in

earth-moving equipment and damage the natural beauty of the site.

McAdam began looking at the way commercial office buildings were constructed using a rigid frame system. A rigid frame consists of horizontal and vertical elements connected in a way that the structure itself resists movement away from its original configuration.

The search brought him to Barret Hilzer, chief operating officer of FCP,

Inc., in Carpinteria, CA. FCP has a 30-year history of supplying mezzanines, metal buildings, industrial canopies, modular offices, support platforms and trade show booths to a large roster of major companies in various fields.

The FCP frame is an independent rigid frame typically built inside a commercial building to create additional floor space. Commercial mezzanine systems are essentially buildings within buildings, often on the scale of a home. The FCP mezzanine system was designed to hold up under the lateral and vertical thrusts caused by earthquakes. Since mezzanines are often built inside an existing building the system was designed with framing members light enough to be carried through a door by hand and to be assembled with hand tools.

FCP’s design is the first moment-resistant, bi-directional rigid frame to be approved by the American Iron and Steel Institute. The structural rigidity of the frame is provided both by the materials and the bolt connections that link beams to columns. The connections consist of eight bolts arrayed according to a proprietary software system so they can withstand the lateral and vertical shocks of a severe earthquake. The only structural components are columns at the corners of the building. This means there is no need for load bearing or shear walls inside or outside the house;



this in turn allows the design of large open interior spaces that can be customized into a variety of floor plans.

McAdam had found the framing system he wanted. The 1,000-square foot Blue Sky Homes prototype would be adaptable to other floor plans because the variables would be at the corners. All the connections would be

the same and superfluous elements would be eliminated.

Further, the flat pack system had other advantages; the most efficient way to load a truck is with as much weight as possible and as little air as possible. Large, open items (such as house sections) don't make for efficient shipping and both remote and urban sites can

pose a serious problem. Bulky prefab sections often cannot get to remote rural locations at the end of dirt roads while many urban infill lots are located on congested or narrow streets where access is difficult.

Large cranes cannot get to some urban sites and power and phone lines may mean a crane cannot be used at



all. When they can be used they are expensive. Housing components and systems that can be stacked flat or nested on a truck are more economical.

The next step was finding an architectural firm that would design a prototype home and a system that could be used for a Blue Sky Homes model line. Lance O'Donnell founded o2

Architecture in Palm Springs in 2006 after three years as a partner with a prior firm, along with project manager Martin Brunner, who had 20 years previous experience in Europe and the U.S. O'Donnell had done work on several steel homes built in Palm Springs in the early 1960's designed by architect Don Wexler. This experience

Photos courtesy Blue Sky Homes.

The Passive House

One of the approaches to sustainability attracting attention among architects and builders is the Passive House concept. Developed in Germany, it is based on the view that using alternative energy sources is not a direct response to the problem of conserving resources. Instead, Passive House design is shaped by the idea that conventional heating and cooling systems are unnecessary, wasteful and damaging to the environment.

The term 'passive house' refers to a design and construction standard that aims to drastically reduce heating requirements in homes so that oversized conventional heating systems are no longer necessary. These homes maintain constant temperatures and do not rely on large amounts of fossil fuels to continually heat and cool and are therefore 'passive.'

The strategy of a Passive House is to reuse so-called 'free heat' to heat the home. Free heat is generated from

electrical and gas appliances such as ovens, refrigerators, computers and light bulbs. To accomplish this goal the building envelope of a Passive House is extremely well insulated and air-tight so that this free heat will not leak from the building.

This process is sustained by a ventilation system that keeps fresh air moving throughout the house but also retains the heat or coolness of that air depending on the season. The system's air-to-air heat exchanger sends the warm air going out next to the cold air coming in, exchanging heat with 90 percent efficiency. Therefore heat given off by appliances, computers – even human beings – is retained

To become a certified passive house, a structure must undergo an extensive test outlined by the Passivehaus Institute in Germany. This test measures air leakage from the building and also uses a formula of kilowatt hours per square foot per year to measure its energy use. The structure must not exceed 1.4 kilowatt hours per square foot per year.

Passive house standards go well

beyond the LEED certification developed by the U.S. Green Building Council which serves as a guideline for environmentally sustainable construction.

Architect Nabih Tahan, a pioneer in promoting Passive House building in California, says that the LEED system's emphasis on alternative energy sources like solar panels doesn't address the root problem: houses that leak air and require new hot or cool air to be pumped into the house to regulate the temperature.

Tahan uses the analogy of fixing a leaky gas tank by ignoring the leak and filling it up with bio-fuel instead of gasoline; the change might make you feel like you're making a difference but your gas tank is still leaking.

While there are fewer than 15 passive structures in this country, according to the Passive House Institute in Urbana, Ill., that figure is expected to increase to 100 by 2010. But these numbers are dwarfed by the more than 15,000 passive houses that have been built in Europe in the two decades since the system first gained prominence.



The Passive House Concept is concerned with creating a more efficient building shell, higher performing windows, thicker walls with more thermal mass... and enhanced heat recovery from exhaust air.

Paravant Arkitektur

Paravant Architektur is a workshop for environmentally sensitive design concepts located in Los Angeles since 2003. Founding partners Christian Kienapfel and Halil Dolan are AIA members, LEED accredited professionals and members of the German Chamber of Architects Architektenkammer Berlin & Baden-Württemberg.

Their goal is to foster sustainability

through the use of the Passive House concept and the integration of prefab building systems including one new to the U.S.

Born in West Berlin and raised in Germany, Kienapfel received his Master of Architecture degree in 1999 from the University of Applied Sciences Fachhochschule Lausitz in Cottbus.

Born in Stuttgart and raised both in Germany and Turkey, Dolan received his



**.Left: Passive House entry.
Opposite: Passive House, winter.
Images courtesy Paravant Architektur.**

Master of Architecture degree in 1999 from the University of Applied Sciences Hochschule für Technik in Stuttgart. In 1999, Kienapfel and Dolan came to the United States as Fulbright Scholars participating in the Master Degree Program at Virginia Tech. They received their Master of Architecture degrees in 2001 and have been registered architects in Germany since 2004.

Both men have been involved in large scale projects in Europe, Asia and the U.S. Through their associations made at Virginia Tech, Kienapfel and Dolan have established a network of architects and designers in four continents which enhances their ability to adapt to local conditions and markets.

A current Paravant project in Virginia focuses on a model home design which is based on the Passive House concept and technology.

Dolan says, “The Passive House Concept which has been developed in Germany is concerned with creating a more efficient building shell, higher performing windows, thicker walls with more thermal mass, high air-tightness building skins and enhanced heat recovery from exhaust air. These measures result in a drastically reduced demand for heating and cooling energy. It is a low-tech process which produces a compact house. It means lower life-cycle costs and the energy efficiency improvement

measurements are economically more reasonable under current conditions. The Passive House can help to reduce the remaining energy demands so that it is possible to meet those demands solely with renewable energy sources.”

Kienapfel and Dolan plan to build the structure using a technically refined prefab building system invented and produced in Germany and imported to the United States.

The HIB System employs wooden components attached by connectors and has been used successfully in hundreds of buildings in Europe. The components are similar to masonry units and are laid out in a certain construction raster. The units are stacked with a numbering system for assembly and connected by metal fasteners like a LEGO system. The components will be pre-cut and assembled in mills throughout the U.S. in order to serve different local markets.

The architects note that the HIB system components don’t require special labor skills – just a short training period. Transport is easy since a single worker can carry an HIB component and the assembly is simple.

Kienapfel says, “Here in the United States everyone is familiar with wood construction. In Germany they would call us crazy so in time we need to expand to the German market. In Germany people are more conservative



and prefer to build with concrete and masonry as they think in terms of building for the next 200 years.”

Dolan says: “Nevertheless there are at least 60 buildings in Europe constructed with the HIB system. One reason for this is the fact that the concept of prefabrication has existed in Europe for a long time and many high-rise buildings are constructed with prefab systems where exact tolerances are required,

such as the Nobel Tower in Paris designed by architect Jean Prouvé.”

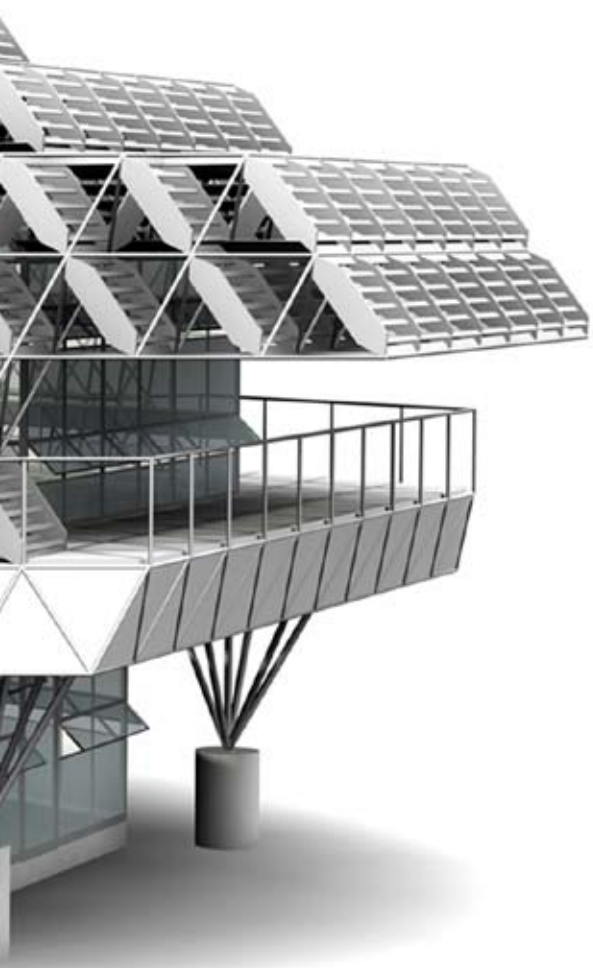
“The Bauhaus movement was the starting point for prefabrication and industrialization in building production,” Kienapfel says. “It began with standardizing elements to save costs and to enable constructing more quickly. It arose in 1923 out of a need for one million buildings. It was a Bauhaus experiment supported by important

figures such as Walter Gropius in order to produce 300 to 400 building units at one time.”

Dolan adds, “Now, in one sense, prefab has become a fashion – which often defeats the purpose of cost efficiency when it is used for a single house. There is a difference between the Passive House concept and passive house technology. This is a low-tech perspective which takes into account



The Pearce Ecohouse, images courtesy Peter Jon Pearce.



What is needed in building design, if there is any chance of creating a sustainable future, are radical solutions - a paradigm shift.

Pearce Design

Looking at the architectural drawings for the Pearce Ecohouse, a first reaction might be that this is a radical statement not suited to the natural environment.

Peter Jon Pearce would disagree, saying it's a sound and informed statement about sustainability; conserving energy, conserving resources, minimizing impact on the earth and above all, learning these lessons from the original source, Nature.

The Pearce Ecohouse embodies a philosophy of efficient building proven over decades of practical experience designing a variety of products and structures. This includes a stint with Charles Eames and, with his own company, structural design for some 80

projects over 35 years, among them the Biosphere 2, the Fremont Street Experience in Las Vegas, Universal City Walk, the Seventh Street Mall in Los Angeles and a two-acre solar array in Saudi Arabia, to name a few.

The rationale for the Pearce Ecohouse originated in a deep examination of form and its relationship to structure.

Pearce says, "The natural structure I've always been interested in is what I call 'first principles.' What are the governing, immutable principles of the universe – if you want to be cosmic about it – as opposed to what are those things that are cultural determinants?"

Pearce delved into biology, the form determinants rooted in natural structures, because he was trying to eliminate the arbitrary in design. This study resulted in his book titled *Structure In Nature Is A Strategy for*



D.A.R.E. design + architecture

In November 2008 Deger Cengiz was awarded the Red Dot Design Award by an international jury of experts for his Versadome modular building system. The Red Dot design jury examines each design concept and assesses it according to criteria such as degree of

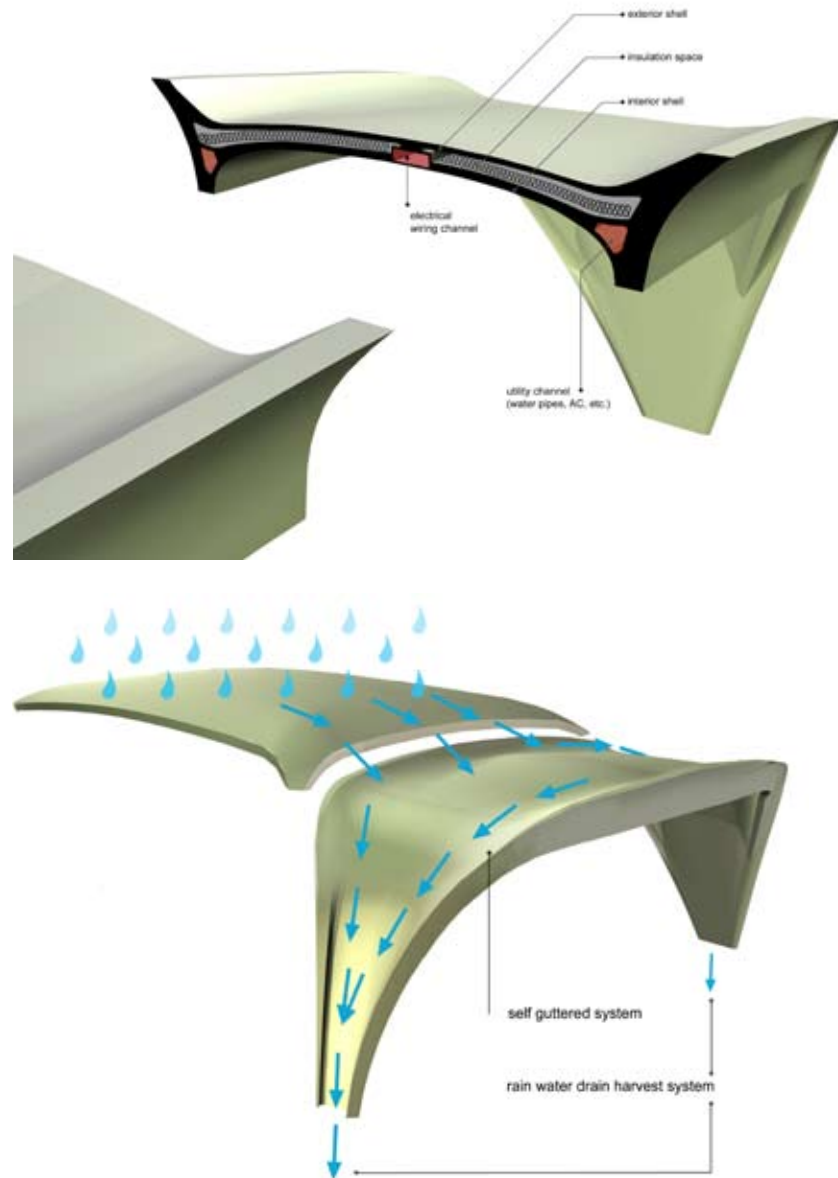
innovation, realization potential, functionality and usefulness, ergonomics and human interface. With more than 10,000 entries in its three categories the Red Dot Award is one of the largest design competitions world-wide.

Architect/designer Deger Cengiz received his degree in architecture from Mimar Sinan University, Istanbul, Turkey. Moving to the United States in 1999, he launched his firm D.A.R.E. design + architecture in 2005.

At that point Cengiz began his research into what the public wanted in dwelling design and what was available in the marketplace. He says, "Prefab structures are usually composed of hundreds of pieces but the end result is not substantially different from traditional buildings. The panels are four by eight, the windows are like those you can buy in Home Depot. They design these buildings but the prefabrication doesn't seem to be modern. They're boring with not much taste."

Growing up in Istanbul, Cengiz was surrounded by imposing examples of Byzantine architecture, notable among them the Hagia Sophia, famous for its massive dome. The Hagia Sophia was the largest cathedral in the world for nearly a thousand years, dating back to the reign of the Emperor Justinian, circa 537 a.d.

The dome is supported by pendentives, which had not been used in large buildings prior to that time. A pendentive is defined as a construction device permitting the placing of a circular dome over a square room or an elliptical dome over a





Images courtesy Kjellgren Kaminsky Architecture.

Kjellgren Kaminsky Architecture

KKA is deeply involved in two critical areas of design build; urban planning and prefab housing design, including the use of the Passive House concept.

Fredrik Kjellgren, architect SAR MSA, received his Master of Fine Arts degree from the School of Design and Crafts in 2006 and took architecture studies at

Chalmers University of Technology from 2000 to 2004.

Joakim Kaminsky, architect SAR MSA, AB received his Master of Architecture degree from Chalmers University of Technology in 2006. This followed working with Wingardhs Architecture, Gothenburg, Sweden on competitions



**Opposite page: park area, Ulricehamn.
Left: elevation for Gothenburg, Sweden.**

and detailed design for a wide range of projects including city plans, apartments, offices and museums in 2005 and 2006.

Partners Kjellgren and Kaminsky founded Kjellgren Kaminsky Architecture in 2007 and quickly won a number of prizes, among them the First prize at SalonGen 35 in 2009, the Green Dot Award in 2008, 1st Prize at Ahus in 2008, Dezeen's Top Ten Houses 2008 and received the Carl Larson Grant in 2007

KKA's manifesto states putting people, needs and context as the primary criteria for their work. Their recent projects shows this isn't an idle claim; awareness of spaces designed to encourage community, recreation and preservation of the urban environment are clearly key to their community planning concepts. Their manifesto states "Every project has its own story. It starts with a demand for change within a context. From this point of de-

parture we narrate the process in collaboration with the client. In the end we aim to create functional and sustainable architecture with a poetic dimension."

KKA is a network-based company. With every project contributions from different fields are integrated, beginning with the two founders complimented by the financial and communications experience of board members Martin Waldstam, chairman and civil engineer, and Philip Ahlqwist, art director.

The network also extends outside the company where KKA collaborates with specialists in the fields of sustainable development, visualization and engineering. This is evident in the development of the Gothenburg Sustainable City project. The project calls for the transformation of Gothenburg into a sustainable city while challenged with population growth. Until 2020 Gothenburg will grow by 8,000 new inhabitants each year. This requires

new housing and a change from previous growth through sprawl. KKA determined that choosing the bridge connecting the two side of Gothenburg as the focus of redevelopment produced the following advantages: if the city grew denser then distances and transports would decrease. The river creates a dividing line through Gothenburg where the city could be densified and connected while heavy shipping traffic now passing through the city center could be redirected to the north.

The development KKA proposed would house one third of the estimated city growth until 2020 and form a strong connection between the river's sides. Roofs could be used for leisure, agriculture and solar power. The roofs are terraced to the south so that people, plants and solar panels will have more sun and apartments will need less heating and lighting. Finally, structures take inspiration from the traditional Gothenburg social and architectural heritage of yellow bricks, streets paved with granite, markets and canals. Among the goals is Gothenburg using half the current amount of energy per



**Above: The Smart Home, based on the mkSolaire.
Opposite: The Breezehouse. Photos by John Swain.**



Michelle Kaufmann Studio

Known as a pioneer in bringing prefab design to a new and wider audience, Michelle Kaufmann is now in the leading rank of architects meeting the need for sustainable community design and construction.

Michelle Kaufmann, AIA, LEED ap, is both an advocate of ecologically aware housing design and an architect who expresses her vision in the modern vernacular. In 2002 Kaufmann founded Michelle Kaufmann Designs, a full service architecture firm specializing in sustainable design. The firm designed

and built single-family and multi-family housing using modular technology.

Kaufmann's mission is to make thoughtful, sustainable design more accessible by mass production economies, thereby making it more affordable. Prior to founding her own firm, Kaufmann was an associate with Frank Gehry Partners. She has been a lecturer and keynote speaker and has taught at Iowa State University and Woodbury University.

Kaufmann homes have been showcased in the National Building Museum,



the Vancouver Art Center, MOCA in Los Angeles and in the Smart Home: Green and Wired exhibit at Chicago's Museum of Science and Industry. Kaufmann was named Advocate of the Year 2009 by the National Association of Home Builders. Among her signature models are the Glidehouse, Sunset® Breeze-

house™, mkLotus and mkSolaire.

As a result of the 2008 financial recession and the contraction of the building industry, Blu Homes, Waltham, MA, acquired the intellectual assets of Kaufmann's mkDesigns. She worked with the company on applying the MKD designs to Blu Homes' fold-out modular

technology.

Kaufmann notes, "One of the issues is that Blu Homes uses a different technology than the standard modular sections than those designs were meant to employ. So there will be some revising of the designs. The Blu Homes technology is an unfolding

Opposite: 52nd Street Row Homes, Aria Denver. Image courtesy MKS.

modular which allows shipping with less width. I always think you should design to the efficiencies of the building system so that you're doing something with that technology."

Kaufmann also recently joined the Advisory Board for Architecture for Humanity and is looking forward to working to help with rebuilding in Haiti. Meanwhile, she has launched Michelle Kaufmann Studio, which will focus on custom, net-zero energy homes, sustainable communities and eco-resorts.

She says, "The current technology now is so fascinating that I ask 'Why isn't everyone doing this?' Some architects say it's fantastic, it's the golden egg but some see it as selling out and minimizing their own work. I went into this business as more of a passion. It started when my husband and I were looking for a house and we couldn't find anything green and affordable and it was really painful. So I started the business and it grew fast, maybe too fast, from one person to 60 in two years. But we were on a mission to build a thoughtful, healthy, sustainable design that was accessible to people."

Kaufmann is currently working on one project in Colorado with a total of 106 homes planned, which mixes affordable and market rate housing exploiting the

In the design phase I started to think 'What is a sustainable community? How would we think about the spaces between the buildings? How can we encourage the residents to help one another and live in a more communal way?'

use of modular technology.

The Denver community project is called ariaDenver and involves the redevelopment of a 25-acre campus in northwest Denver by the groups Urban Ventures and Perry Rose, designed by Kaufmann and Oz Architecture and the site planning firm of Calthorpe Associates.

Promotional literature describes the project as follows: 'Aria Denver will provide a replicable model of environmentally, socially and economically responsible community development—one that creates a diverse, tight-knit community with a sense of place and that increases residents' health and the health of our environment. The development embraces the legacy of community improvement and environmental stewardship supported by the land's previous owners, the Sisters of St. Francis.'

Beyond an extensive list of 'smart and green' features, ariaDenver will incorporate sustainable materials and methods to minimize energy and water usage as well as create a healthy environment, based on Kaufmann's

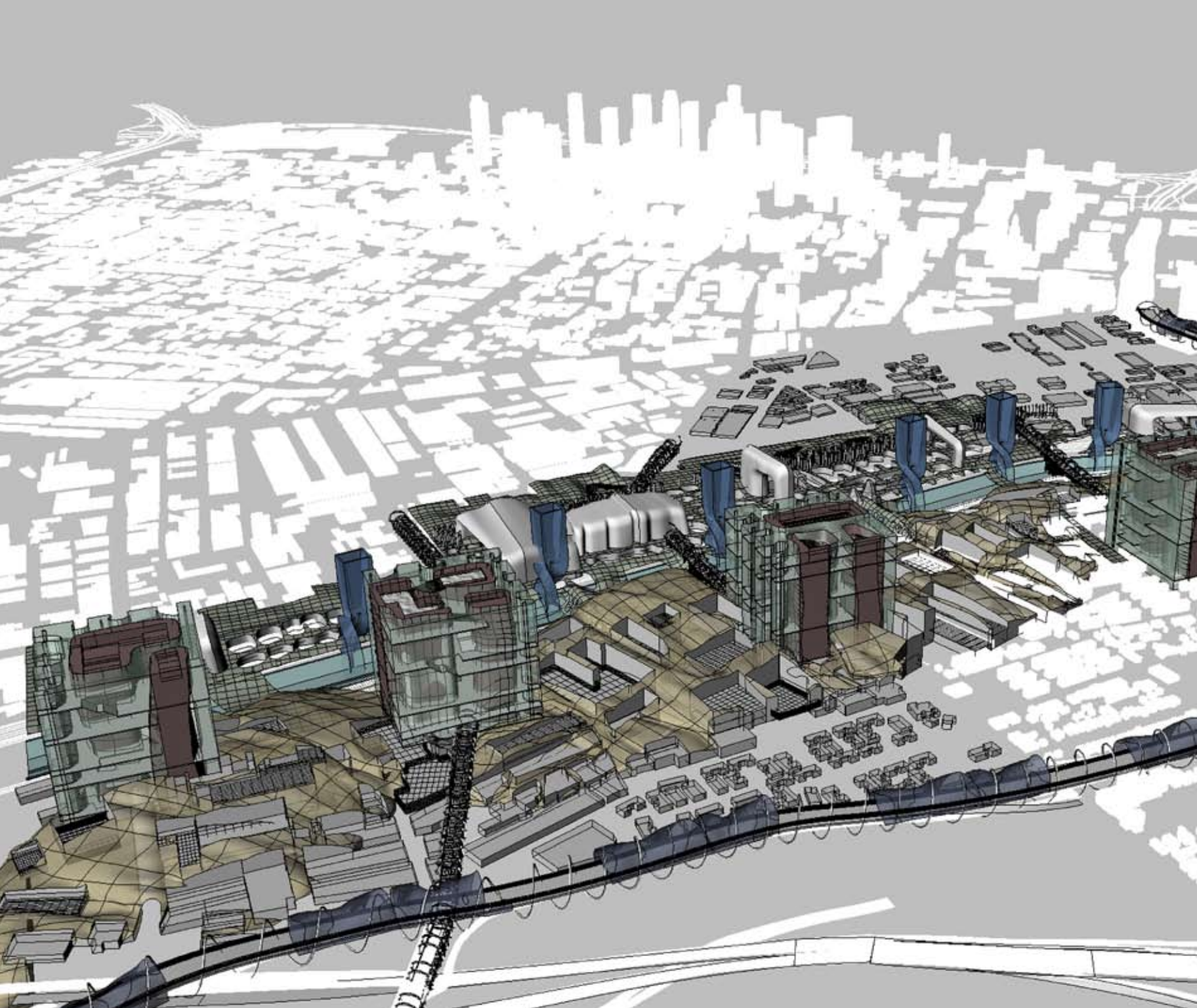
'Five Eco-principles.'. This reduces each home's environmental footprint, while adding financial benefits in energy and water savings for the homeowners.

The ariaDenver project doesn't separate market rate homes and the affordable homes. Both have sustainable criteria and the houses look the same but some materials and features will be different in the two versions.

Kaufman says, "The construction part is fascinating. Working in the factory with multiples is where the modular approach comes to life and the efficiencies sing. In the design phase I started to think, 'What is a sustainable community?' How would we think about the spaces between the buildings? How can we encourage the residents to help one another and live in a more communal way?"

"One answer would be green roof scapes where the residents could grow their own food. Since we're doing solar, how could we encourage more proactive health care, organic cooking, a different health care model?"

In the ariaDenver project there will be





The freeways, tracks, power grids and concrete rivers originally designed to connect a horizontal city often deliver the opposite: the piecemeal city with infrastructure as a consistent obstacle to the integration of the disparate civic parts.

Eric Owen Moss Architects

Eric Owen Moss opened his office in 1973 in Los Angeles, now composed of 25 professionals who strive to create powerful and clear design solutions individual to each project. EOMA has designed and completed a variety of project types involving both new construction and renovation and reconstitution of existing structures. This work has included university facilities, office buildings, corporate headquarters, cultural institutions, theaters, galleries and exhibition spaces, restaurants, large scale urban projects and public space, housing and private residences.

Looking into the future, Moss envisions a remodeled urban landscape for the City of Los Angeles – an appropriate choice since LA is expected to become a megacity by the year 2015. With its invisible boundaries to adjoining communities it appears to be and functions as one now.

In a document called *Los Angeles, The City of the Future, The Future of the City*, Moss describes the LA built environment and what he would do about it, as follows:

“The primary organizational components that define contemporary Los Angeles are enormous