works/sectors issue
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Prefab: Myth or Reality?

In Search of Modernism's Holy Grail

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Walter Gropius and the (Not So) Infinite Possibilities of Prefabrication

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arcCA 07.4

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Inquiries and submissions: Tim Culvahouse, Editor: tim@culvahouse.net; c/o AIACC, 1303 J Street, Suite 200, Sacramento, CA 95814; 916.448.9082; fax 916.442.5346. Bob Aufuldish, Aufuldish & Warinner: bob@aufwar.com.

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Comment

I had lunch recently with a gifted young [architect] who was once a student of mine. I put "architect" in brackets, because she is not quite one: she hadn't heard the results of her California Supplemental Exam. But she was eager to tell me about the experience, the way you tell people about the car wreck you were in, over and over and over, struggling to purge the feelings of shame and terror.

Her account accorded almost exactly with my own Examination Day, although I flatter myself that mine was even more horrific. In the first place, it was at a hotel in Irvine, which added a super-supplemental test: finding the hotel among an undifferentiated landscape of glass boxes, some of which were offices, one of which was the city hall, and one of which was presumably my destination.

I did eventually find the hotel, and in plenty of time to enjoy the "architecture" of its lobby. I know it would be unrealistic to ask the Architects Board to schedule the exams in the DeYoung Museum or the Disney Concert Hall, but this was like taking your medical exams in a morgue.

And then, when I got to the room and sat down across the folding table from the three examiners (or was it four? All I remember was noticing that the number of questions was one too many for each to ask an equal number, an asymmetry that troubled me more than it should have)—when I sat down opposite them, I saw directly behind the examiners a mirror, which allowed me to watch my own disintegration.

And it was my birthday.

I left there more certain than I had ever been of failure, which, blessedly, turned out not the case. My young friend also was absolutely certain she had failed, and for the same reason, the hallmark of the proceedings: "Let me repeat the question." You think you've answered the question, and the examiner says, "Let me repeat the question." Then, "Let me repeat the question." And, "Let me repeat the question." Water-boarding shmater-boarding, *this* is torture. You know they've concluded you've done something wrong, but you have no idea what. I'd rather face Detective Sipowicz in a bad mood.

And what is the point? What was once a wide-ranging discussion among peers has been progressively circumscribed, to the point that it is just another segment of the ARE, read aloud. It could be computer-administered, and if it cannot be machine-graded (which I bet it can, but I'm no expert), it would still take fewer people to grade than it now takes to haze the incoming generation.

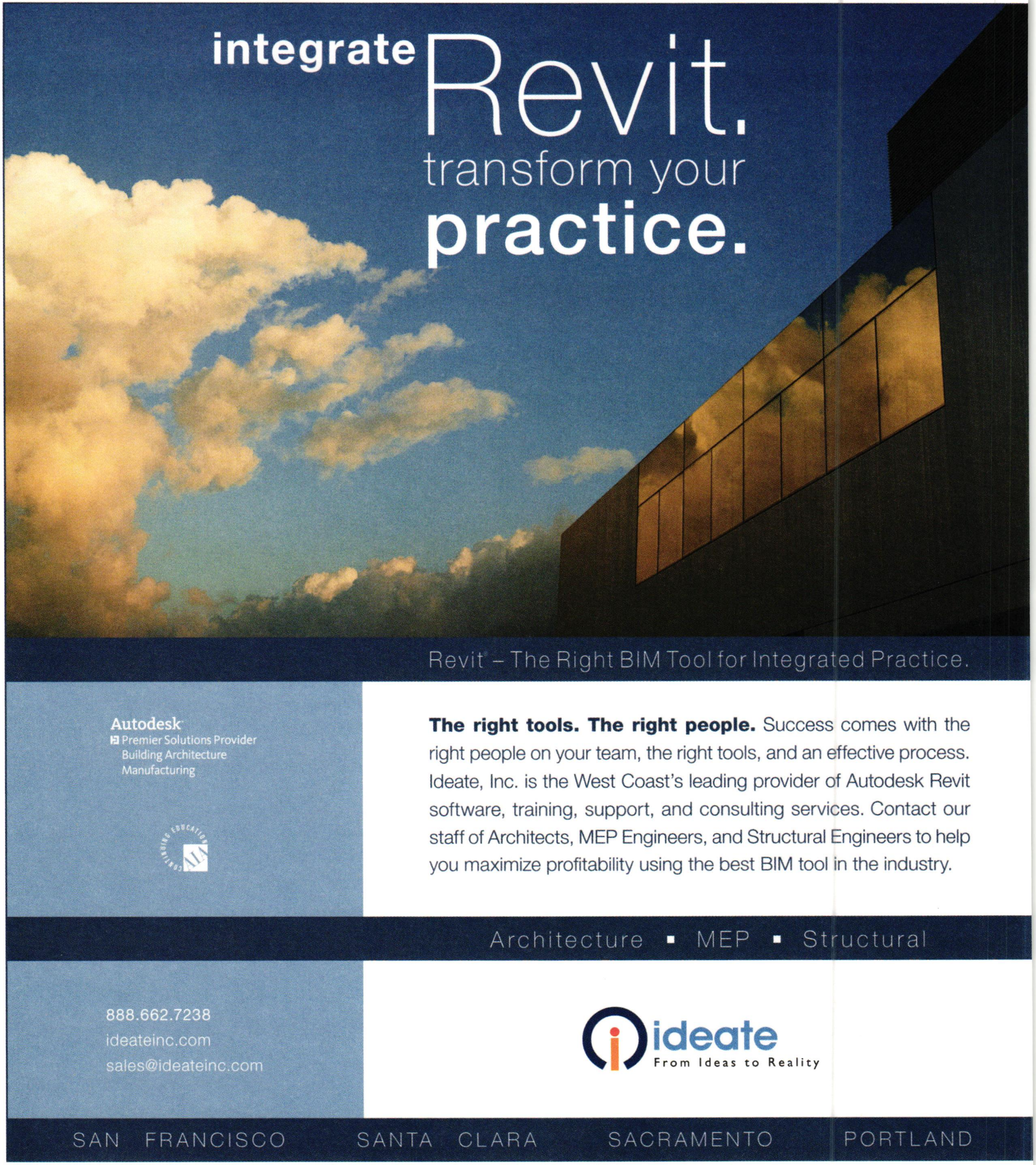
What can the Supplemental Exam judge that a computer-administered test can't? Well, it can judge whether you clean up nice, it can judge your hue, it can judge your gender. It can judge whether you sound intelligent (I, for example, am a hillbilly, and I sound kind of stupid—but I'll sneak up on you). It can judge how well you handle pressure, which is perhaps relevant to architectural practice but is hardly a criterion for licensure.

In other words, it's a lawsuit waiting to happen, and it should be discontinued. Architecture school is hellish enough. We don't need a belt line, too.

Tim Culvahouse, FAIA, editor
tim@culvahouse.net

I want to welcome two Los Angelenos to the **arcCA** editorial board, Annie Chu, AIA, of Chu + Gooding Architects, and Stephen Slaughter, AIA, of RNL Design. Their names should have been in the editorial board roster in the last issue of **arcCA**, but, well, I forgot. It's great to have them with us.

We also neglected in the previous issue to note a correction: in the article "GSA: The Modern Medici?" in issue 07.1, we failed to credit Langdon Wilson, the associate architect for the Sandra Day O'Connor U.S. Courthouse in Phoenix and the Lloyd D. George U.S. Courthouse and Federal Building in Las Vegas.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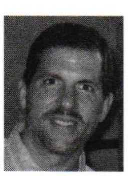
Contributors

Professor **Richard Bender** was dean of U. C. Berkeley's College of Environmental Design, where he continues to direct theses and research in Urban Design and Technology. As a consulting architect and planner, he is working on major projects in Japan, Europe , and the Bay Area. He may be reached at bender@berkeley.edu.

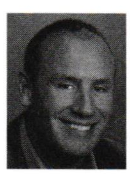
Nicholas de Monchaux focuses his design practice and research on the intersection between organizational thinking and the built environment. He is the author of the forthcoming *Spacesuit: 21 Essays on Technology, Complexity, and Design* (Princeton Architectural Press). He has worked as a designer for Michael Hopkins & Partners in London and Diller + Scofidio in New York. From 2001-2006 he taught at the University of Virginia. He is now an Assistant Professor at U.C. Berkeley.



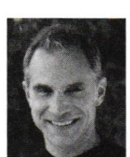
Steven I. Doctors is principal of The CM+ Group, LLC, a project management and consulting practice serving the San Francisco Bay Area. He is an adjunct professor in the Architecture and Community Design program at the University of San Francisco and a Ph.D. candidate in architecture at the University of California, Berkeley. He may be reached at sdoctors@thecmpgrp.com.

Larry Dodge, architect and urban designer, attempted, with little success, to apply systems principles he was exposed to through working for Ezra Ehrenkrantz in the 1960s to city planning and urban design projects in sixteen countries over the past thirty years. He may be reached at lfdodge1@yahoo.com.

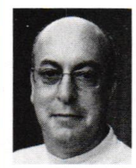
Dr. Dora Epstein Jones is the program coordinator of Cultural Studies at SCI-Arc and collaborator with Jones, Partners: Architecture in Redondo Beach. She believes firmly in the strength of the architectural discipline.



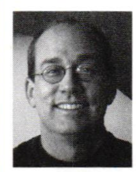
Brian Linder, AIA is an Architecture Broker with tvoa.net and Keller Williams Realty, Beverly Hills, where he has built his reputation as curator of numerous transactions involving architecturally significant properties. He is a licensed architect, general contractor, and real estate broker, and his business background includes work as a management consultant for Big Four accounting and Fortune 50 companies. He is a frequent guest speaker at the American Institute of Architects, Society of Architectural Historians, Appraisal Institute, and other forums for architectural discourse. He may be reached at blinder@tvoa.net.



Marc L'Italien, AIA, is a design principal with EHDD Architecture in San Francisco. He is a designer of high performance human, animal, and exhibit environments. He has partnered with clients to create structures at universities, zoos, and aquaria throughout the U.S. that express their vision while being perfectly suited to place and climate. He may be reached at marc.litalien@ehdd.com.

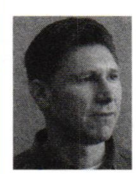


David Meckel, FAIA, is Director of Research & Planning for the California College of the Arts (CCA) in San Francisco. He may be reached at dmeckel@cca.edu.



Eric Naslund, FAIA, is a principal at Studio E Architects in San Diego and a member of the San Diego Planning Commission. He currently serves on the editorial board of **arcCA**. He may be reached at eric@studioearchitects.com.

Lori Reed is Director of Marketing and Communications for the AIA California Council.



David Thurman, AIA, LEED AP is an Associate Partner at Zimmer Gunsul Frasca Architects LLP in Los Angeles.

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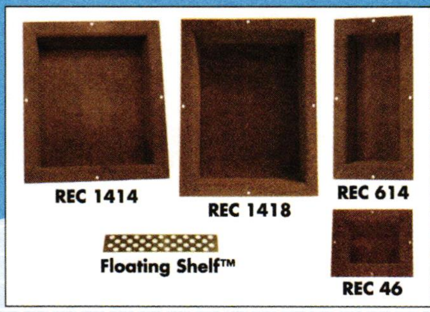

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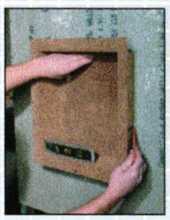

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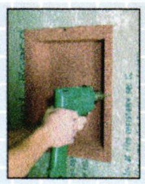

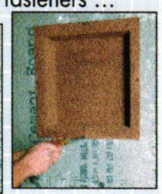

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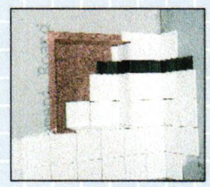

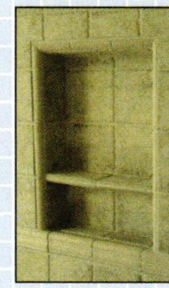

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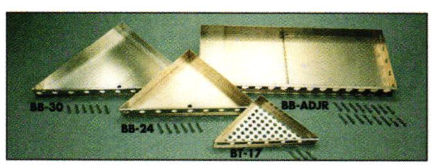

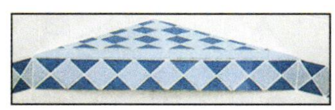

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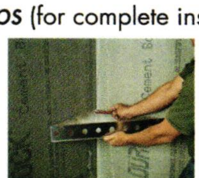

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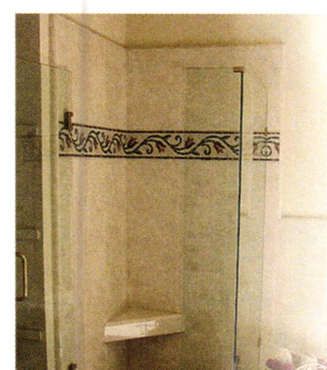

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Prefabrication: Scales of Application

Steven I. Doctors

From fasteners to fantasy cities, prefabrication has long nurtured both the practical and the theoretical. Some notions about prefabrication readily enter the construction lexicon; others remain forever cast as brilliant yet unrealizable dreams. What they share is resistance to a fragmented design and construction industry characterized by ossified disciplinary and classificatory lines. As with other project delivery methodologies, such as design-build and integrated services, prefabrication seeks to blur or erase such lines by re-asserting the fundamentally collaborative nature of architectural production. In doing so, it tackles a host of socio-economic, environmental, and aesthetic objectives at multiple scales of application.

By its narrowest definition, prefabrication privileges shop over field labor. From this perspective, almost any factory-produced material, component, or system intended to reduce or improve upon field labor may be seen as prefabricated. The lowly nail, cut on-site by craftsmen from iron bars until nail cutting machines made this labor-intensive technique obsolete in the 19th century, is but one example.

Similarly, pre-cast concrete wall, stair, and structural components offer efficiencies often exceeding that of traditional in-situ construction methodologies, most notably in high-rise construction, where restricted site access and strong economic pressures drive ever-increasing reliance on off-site fabrication and quality control. Indianapolis-based National Precast Concrete Association, for instance, sponsors a factory certification program in which both the final manufactured product and its constituent materials undergo regular inspections. Indeed, from awnings to z-moldings, the term "prefabricated" has emerged as a market-savvy term evoking cost, time, and quality benefits for a host of building products.

By its broader definition, however—and this is where the blurring of disciplinary and trade boundaries comes into play—prefabrication entails the assemblage of interdependent materials and components in a controlled production environment as an alternative to traditional on-site

opposite: Ron Herron/Archigram, exhibition poster, Institute for Architecture and Urban Studies, 1978, collection of Tim Culvahouse.

construction by a collection of unaffiliated, specialized trades. The pre-hung door assembly, ubiquitous in residential and commercial construction, is a simple example. A door selected by the architect or builder is mortised in the factory, mounted with a specified hardware package into a wood or metal frame, and delivered to the jobsite for quick installation into an interior or exterior wall.

The complexity increases somewhat with larger multiple-component assemblies, such as prefabricated walls, a building strategy employed since before the American Civil War, when modular wall panels were available to frontier-bound pioneers who chose not to rely on the availability of local raw materials. In today's construction market, prefabricated walls—categorized loosely as open sheathed panels, structural sandwich panels, and unsheathed structural panels—are widely available, complete with framing members, glazing units, door assemblies, insulation, weather barrier, and exterior finish.

Beyond this generic assemblage, prefabricated walls may be fitted with mechanical, plumbing, and electrical components or, as in the 1950s Case Study House by Rafael Soriano, storage units incorporated into factory-built interior partitions. Manufacturers of prefabricated wall assemblies today employ a variety of promotional arguments, but the common narrative is that factory-built wall assemblies minimize the impact of inclement weather on construction schedules, facilitate continuous and consistent quality control, reduce costly and space-consuming on-site storage requirements, and simplify onsite management of multiple trades.

Factory-built wall assemblies lead inevitably, of course, to discussion of prefabricated buildings. As early as the 1820s, British settlers toted portable modular cottages on their journey to inhabit Western Australia. In the modernist era, the distilling of a house to a set of standardized, reproducible, and adaptable components to facilitate rapid and cost-efficient field assembly has a long history of experimentation. In the 1940s, Walter Gropius and Konrad Wachsmann pursued such a dream with their General Panel System kit of parts (see Dora Jones's article in this issue of *arcCA*), and the 1950s post-war housing demand fueled wide-ranging research and development activity on prefabricated homes.

Terminology in the contemporary prefabrication industry is a bit fluid, but the discussion tends to revolve around four general classifications of "factory-built" structures. Pre-cut buildings, the first classification, are assembled in the field from a factory-supplied kit of parts—Lindahl Cedar Homes is a well-known example—containing all necessary construction materials and components. Panelized buildings, by contrast, rely more heavily on prefabricated floor, wall, and mechanical assemblies in an effort to reduce the field labor required for construction. The iconic Dymaxion House (1927-28) by Buckminster Fuller, with its central mast housing a prefabricated service core and a kit of parts, might today be viewed as a hybrid of these first two classifications. The reliance on factory labor is further extended with modular buildings, the third classification, comprised of two or more prefabricated modules delivered to the site for assembly on a site-built foundation, and to its ultimate iteration with manufactured buildings, which are pre-assembled in their entirety before delivery to a site. While the attributes of each classification vary, the most frequently cited advantages over traditional field labor-oriented construction are continuous quality control, reduced weather delays and material damage, assemblers working for the same business entity, and, in the case of mass-produced homes, cost efficiencies gained through the volume purchase of building materials.

It has become increasingly evident that prefabrication—long an object of derision by architects for its seemingly obsessive attention to stripped-down standardization and a presumed absence of stylistic sensibility—is no longer a building strategy limited to the mass production residential market. A case in point is a recent exhibit curated by Andrew Blauvelt for the Walker Art Center in Minneapolis with support from *Dwell* magazine and furniture retailer Design Within Reach. Entitled "Some Assembly Required: Contemporary Prefabricated Houses," the motivation behind the exhibit was to draw attention to recent technological advancements in prefabrication and to promote its future potentialities. The exhibited projects—ranging from a ten-module Desert House prototype (2005) by Marmol Radziner + Associates to the one-room weeHouse in Wisconsin (2003) by Alchemy Architects offered on a turn-key basis with all but appliances and mechanical equipment—demonstrate an array of approaches to prefab experimentation and a vibrant interest in mainstreaming its technologies within the architectural community.

Further evidence of architectural interest in prefabrication is the recent announce-

left: Butler Storage Building, Clay Spur Bentonite Plant & Camp, Weston County, Wyoming, 1940s[?], courtesy of Library of Congress; middle: Buckminster Fuller, Dymaxion House; right: Quonset Hut Type 1, Barbers Point Naval Air Station, Honolulu County, Hawaii, 1940s, courtesy of Library of Congress.

ment of a 2007 AIA Education Award to the ecoMOD project at the University of Virginia—directed by architecture professor John Quale and engineering professor Paxton Marshall—with the stated objective of generating ecologically-sensitive, prefabricated prototypes for the affordable housing market.

Prefabricated buildings have long served other market sectors as well. Fully-functional data centers housed in standard transportable containers facilitate expansion of existing technology infrastructures without the time-consuming design and construction process customarily associated with building expansion or renovation. These mobile data centers include on-board technology configured to a user's requirements and the HVAC and UPS support systems critical to sustaining proper environmental conditions. While there is some argument in the technology industry as to whether such prefabricated data centers are viable as a long-term solution, it is clear that they can serve as part of a comprehensive disaster recovery effort when a primary technology facility is non-operational.

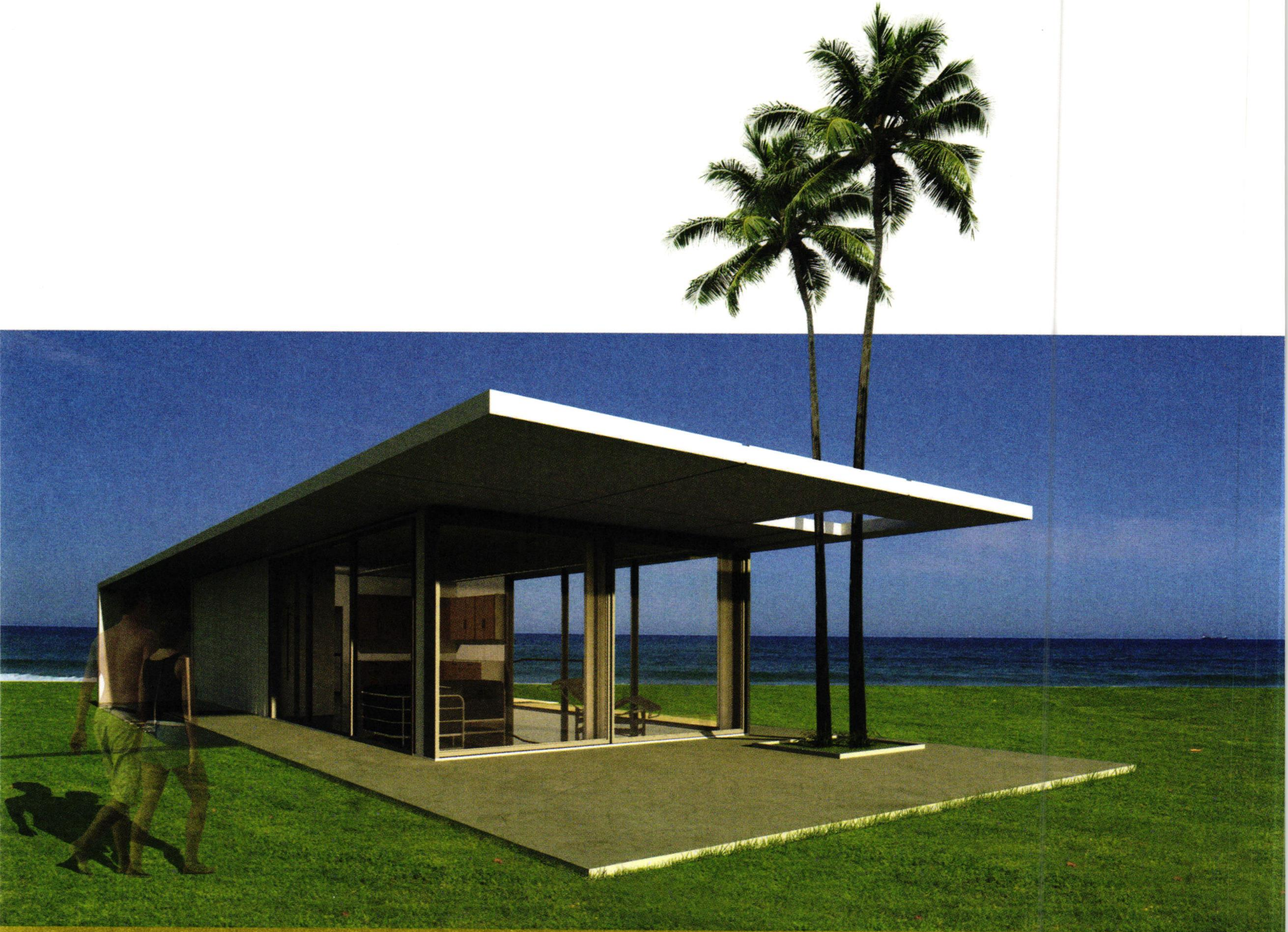
Similarly, prefabricated central operating plants complete with mechanical, electrical, and plumbing components are touted as alternatives to time-consuming central plant construction. Prefabricated steel buildings—think Butler Buildings—have, since early in the twentieth-century, served a broad range of building typologies for agricultural, industrial, commercial, retail and military use.

Prefabrication is also a common methodology in bridge construction for both pedestrian and vehicular use. For limited spans, bridges may be factory-assembled in their entirety. For longer spans, it is common for a bridge to be assembled on-site from fully prefabricated steel modules or from pre-cast concrete columns, bent and pier caps, decks, and other substructure and superstructure components. The Federal Highway Administration suggests that prefabricated bridge components minimize impacts on vehicular circulation due to shorter construction periods, reduce construction zone safety issues, and lessen the impact of construction on the surrounding environment.

If buildings and bridges can be prefabricated, why not an entire city? One can argue that prefabrication has pervaded much twentieth-century thinking about the city. Amidst a deepening conviction in architecture as a transformative tool, early modernists idealized the Functional City as a rationalized, systematized, and mechanized organism constructed anew to replace its chaotic pre-industrial predecessor. This *tabula rasa* strategy may be seen in the fantastical 1914 *Città Nuova* of Italian Futurist Antonio Sant'Elia, again in the 1925 Voisin Plan by Le Corbusier for a new city within a city, and subsequently manifested most notably in Brasilia at mid-century. In the 1960s, the Walking City and Plug-in City depicted by Archigram similarly suggested abandonment of the existing urban fabric in favor of a prefabricated habitable infrastructure that, through its modularity and mobility, would respond swiftly to evolving societal needs. These were mere idealizations, but they tantalizingly envisioned solutions to the human condition through a paradigm of prefabrication.

Mobility and modularity remain key attributes in contemporary discourse about prefabrication and societal objectives, but the scale tends toward either the more realizable—affordable housing assembled from sustainable prefabricated modules—or the more ephemeral—interim solutions such as the problematic FEMA 'cities' deployed in the wake of Hurricane Katrina. Even accommodations for the next generation of explorers, the International Space Station—started in 1998 with a prefabricated Russian control module and recently expanded with an Italian-made bus-sized 'room'—evidences attention to mobility and modularity for an inhabitable infrastructure at a smaller scale of application than that of the unrealized Archigram cities.

While this may seem to suggest an outer limit to the scale of application for prefabrication, its potentialities are indeed limitless. Prefabrication, as we have seen, is more than a building strategy or project delivery methodology. It is a paradigm of design and construction, one that accentuates and capitalizes on the fundamentally collaborative character of architectural production. With such a view, there are no limits to the scale of application. ◉



The Myths and Realities of Prefab

Brian Linder, AIA

It seems everyone is talking about prefab homes these days—from *Dwell* to *Time*, on television and radio. On the Internet, entire websites are devoted to it. But what exactly is prefab? Does it really exist?

In general, prefab refers to buildings that have some portion constructed or assembled in a factory, and a corresponding portion constructed or assembled on site. The spectrum includes everything from mobile homes, manufactured entirely in a factory and simply driven to the site and set down on minimal foundations, to custom stick-built homes with very few factory-built components and a lot of on-site labor. In between we find everything else, from modular (room-size units manufactured in a factory and stacked on site) to panelized (pre-engineered wall, roof, and floor sections produced in the factory and connected together on site), steel frame (the ubiquitous barn-style Butler Building) to tilt-up concrete, and even projects constructed from recycled shipping containers. Simply stated, prefab is any method of construction with some degree of fabrication happening in advance in a factory.

In the popular press, however, a lot of attention is being focused on the modern architectural prefab, which is often presented as an alternative to conventional housing, a solution to the low affordability index. In Los Angeles, for example, the least affordable metropolitan area in the country according to CNN *Money*, only 1.9% of homes sold are within the reach of families earning the median income for the area. As a result of often misleading advertising and journalism, many first-time home buyers are led to believe they can purchase an inexpensive vacant lot (itself a financial misconception), go online and order a prefab home and get it delivered to the lot in short order and at substantial savings—as though it were truly a manufactured product. At present, anyway, this is simply not the case.

opposite: Aegean 640, available from Logical Homes.

In California, and particularly in metropolitan areas with sophisticated city building departments, it is still necessary to hire an architect or engineer to design a custom foundation system

LivingHomes WIRED House, designed by Ray Kappe, FAIA, photo by LivingHomes/Tom Bonner..

suited to the site, and construction documents must be prepared and submitted for permitting. While state permitting of the factory-built components may speed the process, it can still take months and even years to obtain local entitlements for the site-built work. In addition, a local general contractor is usually required to construct the foundation and assemble the factory-built components. Furthermore, prefabricated components (like structural steel) and finishes (like concrete floors, European cabinetry, kitchens, and bathrooms) are not inexpensive. Sometimes it can be just as time-consuming and expensive to build a prefab home as a custom stick-built house.

In California, there are dozens of architects, designers, builders, and manufacturers jumping on the bandwagon and working on some form of modern prefabricated home. Most modern projects are still in development, with very little built work to show for the all the hoopla—fewer than twenty-five completed projects in the state over the last four or five years. Of those working in Southern California, LivingHomes, Marmol Radziner Prefab, Office of Mobile Design, Empyrean, and LogicalHomes appear to be furthest along in the process.

LivingHomes has delivered its second project, the *WIRED* home, in a remarkable six months, from ground breaking to punch list. A marketing and branding masterpiece, this project was designed by Ray Kappe, FAIA, is expected to be LEED certified as of publication, and was sponsored by the magazine and various manufacturers. But it's a $4.3 million spec house: that's about $1,000 a square foot including land! Of course, the media loves it, and it's been featured everywhere from the Yahoo! homepage and any number of blogs to traditional outlets like the *Los Angeles Times*. For my money, I'd rather start from scratch and get a fully-custom Ray Kappe instead of the discount model, where the architecture really feels constrained by the module. In addition, none of the potential benefits of the process (rapid delivery, economies of scale, cost efficiencies) are yet being passed down to the consumer, and the quality in my opinion doesn't match that of custom construction.

Interestingly, the modular company responsible for manufacturing and constructing the *WIRED* house claims to be losing money on the LivingHomes project as well. Modtech Holdings, a publicly traded company with over $200 million in annual revenue, is the leading designer and manufacturer of permanent and relocatable modular prefabricated buildings in the United States. They are also the partner of choice for developers, architects, and designers who want to get in on the prefab action without making a substantial capital investment. Other Modtech customers have included Michelle Kaufmann Designs in Oakland and Marmol Radziner and Associates in Santa Monica.

After completing their Desert House prototype with Modtech in 2005, Marmol Radziner Prefab opened their own Los Angeles manufacturing facility, which also houses their cabinet, metal, and window shops. At around $400 a square foot, however, the finished product is positioned more as the Armani Exchange non-couture version of the fine bespoke architecture which has made the firm famous—less expensive than full custom but not a low-cost housing alternative. That being said, Marmol Radziner is most attentive to detail and finish, delivering an exceptionally high quality home complete with their own line of furniture.

Similarly, working with a competitive modular manufacturer, architect Jennifer Siegal and the Office of Mobile Design offer a higher-end product at reduced prices. With several models complete and more under construction, OMD champions "mass customization," celebrating individual choice and providing a wide range of options and configurations

Marmol Radziner Prefab, Desert House, photo by Benny Chan/Fotoworks.

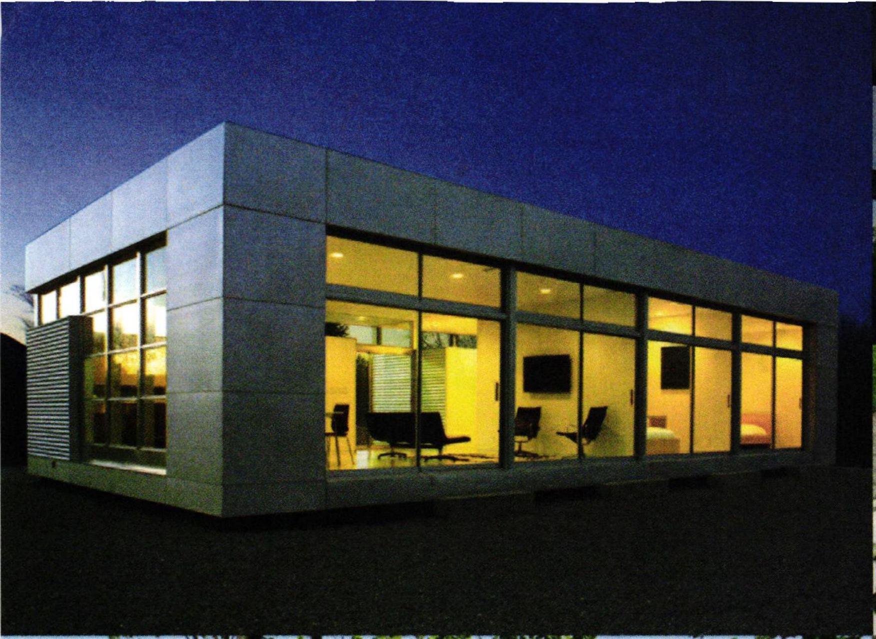
in their prefabricated homes. They typically cost about 15% less than conventional building, take less than half the construction time, and employ more sustainable building methods. OMD's prototypical Portable House is now on the market for $200,000, a 750 square foot mobile home dressed up with European kitchen, bamboo floors, Polygal windows, and corrugated steel siding. Again, however, at a cost of around $300 a square foot, these homes aren't for first-time homebuyers looking to improve their chances of owning a less expensive home.

On another front, Empyrean International is banking on its fifty-year history designing and manufacturing over 20,000 homes, now licensing the *Dwell* magazine name to market a line of modern homes designed by several award-winning architects. While the firm has a long history installing more traditional designs on the East coast and does have several *Dwell* Homes completed around the country, the company's track record in Los Angeles is more mythical than real. For months, Empyrean has been running full-page ads in *Dwell* featuring an attractive couple and their charming triplets, exclaiming their belief in prefab and recommending the experience to anyone. Oddly, the couple is standing on a vacant patch of ground with no house in sight, and when I contacted the manufacturer for an update I was told the project is not going forward.

Two additional *Dwell* Homes by Empyrean have stalled out in the planning phase and are now on the market in Los Angeles. The Silver Lake Twins were conceived as low-cost alternatives for two brothers, but the realities of hillside construction, zoning variances, and neighbor approval have proven more daunting and costly than anticipated. For $350,000 each, a buyer can purchase the land with partial plans and pick up where the brothers left off—facing an uphill battle (literally) and foundation costs alone expected in the $400,000 range. All in, the $900,000 projected cost of construction just didn't make sense to the sellers on top of the cost of the land.

Of all the potential candidates and likely suspects, one Southern California firm stands out for its desire to actually deliver on prefab's promise of low-cost housing for the masses. LogicalHomes is a joint venture between architect Peter DeMaria and Michael Sylvester of fabprefab.com (itself an excellent resource for information about the field of prefab players). The company was born out of social conscience and a commitment to providing a predictable process at an affordable cost: the goal is $175 a square foot or less. The method of construction involves the adaptive re-use of cargo containers, cutting into them and cleverly joining and stacking them as needed into permanent, welded constructs on site.

Despite the fantasy/reality disconnect between the promise of prefab as presented in the popular press and the economic and practical realities of designing, permitting, and building prefabricated homes in the real world, there may be some light at the end of the tunnel. The good news is that prefab as an industry is gathering momentum, with more research being done and more projects being completed every year. At some point it may be that the industry will catch up with all the promotion, and that larger numbers of units will lead to manufacturing efficiencies and economies of scale on the construction site, ultimately bringing the total cost down to a level affordable to the average family. In the meantime, however, prefab is not a housing solution—it's just a method of construction.

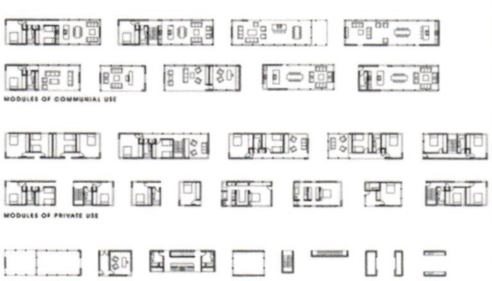



KENNEDY

In Search of Modernism's Holy Grail

David Thurman, AIA

Prefabricated homes have been popular among nearly every generation since early modernists began to look at industry as inspiration. Most prototypical prefabs have been "one-offs," too impractical for mass production, yet the prefab home has remained a resilient symbol, conveying a core modernist hope that industrial technology might reconstitute everyday life in the most personal ways. Despite its rocky history, many architects see the prefab home as a modernist rite of passage. Today, with a steadfast group of architects offering a wide range of designs, we are perhaps enjoying prefab's most compelling moment in the last hundred years. A survey of three firms who have completed at least a dozen homes each provides a closer look.

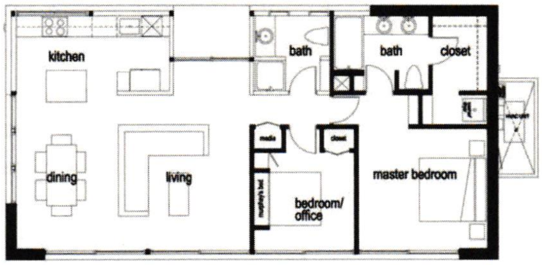


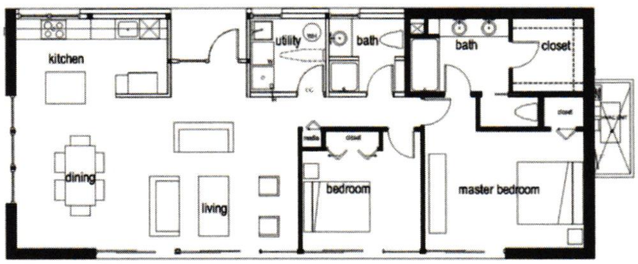
above: Resolution: 4 Architecture, modules of use; opposite, top to bottom: Rocio Romero's LV, photos by Richard Sprengler; Resolution: 4 Architecture's Harmony Hill, photos courtesy Resolution: 4; mkd's Glidehouse, photos by John Swain Photography.

Rocio Romero Homes

To many, a kit-of-parts is the embodiment of prefab; among our group, the sleek and simple work of Rocio Romero comes closest to this hope. With 18 houses completed and 20 more in production, Romero's Perryville, Missouri, firm is a leader in completed projects. Affordable, disarmingly simple, strikingly modern, and visually light as air, the metal-clad base model of the LV series (1,190 square foot, two-bedroom, two-bath) costs $35,923. Total cost, after site work, shipping, and contractor assembly can range from $100 to $120 per square foot in the Midwest and $120 to $195 per square foot in California and other high labor-cost areas.

The LV home is endearing in the best sense; it is the classic Volkswagen of the prefab field. Its delicacy is reminiscent of the work of Prouvé or Frey. In practical terms, it is emblematic of two themes critical for success: disciplined adherence to a system and flexible response to sites, needs, and preferences. Although color and material options exist, the basic design is loyal to strict dimensional parameters and a predictable, pre-engineered structure, allowing extraordinarily quick, thirty-day production. Houses are produced in response to orders, and outside fabricators manufacture individual parts. Romero's firm groups them, provides assembly documenta-





this page, top to bottom: Romero's LV, alternate plans; the LV flat-packed for shipment; mkd's Glidehouse modules in transit

opposite page, top to bottom: Resolution: 4 Architecture's typological configurations; mkd's Glidehouse variations: G5, 672 sf, $98,050; G1, 1,347 sf$188,580; G3, 1571 sf, $219,940; and G4, 2112 sf, $295, 680, prices reflect factory costs only and exclude site work, tax, transportation, & permits.

tion, and ships them disassembled on trucks in a flat pack.

Flexibility in foundation and structural systems addresses differing soil and groundwater conditions and regional preferences for basements, crawl spaces, or slabs. Pre-engineered framing options accommodate hurricane, seismic, and snow loads. Added modules provide more rooms, and interior walls can be reconfigured. Although the design is one of the most disciplined among prefabs, to Romero it is critical that it "do different things for different people."

Romero limits her company's role in site preparation and construction administration. Buyers take an active role, seeking bids from contractors for permits, site work, and assembly. Simple assembly details and clear, complete documentation support this approach. The firm's website offers substantial resources—a standard contract, a short specification for contractor ballpark bids, and plan diagrams—encouraging buyers' confidence in the unfamiliar process.

Romero is comfortable with the role. "You have to let go. Clients are different today. They want something well designed, and they want it to be easy. The design process can be painful if you are trying to design every last gadget. I started this company with one clear mission, to do affordable modern architecture. What is the point of getting prefab if it is going to cost as much as stick-built?"

Resolution: 4 Architecture

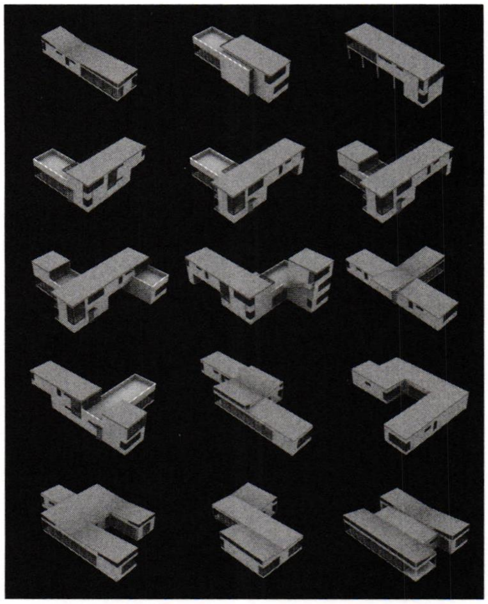
Resolution: 4 Architecture of New York takes a different approach, focusing on typology rather than refinement of a base model. As principal Joseph Tanney notes, "We are operating as architects, as opposed to designing a model home to be sold. We have developed a system of design which will leverage existing methods of prefabrication." The firm has completed 12 houses and designed more than 120.

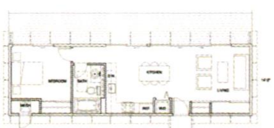
In some ways, Resolution 4's houses have more in common with custom than standardized houses. Designs average $250 per square foot (in higher markets) plus architect's commission. The firm has tested its assumptions by pricing designs both ways (factory vs. site built); the $250 square foot factory-built cost—$125 for factory work and $125 for site preparation and labor—has been estimated as high as $600 for stick-built site construction. Even at $250 there may be less expensive prefab options, but it is a very well-priced alternative to a custom home.

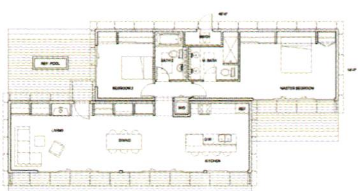
The firm's system is based on two "modules of use," one for public spaces and one for private, factory-assembled and trucked to the site. The lowest common denominator is the truck dimensions: 16' wide by 11' high by 60' long, which equals roughly 1,000 square feet. A rigorous set of typological diagrams reflects many variations of the "modern modular."

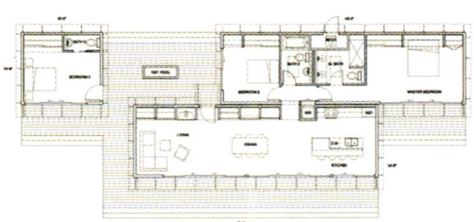
Resolution 4 has worked with five different factories. "For each factory there are also specific limits relative to where they are licensed to build, where they are allowed to deliver homes, each factory's line space. When we understand the factory's assembly process, it allows us to leverage efficiency of implementation, and it gives us better value."

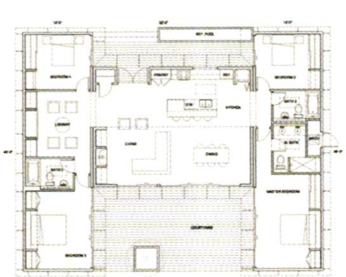
Although mass customization is ingrained in the firm's work, it











maintains a traditional role in both design and implementation. In addition to full design services, the firm remains involved in site work. Different energy codes, climatic conditions, and other local influences need to be addressed. "We respond specifically, but we rely on standard components and a language of typology." As a result, massing can vary significantly, offering greater expression with form.

The payoff is a homegrown version of prefab. Although Tanney acknowledges modernism's long-deferred dream, it is not his firm's objective. "A lot of architects are pursuing this 'holy grail of modernism.' Our interests lie in continuing to develop a process that allows us to respond specifically to each client and budget, as opposed to trying to develop 'this year's model.'"

Michelle Kaufman Designs (mkd)

If Rocio Romero's strength is its highly refined kit, while Resolution 4 Architecture rejects the notion of a base unit, Michelle Kaufman Designs adopts both approaches simultaneously, offering clients either pre-configured or modified/custom solutions. With 20 houses completed and 70 in the pipeline, the firm is branching out to produce new models, while pursuing custom designs, as well as a multifamily design. Located in the Bay Area, the firm emphasizes green design and has ambitious plans to expand its efforts nationwide.

An impressive website with extensive descriptions of the process, step-by-step planning and budgeting tools, floor plans, delivery assessment services—even Sketchup models—offers transparency to the curious or confused. Prefab solutions can require clients to take on unexpected roles; mkd's commitment to communicating how these details work is clearly a strength.

Unlike the other firms, mkd has established its own factory in Washington State, near its primary suppliers. Standard plans for the Glidehouse, mkd's most popular preconfigured model, vary in size from a 672 square foot studio to a four-bedroom, three-bath house of 2,112 square feet. Typical costs range from $250 to $275 per square foot, except in higher priced markets. The firm's custom modular houses are estimated in the $400 per square foot range. 15'-6" wide modules are trucked from the factory and craned onto the site; usual fabrication and construction time is ten to fourteen months. Although the design is modern, a simple, linear bar configuration and combination of wood and metal cladding make the Glidehouse at home in natural settings.

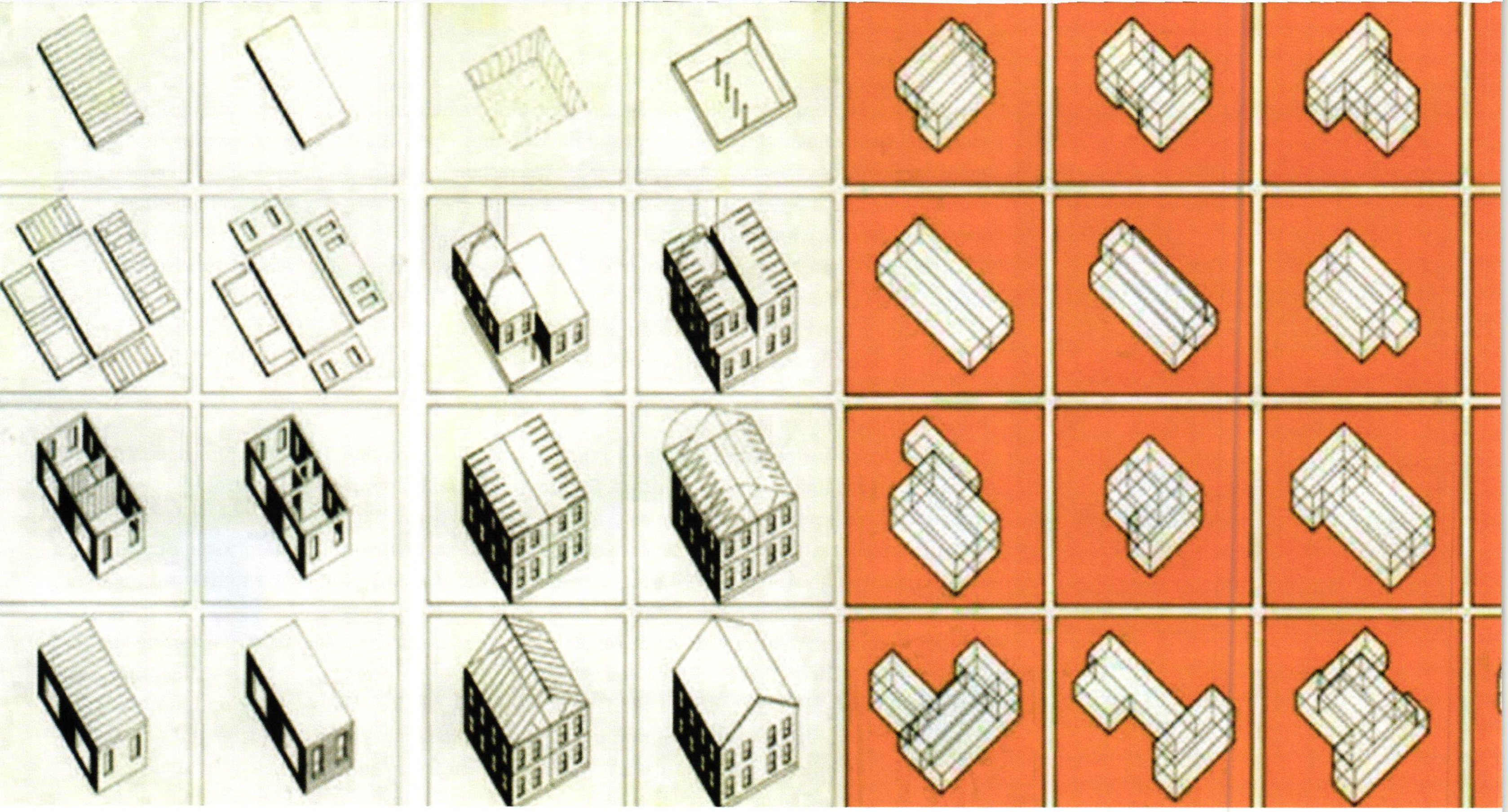
What has the firm learned during its short life? "When we started," Kaufmann observes, "we were too much like architects...Clients would say 'I love the Glidehouse, but I want to stretch the kitchen and I'd like to flip this and turn this over here, and we would [say], 'Yes, let's do that, that sounds great.' We didn't realize until we built some that it took away efficiency in time and cost. The clearer we have been about the [cost implications of] preconfigured houses versus custom, the more people can make their choices accordingly."

Kaufman aspires to the legacy of Eichler homes. "Our goal is to do what Eichler did: brought good design to the masses and did 10,000 homes in somewhere between 10 and 15 years. That's our goal, to do 10,000 homes in the next 10 to 15 years."

Lessons

Prefab design combines the complexity of product design with the conventional building challenges of local conditions, codes, and weather. Perhaps less obvious are the challenges of a new relationship with clients, in which extended, architect/client communications have been compressed, and in which the Internet plays a significant role. Finally, although prefab sounds like a monolithic term, it actually represents a broad continuum of offerings, approaches, and pricing.

Each of these firms can rightfully claim a record of success. While production numbers are small but growing, the enthusiastic reception of each of these approaches suggests a promising future for these pioneering firms. ◉



Multiple Takes

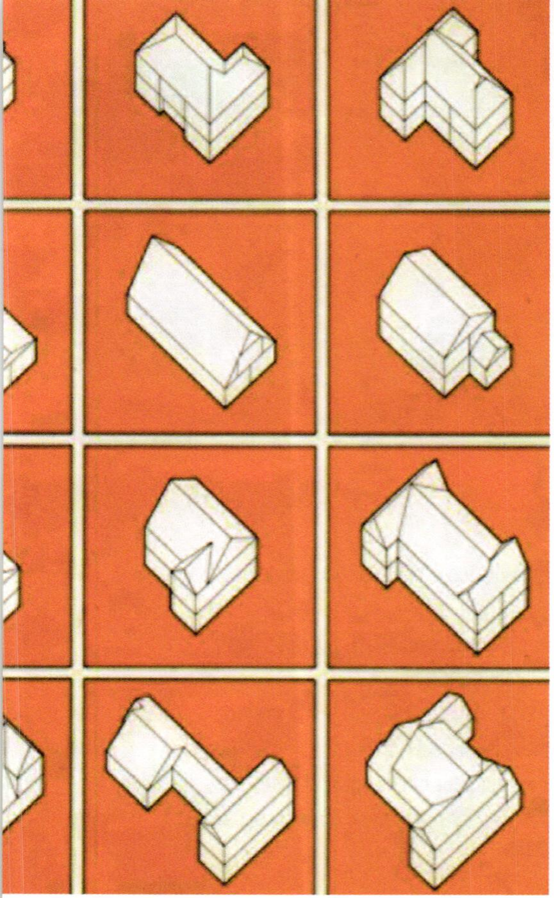
arcCA asked sixteen authorities on prefabrication—some designers and producers, some critics and observers—to offer their current reflections on the industry. Here they are.

Notes on Prefabrication in the 1980s

Deborah Berke, AIA, founded New York City-based Deborah Berke & Partners Architects in 1982 and has taught at Yale since 1987. She is co-editor with Steven Harris of Architecture of the Everyday *(1997), and Yale University Press will publish a book on her firm's work next fall. She may be reached at dba@dberke.com.*

My particular attraction to prefabrication goes back to the late 1980s. In the heat of the moment, the '80s seemed about only greed and consumption, overly big houses, and post-modernism's architectural excesses. Compared to today's greater excesses, those of the '80s now seem understated and naïve. But back then, those of us interested in a certain modesty of means were looking outside architecture not only for inspiration but for methods of production.

I was fortunate to get to work for a developer equally interested in these things, a husband/wife team committed to producing houses that were affordable to a broader audience. Together we went to factories where modular houses were being built—ugly houses, but they were built in places of stunning presence by processes that were compelling.



Modular house construction and variations, Deborah Berke and Partners.

Most memorable was the factory that had been used for WWII tank construction—a cavernous, multi-aisled brick hall with light from clerestory windows above cutting through the air thick with sheet rock dust, rendering the entire scene somehow ethereal. The units were lying on flatbed train cars, dwarfed by the huge, high ceiling, a cathedral of two by four modular construction. I was slack-jawed in appreciation of the splendor.

Often, manufactured housing looks cheap, and it has been stigmatized accordingly, but there is no reason for this. With the support of my client, I took on the design of a better-looking modular house that would appeal to his market. Mid-century modern had not yet again become fashionable. The goal was to make houses that would only reveal their method of construction to an informed observer and carry no stigma. The plans would be well thought out and would work for a variety of family (and non-family) structures. The limitations of modular construction would become formal opportunities.

Over the course of two years, we designed twelve models. They were designed in careful response to the deficiencies of the available factory-built product. In three categories of four models each—small, medium, and large—they were designed as generic American houses for the latter part of the twentieth century. To a potential owner, the plans functioned well; to an architect, the module of the "box" was the plan generator. Space was limited but made more expansive through axial alignments and visual connections—controlled entrance, room orientation, and spatial definition were important to this perception. The houses maintained the tradition of residential composition at a general scale without resorting to the application of non-functional items to evoke residential imagery. The production and operational efficiencies of these houses derived from the modular construction process, while their architectural integrity resulted from attention to the design of the house as a whole. Several of these houses were built before the market collapsed in 1991. It was and remains for me a critical exercise and a memorable, albeit thwarted, experience.

Is Not Is

Architect and educator Carol Burns, AIA, is a partner at Taylor & Burns Architects, a Boston-based firm focused on design for communities. She can be reached at cb@taylorburns.com.

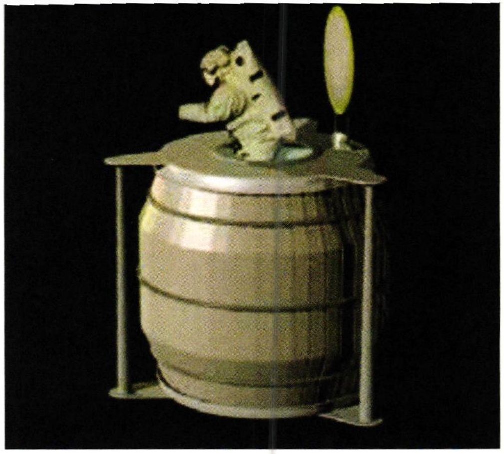
Techniques of industrialized mass production increasingly spread into the construction of all types of buildings. The "site-built" or "stick-built" house includes all sorts of mass produced elements, from wood studs to technologically-refined windows. Manufactured off site in mass quantities, these components can accurately be called "prefabricated."

Nevertheless, the dominant mode of building delivery in the U.S. involves specialized trades working onsite as subcontractors to a general contractor. Labor costs account for more than material costs, creating impetus for exploring more capital-intensive techniques of industrialized production. Over the years, architects—along with developers, owners, and

2005 Construction Methods of Single-Family Homes by Region

Region	Site-Built		Modular		Panelized / Pre-Cut		Total
	Units (thousands)	*% of total*	*Units (thousands)*	*% of total*	*Units (thousands)*	*% of total*	
Northeast	112	85%	15	11%	5	4%	132
Midwest	288	94%	13	4%	6	2%	307
South	734	96%	14	2%	14	2%	762
West	432	99%	2	0.05%	2	0.05%	436
National	1566	96%	44	3%	27	1%	1637

Source: Buildings Energy Data Book, 2006, U.S. Department of Energy, September 2006



government agencies—have made repeated, systematic efforts to invent and work within alternative modes of delivery. Presently, single family homes (which comprise over ninety percent of housing in the U.S.) are produced according to various methods in different regions (see above.)

The word "prefab" is not an industry term, as are "modular home," "manufactured home," "panelized home," or "site-built home." In today's popularizing usage, the term "prefab" seems more related to style—usually modernist—than to a method of construction. Among built homes recently featured under the prefab rubric, the majority are custom, one-off houses. The recent interest in prefab is, arguably, not aimed at addressing mass production (or even mass customization); it is another way to market modern style houses with a new twist, itself not a bad thing.

Style aside, I would like to argue for the potential benefit of continued efforts within the industry to build more environmentally-sustainable houses. Modular and panelized industries have the potential to attain higher performance standards, as measured by the "green" yardstick.

One reason is that site-building produces more waste materials; for example, one-fourth the drywall in new residential construction goes to waste. Factory processes minimize waste: cutting equipment can be programmed to maximize use of each piece of wood, and left-over materials are typically recycled elsewhere in the process. Factory-built homes can be sealed and insulated better, due to inside-out access and alternative construction sequences. Many systems-built houses today exceed the federal EPA Energy Star requirements, and improved construction techniques can reduce long-term energy use as well as operating costs. Transportation costs for systems-built houses can be managed to consume less energy and cost than site-built construction. Warranties cover all aspects of a new home, most crucially mechanical systems, which are a main factor in high performance construction: local builders usually offer a one-year warranty, while modular manufacturers offer a ten-year limited warranty. With efficient factory production, systems-builders have the potential to deliver these benefits at a lower cost.

The images in the architectural press are not unlike the images in magazines at the supermarket check-out line: a way to stay informed of promotion machine churn. Improved delivery of more environmentally sound—and affordable—houses might not have the modernist appeal of *Dwell*, but if harnessed to mass production to affect a statistically significant portion of the housing market, just might make for better dwellings.

What's Out, What's In

Todd Dalland, FAIA, co-founded FTL Design Engineering Studio in 1977. His design licenses for prefabricated buildings cumulatively represent billions of dollars in sales and annual royalties reaching seven figures. His new start-up with Robert Lerner and Tony Saxton, FTL Ventures, provides prefabrication architecture integrated with flexible photovoltaics. He may be reached at tdalland@ftlventures.com.

Out

High-design architecture as unique building

Design concepts
Prefabrication as custom components of a building that are built in a shop
In-house model-making shop
Designing for one client at a time
Fee-based design office business model

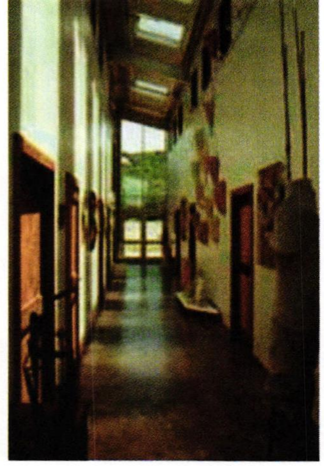
Brochure and website for clients
Site specific design
Design credit
Owning a design office

Construction industry lawyers and accountants

Making a masterpiece once, per project
Scale
Hourly fees and expenses on the front end, no back end

Architect
BArch
Renzo Piano Building Workshop
Professional Liability Insurance
AIA contracts

Familiar areas of design and construction

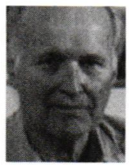


previous page: Deployable Foyer (Airlock) for Spacewalks for Next Generation Space Shuttle, FTL with Peter Hepple for Honeywell for NASA; this page: Hersey house and studio, Petaluma, photos by Robert H. Hersey.

In

- High-design architecture as unique, mass-produced buildings
- Intellectual property
- Prefabrication as high rate, mass-production of entire buildings
- In-house proto-typing shop
- Designing for thousands of clients at one time
- Capital-based design manufacturing business model with assets sufficient to self-fund self-generated projects
- Business plan for investors
- Adaptable site design
- Patents
- Owning a factory with an integrated design office, proto-typing shop, and marketing and sales group
- Securities industry business lawyers and accountants, intellectual property lawyers and patent attorneys
- Making masterpieces thousands of times, per deal
- Economy of scale
- Sweat equity and investment operating capital on the front end, royalties, profit-sharing and equity on the back end
- Design entrepreneur businessperson
- BArch plus MBA
- Dean Kamen, DEKA
- Product Liability Insurance
- Non-Disclosure Agreements, Letters of Intent, Licensing Agreements, and Distribution Agreements
- Undiscovered areas of design, manufacturing, and business

Thirty Dollars a Square Foot



Robert H. Hersey, AIA, has a small architecture firm in Marin County. He has designed live/work and studio spaces for artists throughout the Bay Area, often using factory built components. He may be reached at studio-hersey@earthlink.net.

1. Design

Thirty dollars a square foot was too good not to investigate further. That was the "rule of thumb" budget for a steel framed, small industrial building made by Butler Manufacturing Company. It would include concrete foundation and slab, clear span steel frame, exterior formed steel wall and roof sheathing, one ten-foot wide roll up door, and one "man" door. I was looking for a cost effective construction system with which to build a live work structure for my artist wife Susan and me. This system looked good from the point of view of cost and the environment, as new steel contains recycled scrap material and is itself recyclable.

Working with CSB Construction in Oakland, a Butler recommended design/build contractor, we launched into this venture of creating residential and studio space with a system designed to shelter manufacturing and storage facilities. I would be the designer, CSB's design and detailing staff would be my mentors.

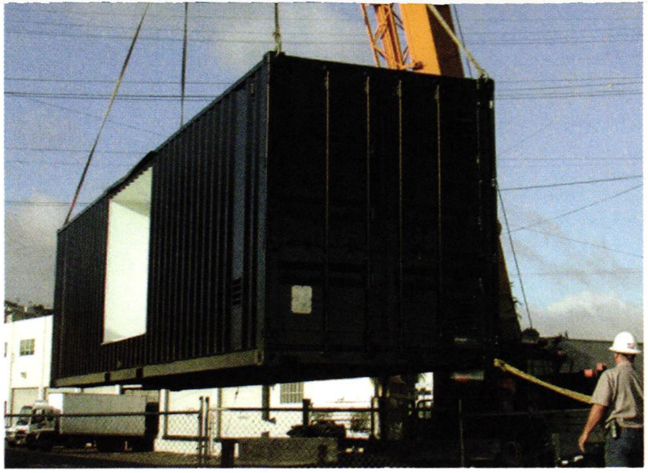
The first discovery was that $30 buys only a *Monopoly* house-like shell on a rectangular slab. My initial designs, with plan offsets and multiple roof ridges to better tuck into a constrained site, were estimated at twice that. One lesson learned, I settled down to learning how to tweak the standard industrial details.

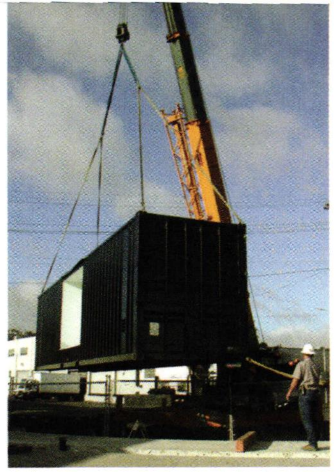
In the end, the only real changes we made to the "standards" were the openings. The $30 building has no windows. Heavily corrugated siding, which we used for its shadow creating profile, requires gross and often inelegant details at the heads and sills of windows and doors. So, I decided that all openings would run full height, slab to roof. The slab would form the sill, and the roof rake trim and rain gutter at the eaves would provide the head flashing. This system of openings, as it turned out, simplified the steel framing. The standard Butler is framed with horizontal "girths." Any vertical opening will interrupt these girths. We handled the problem by installing 8" deep steel channels at both jambs from slab to roof framing. They received the girths and carried the horizontal loads simply and directly to the slab and the roof framing system. Once cut into the standard shell, these openings were used for access, light, and ventilation. They were designed with doors at the bottom, hopper windows above them, and fixed glazing to the roof.

These slab-to-roof openings, designed to keep the system as standard and straightforward as possible, became the defining signature for the building and the only variation on the *Monopoly* block. The light that pours into the building is superb and is responsible for the singular quality of the interior spaces.

2. Construction

It took only a few days for the factory in Fresno to make the bents and cut and assemble the parts of the construction package, though there





photo, Restroom-in-a-box, California College of the Arts, San Francisco, Jensen & Macy Architects, photo courtesy of Jensen & Macy Architects.

was a several month wait to get to that point. CSB planned on completing construction of the building shell in 15 working days; it took about 23, as they were delayed many days by rain.

CSB's crew arrived at the site with truckloads of steel, insulated panels, and exterior metal sheathing on Friday, November 14th, after the slab had been poured and cured. Monday morning, the 17th, a crew of four with a heavy-duty forklift started erecting the frame. By the following Monday, the frame was up and insulation and siding materials were being applied. December 1st, the windows and doors were starting to be installed. The entire shell was closed in and trimmed out by December 17th.

The winter was stormy, with twice the normal rainfall. Once we had the building enclosed, though, we had a dry work site. The lumber for the interior construction was delivered on the slab before the shell was complete. Not only were we protected from the elements, we had our supply of lumber in there with us.

3. Cost

Our total out-of pocket-expenses, excluding landscaping, garden structures, and the water and sewage systems, was $90 per square foot in current dollars. I acted as contractor on the job and spent a year working on it, which I figure would add another $18, for a total of $108 per square foot. Had it been contracted, overhead and profit at 20% would bring the total to about $130 in today's dollars.

Part of the difference between that number and current square foot prices for custom construction lies in the simplified finishing system. The steel framework was left exposed on the interior, and so it seemed logical to leave most of the interior wood framing exposed. The CDX plywood interior finish is typically installed on only one side of the studs. The four-foot high wainscot, a horizontal piece of plywood, is, however, installed on both sides to conceal most of the electrical and plumbing lines. The rough plywood was installed butt joint-to-butt joint and painted with two coats of semi-gloss enamel. The result is a textured but civilized finish that works well with the quasi-industrial esthetic.

4. Outlook

Features of the building's construction type make it quite unlike other buildings. The full height windows were developed partially in response to how the steel framing and panel siding lay out. However, with no overhangs (another "standard" detail), they also invite the sky into the building. Combined with a row of skylights over the central gallery, they obviate the need for artificial lighting even in the cloudy, dark days of winter.

The siding and roofing panels, 2-1/2" foam with integral interior metal skin and corrugated exterior steel panels, turn out to be quite acoustically transparent, with very little mass in that combination of materials. The sounds outside the building pass through the wall readily. Bird and animal sounds, the sound of wind and rain, horses whinnying, cows mooing, goats bleating are all there to be heard. Combined with the "sky" windows, this acoustic transparency makes the interior feel only lightly separated from the natural environment, protected and warm but still very in the "outdoors," a pleasant and unexpected benefit of this system.

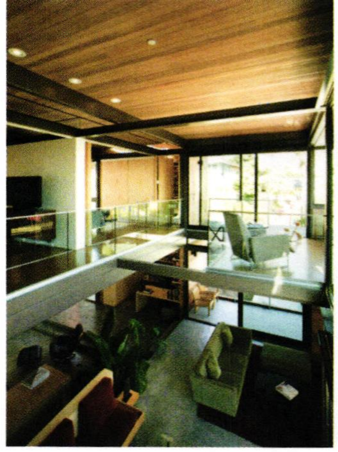
5. Data

Ground floor area: 3500 sq. ft.; lofts: 1000 sq. ft.; total: 4300 sq. ft.
Plan dimensions: 66 ft. long x 53 ft. wide; eave: 14 ft.; ridge: 23 ft.
Radiant heating in concrete floor slab.
Thermal siphon ventilation activated by operable skylights in the gallery.

The Child's Toy

Mark Jensen, AIA, is principal of Jensen Architects in San Francisco. He is the former Chair of the Interior Architecture Department at the California College of the Arts (CCA) and is currently Vice Chair of the Board of Trustees at the Headlands Center for the Arts. He may be reached at markj@jensen-architects.com.

There is an irrational exuberance around prefab. The volume of books, magazines, and evangelical architects dedicated to promoting this phenomenon is disproportionate to its accomplishments. The movement is not without appeal, but the real value of much of the work has little to do with its over-hyped claims. Cheaper? Faster? Not really, unless you are on a flat site in the desert. Factor in a sloped site, planning departments, neighbors, fire protection, potential seismic events, or customization—in other words the reality of most building projects—and so far the record doesn't match the rhetoric. The benefits of prefab remain, com-



LivingHomes RK1, Ray Kappe, FAIA, photos by LivingHomes/C.J. Berg.

pellingly, more poetic than practical.

When we have massive factories turning out houses as if they were planes, cars, or iPods—thousands at a time—they will undoubtedly be cheaper and faster than traditional site-built structures. Until then, prefab experiments are artisan craftsmanship, not assembly line products. And herein lies their charm.

The appeal of the recent round of prefab experiments (each generation of architects seems destined to pick up the challenge) has nothing to do with their efficiency as a building delivery method but rather in how they spark our poetic imagination. Perhaps it is their toy-like quality (they are like a child's building blocks). Perhaps it is the fascination of the miniature (many are quite small). Perhaps it is just their stylistic flair (there is a surprisingly consistent formal language in these projects, not entirely explainable by fabrication processes). Perhaps it is something more fundamental: their completeness when they arrive on site makes them imaginable as luxury goods, not the product of a messy and dirty construction process.

For now, the systems that can make real claims for efficiency are the ones that deal with components of buildings. The 4x8 sheet of plywood, an inarguably efficient building component, is prefab. And certainly pre-engineered steel buildings, although not pure prefab, are able to match many of the claims of the movement.

Which brings me to toilets. As any architect knows, the structure and shell make up only part of the cost and time of a building project. The stuff generally hidden from view is the real challenge: plumbing, electrical, lighting, heating, and, increasingly, data and telecom. These are the expensive, time-consuming guts of most projects.

With this in mind, we proposed a prefab restroom for the graduate studios at the California College of the Arts in San Francisco. It is an entirely factory-built restroom. Plumbing fixtures, lighting, finishes, even toilet paper were pre-installed in a shipping container shell at the factory. The completed product was put on a truck, driven to the site, craned into place, and plugged in to power, water, gas, and drain connections. It truly was faster and cheaper than building on site. But, in the end, that was not the real appeal of the exercise. Instead, it was the idea of the crane lifting the completed building block onto the site that became the story embedded in the building. It is the joy of the child's toy.

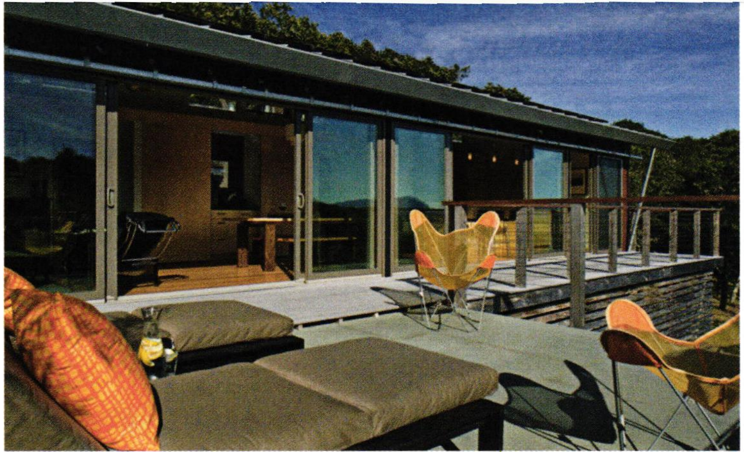
Remarks at the Hammer

Ray Kappe is the founder of SCI-Arc, the Southern California Institute of Architecture, which he directed until 1987. At the Hammer Museum in Los Angeles, he recently discussed his long exploration of prefabrication, leading to the LivingHome, a modular, steel-framed, pre-fabricated house recognized as the first LEED® Platinum home in the U.S.

I started back in the early '50s. I wasn't a Case Study architect, but the work we were doing was Case Study-like, and my first work was mostly post and beam houses. The thing I liked about post and beam houses was that they had the potential to be precut and predrilled, prefabricated in a sense but built on the site, and they could have infill panels. So the houses looked not so different from the Case Studies, but they were wood houses and detailed in wood rather than steel.

For developers, though, I was doing conventional construction in condominiums. It was about ten years into my career. I'd completed about fifty houses and quite a few apartments and other commercial and industrial work, but I felt that I didn't want to build them that way if I could help it. I would rather try to develop a modular system that could be built either on site or off site—made out of mechanical cores and laminated beams spanning between them, then bedroom and living room units could be slipped in. I was supposed to build [one], but the condominium market fell out at that moment. Banks weren't loaning any more, and so that project didn't go ahead. Later, when I had a chance to do student housing at Sonoma State, I tried to do it again, but again the developer didn't go ahead. So, through the years, I kept trying to use this system. I tried to do it with custom houses; my own house has that same idea.

And then I did a hybrid system, in which there was a combination of post and beam and core units, and in this case they were all precut and predrilled, brought to the site and erected in one day, very similar to the way you do a steel erection. My goal was to try to use the crane, try to speed up the building process, try to have repetitive housing, because I was more interested in mass housing, as many architects were and are.



Glidehouse, mkd, photo by John Swain.

In 2004, I met Steve Glenn (CEO of LivingHomes), and he was interested in getting into the prefabrication business. He asked me if I was interested, and I said I sure was, I've been waiting my whole life to be able to do this.

A Virtual Symposium

Growing up in Iowa, Michelle Kaufmann has always had a deep understanding of the relationship between humankind and the environment. When she relocated to Northern California, she found a lack of affordable, sustainable, well-designed homes, which prompted the founding, in 2002, of Michelle Kaufmann Designs. She may be reached at info@mkd-arc.com.

A co-innovator of Project FROG, Mark Miller, AIA, has worked with leading international corporations, financial institutions, non-profit organizations, and institutions of higher education in the United States, Asia, and Europe and has been a Keasbey Fellow and a Henry Luce Scholar. He may be reached at miller@projectfrog.com.

Michelle and Mark responded independently to a set of questions submitted by the editor of *arcCA*. We juxtapose their responses here, which also gives us the chance to correct a misperception we have encountered on occasion: Kaufmann's firm, Michelle Kaufmann Designs (mkd), is not affiliated with Miller's professional services partnership with Steven A. Kelley, AIA, MKThink.

arcCA: *How do you see current prefabrication in relation to the history of attempts at prefabrication for a consumer market?*

Miller: The more exciting current efforts return to a successful tradition with roots as important as the 19th century Sears catalog and the building industry of the 1950s and '60s. Efficient use of materials and the need for affordable solutions are the common thread. What is unique about the current situation is the convergence of digital design technology, product culture, and efficiency issues within building design, specification and construction, which together provide opportunities for alternative solutions.

Kaufmann: Today's communication technology is different: using email and shared servers, we can have fifty clients in fifty geographical areas and be able to develop and build their projects effectively, because we do not need to meet face to face all the time to make it happen. The other big difference is software technology that allows us to maximize efficiency with our drawings and production, to minimize time as well as significantly reduce material waste. And people are becoming more comfortable with the idea of good design and customization within mass production. Look at the iPhone. It is mass-produced but customized to one's personality and life.

arcCA: *Is prefabrication a fulfillment of the Modernist dream?*

Miller: There is no question that you need to connect a future-forward designer with an equally prescient customer to explore fully the potential of prefabrication, and the core modernist principle of achieving more through less is essential to our efforts. Nostalgia and prefabrication do not make great bedfellows. I dread the day when the Post-Modernist goes prefab. Still, much of the potential of prefabrication lies in the convergence of good economics and good environmental principles. These goals, while related, may be tangential to the Modernist dream.

Kaufmann: For us, prefab is simply a means to an end. We didn't set out to do prefab; we set out to make thoughtful, sustainable design accessible to more people, and, we hope soon, accessible to all. Modular technology is a way for us to maximize the predictability of time and cost and to prepackage green solutions.

arcCA: *Did you look at historical precedents?*

Miller: We respect the experiments and successes in historic prefabrication, but our roots are contemporary, relating to design, fabrication, and delivery clues available in today's product design industry, where we see the most innovative and design-forward ideas.

Kaufmann: Charles and Ray Eames are some of my favorite designers of all time. They mixed play with genius, and the result was inspirational. I often wonder what they would be doing today if they were still alive. I think they would be doing this.

arcCA: *What are the most significant external impediments to a wide acceptance of well designed, prefabricated buildings?*

Miller: I am biased, but with the exception of very unique site conditions or extreme user needs the only remaining reason for site-built

Project FROG modular classroom, Jim Russell Racing School, New Learning and Technology Center, Sonoma, photo courtesy of MKThink.

buildings may be the need for fulfillment of architects-as-artists. Otherwise, the advantages of substantially site-built projects may be limited. Prefabrication should be less expensive, faster to deploy, potentially of higher quality, and certainly more green. It can also reduce the cost, schedule, and quality risks that dominate the one-off, site-built process. With appropriate investment and a prescient approach, there are few design limitations in prefabrication.

Yet, human nature causes us to fear what is not familiar. If we want people to be open to the advantages of prefabrication—such as building more with less—we need to make the issues and opportunities familiar. To become popular, we need good PR. Also, prefab needs to work with industry and regulatory agencies to establish trust and standards; this means no short cuts in building code compliance.

Project FROG is the creation of, and has been incubated substantially by, architects, which has been a hurdle with investors and the marketplace, as both have misconceptions of the value brought by an architect. The perceived ego of the architect has been a big obstacle. Provided architects are willing to work collaboratively with other thinkers and professionals, the viability of architects in this industry could increase.

Kaufmann: The only real constraint with modular is what can go down the road, and once you understand the rules of that, there aren't many constraints. If we want a wider space than what will go down the road, we do multiple modules that are open to each other. If we want a taller space, we can do a roof module that sits on top of a lower module. We can do (and have done) curves, angles, and cantilevers. The possibilities are endless. It is like working with Legos.

arcCA: *Can architect-designed prefabricated homes compete in the marketplace with manufactured and modular housing?*

Miller: They MUST. Much of the architecture profession has surrendered its cultural value. Its focus has become self-referential, removed from the critical issues of society: affordability, sustainability, accessibility, and broad cultural dialogue—while the marketplace is marginalizing and commoditizing architects' traditional technical and advisory services.

To be relevant in a digital and consumer-oriented world, architects need to engage their considerable skills in the key issues, industries, and economics of the future. There is more conversation about the design of the iPod or the Mini than there has been about 99.9% of architect-designed buildings completed in the same era.

Fortunately, architects can play a meaningful role in this field, provided they understand and will work within the parameters of manufacturing processes and economics. Quality and response to user needs matter to clients. Architects understand these issues and can inform successful modular solutions.

Kaufmann: We aren't trying to compete with the typical prefabricated homes that are out there. We are trying to make good green design accessible. We are applying the attention and care that most architects give to site built homes, but using automation and technology to make more homes designed by architects, rather than homes designed by subdivision developers.

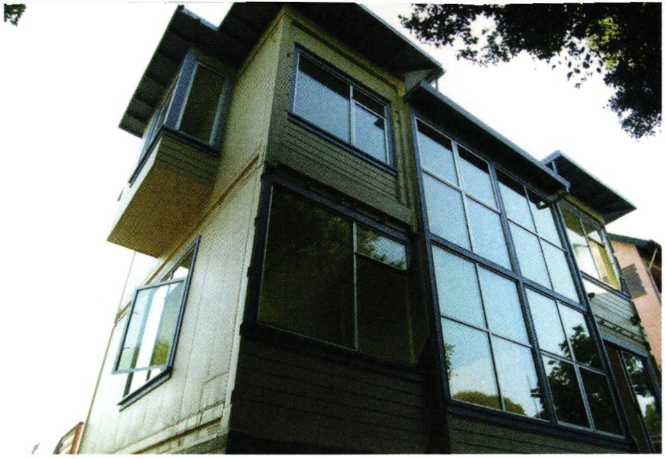
arcCA: *Can prefabricated buildings fully respond to the cultural context? Or must we acquiesce to a limited set of 'universal' forms? What if I want Georgian?*

Miller: Is the iPod responsive to the cultural context? Is Nike? For better or worse, products form today's cultural context. A turn to product industry-informed buildings can respond better to cultural context than one-off custom solutions that take years to implement. The lengthy, defensive process of achieving the majority of site design/bid/build projects often bleeds out the cultural context that is critical to informed and reflective architecture. There is a vast uniformity in today's architect-designed buildings, a monologue we hope to liberate by making the conversation affordable. Going Georgian needn't be an issue of prefab or custom design; it's an issue of taste. Both approaches can give you an equally tacky solution.

Kaufmann: As people in the U.S. are seeing the benefits of prefabrication (which other countries have known for awhile), more and more people are working in this space, many different designers who work in many different formal languages. We design with warm, natural materials mixed with clean lines and healthy environments. We study the climate and design based on it, rather than designing based on what something looks like. So, if you want a Georgian prefab, I am sure there is someone out there who could do that with you. It just wouldn't be us.

arcCA: *Assuming that prefabrication is not perfected, where are opportunities for improvement?*

Miller: When culture is perfected, then prefabri-



this page: Boucher Grygier Container House, Richmond, Leger Wanaselja Architects, photo by Karl Wanaselja; opposite page: two Modern Cabanas, photos by Bruce Damonte.

cation can follow. Until then, perfection can be less the goal than providing viable, affordable alternatives that are unwaveringly green. Project FROG sees opportunity in the creation and integration of quality green products that can be a platform for customization by end users, architects, engineers, and contractors. Also, we need to educate this market in the advantages of pre-engineering and prefabrication—almost all clients and facilitators hear prefabrication and think trailer classrooms. This is a big opportunity, because that doesn't have to be the case.

Kaufmann: There is always room for improvement. With volume and scaling, the costs will reduce. With every home we do (we have twenty-two completed now, but will have fifty completed by the end of the year), we learn and improve. It is one of the best things about manufacturing; it is one of the reasons we bought our own factory. We are no longer just thinking like architects, but also like manufacturers. It is a different mindset. That is the only way to pull this off: thinking with both hats on.

arcCA: *Can you share an anecdote that captures a characteristic moment of the process?*

Miller: Project FROG has been blessed with supportive yet demanding clients for our two pilot projects. But, in both cases, they did not want us to use the term "modular," "prefabricated," or any other reference to an alternative approach, even though this was the key to our success with challenging budget and schedule constraints. They felt that, if word got out, their accomplishments would be tarnished. I guess that didn't turn out to be the case, as we are discussing four more campuses with one of these early clients.

Kaufmann: One of the first homes we did was for *Sunset* magazine. Everyone was excited for its arrival. There were so many of us from our office, *Sunset*, press, photographers, all waiting in anticipation. But the house got stuck in traffic. So, we all drove out to the freeway to get an early glimpse. Soon, we saw it coming down the 101. There was clapping and screaming (OK, maybe that was me screaming). We followed the house, led by police escorts, through the town. We became a green prefab parade.

Insulated Shipping Containers

Cate Leger is a principal of Leger Wanaselja Architecture, an award-winning, green architecture firm in Berkeley, www.greendwellings.com. She may be reached at lwarc@pacbell.net.

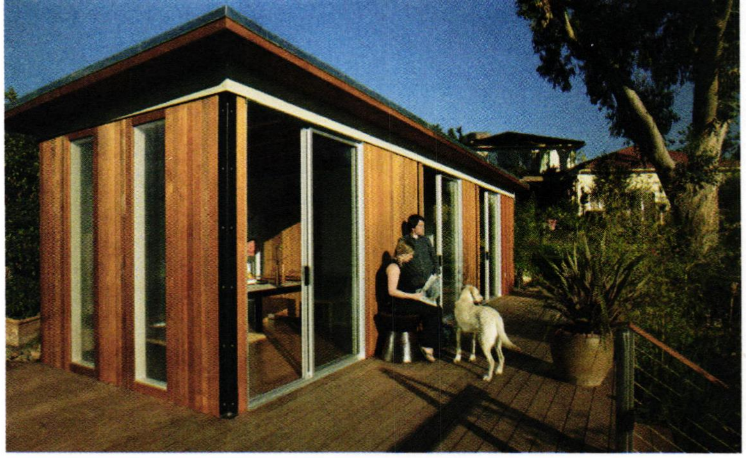
Reuse of shipping containers is a twist on the prefabrication theme. Prefabrication has much promise for resource efficiency and cost savings; adding used shipping containers to the mix takes it a step further. These vessels of commerce are piling up on our shores. While we can debate the merits of the consumer culture that got them here, there are hundreds of thousands in our major ports. They are incredibly strong, designed to be filled to the top and stacked six or eight high on a swaying ship. After many trips around the globe, they are no longer considered worth the return trip empty.

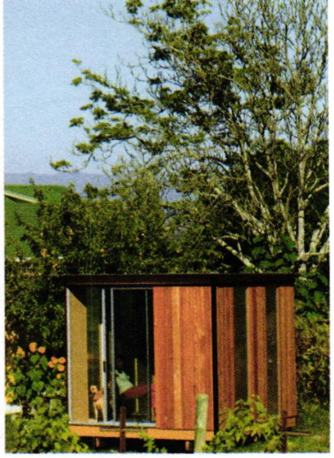
We recently completed a house made largely from three insulated shipping containers. The idea sprang from an ongoing interest in reuse of salvaged materials. We chose the insulated containers over plain corrugated steel containers for several reasons. They are pre-insulated to R-13 at the walls and R- 19 at the ceiling and floor, with virtually no thermal bridging or air infiltration. The structure is in the floor and the two short ends, leaving the longs sides available for large openings. Finally, they are more difficult to recycle than the pure steel ones because of the various materials of which they are made.

We stacked two 40-foot containers on one side and cut and stacked another on the other side of a two-story atrium space with a stair and bridge connecting them. One challenge of working with containers is the narrowness—7'-6" clear on the inside. To counter it, we added bay windows in the upstairs bedrooms. In the living spaces downstairs, we designed large openings connecting the atrium to the spaces inside the containers. The result is a compact, 1,330 square foot, three-bedroom, two-bath house, with a lofty, open feeling.

The project teases at the potential of these building blocks: cheap, salvaged, abundant, incredibly well engineered both structurally and thermally. On the first one, however, the learning curve was high. For example, how does one run plumbing and electrical through the floors and ceilings of containers? And get the plumber on board with these ideas?

Containers offer other challenges. Many city lots won't accommodate a container graciously, let alone two or three. Others won't accommodate the crane needed to unload





them. And then there is the question of curves. Containers, like much prefab, don't lend themselves to curves.

Containers are not for every project; no material is universal. Each program, each site has its own particularities. Shipping containers do fit a niche that, given their potential, offers much room for exploration.

"Cheap, Fast, or Good. Pick Two."

Casper Mork-Ulnes is a founder and partner in the prefab building company Modern Cabana and the principal of MU/D, a multidisciplinary design firm, both in San Francisco. He may be reached at casper@moderncabana.com.

Architects and clients have long considered this statement an intractable reality. Yet, the recent democratization of design by publications like *Dwell* has called this paradigm into question. This trend has fueled the resurgence of prefab, with the promise that good design can be available to the masses. The public expects prefab to be "Cheap, Fast, AND Good." Meeting these three demands simultaneously is the greatest challenge facing this emerging industry and the key to a financially viable prefab business.

Too often, the cost of a prefab structure is on par with or exceeds that of site-built construction. Many consumers are unaware of external impediments—site work, permit fees, and delivery—that add costs to the advertised price per square foot. These costs compound the importance of coming out of the gate with a price point that the market can bear.

Price speaks to our clients and their wallets, and we consider ourselves fortunate to have installed nearly fifty Cabana units across the nation and the Caribbean. We attribute this success largely to striking the right price/design/well-built balance. My partner, a building contractor, has played a key role in the design process, because he is able to bridge design with constructability at a reasonable cost. Our design/build model also allows us to eliminate costs associated with middlemen. These are savings we pass on to clients.

There is, of course, room for improvement. CNC and other computer aided construction methods show promise of further reducing costs and spearheading more unconventional forms. Until these technologies become more developed and less expensive, and until more versatile building materials emerge, we are left with few tools to control costs other than traditional manufacturing methods. In the end, price is what will determine if prefab will survive this time around. Good design is the easy part.

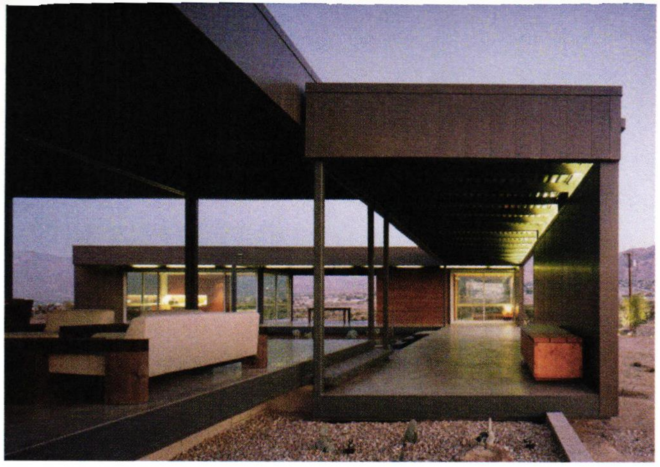
Prefab is Refab

Mikesch Muecke is an associate professor of architecture at Iowa State University. Occasionally, he creates and/or radically transforms architectural vessels with his partner through the design-build firm misumiwaDesign (www.mikeschdesign.com). He may be reached at mmikesch@gmail.com.

Let's assume for a moment that there is another, historical "pre-" before this latest appearance of prefabrication on the architectural scene. One example, Fachwerk (half-timbered) construction can be traced back to the 12th century, when it replaced post-and-beam construction in the wood-rich northern-European countries. This mortise-and-tenon skeleton system for walls and roofs continues to be used, in modified, CNC-routed form, in contemporary construction systems by such companies as ElkFertighaus of Austria, one of the largest distributors of prefab housing units in Europe. And Americans are finally catching on that prefabrication has benefits. There is doubt, however.

My first memory of prefab architecture goes back to the late 1970s, when I visited a friend on the northern-German island of Föhr. His mother's house was a two-story box made with pre-fab walls and floors, bolted together on-site. I was surprised how quiet the highly insulated interior was, compared with conventional houses I had lived in. Yet it felt strange to be comfortable in this house. I thought then, as I'm sure many potential prefab customers think today, that if something is prefabricated, it could not be of high quality. The opposite holds true, at least with respect to quality prefabrication.

And yet, I'm still surprised how pre-fab proponents talk about efficiency of production without considering the effect of construction quality on energy efficiency. Again, the Europeans have a leg up on us. At the beginning of November, I went to the 2nd Annual Passive House Conference in Urbana, Illinois (www.



this page: Desert House, Marmol Radziner Prefab, photo by Benny Chan/Fotoworks; opposite page: Pacific Palisades Prefab, photos courtesy of OMD.

passivehouse.us). Most of the attendees were architects, engineers, and builders, who originally lived in Switzerland, Germany, or Austria but had migrated to North America, bringing their construction expertise with them. What they have built over the past five years will become a model for highly production- and energy-efficient prefabricated building, with super-insulated walls/roofs (built to Passive House standards), heat-recovery ventilators, and thermally broken windows, with superb living comfort to boot.

Which brings me to site: making parts or even the whole building transportable is perhaps as much a desire to live anywhere (especially in the U.S., with its history of mobility) as it is about energy and material efficiency. That is why prefabrication paradoxically requires a superb knowledge of site.

I could wax nostalgic about what is lost in prefabrication: the on-site transformation of raw materials into a cohesive whole. But those times are gone—at least in commercial Western building practice—because of too much waste and too difficult-to-maintain quality control on-site. There is no home to go home to. Prefabrication is the past, and the future. Prefab is refab.

A Means To an End

Ron Radziner, FAIA, is Design Principal of Marmol Radziner and Associates in Los Angeles, as well as Marmol Radziner Furniture and Marmol Radziner Prefab. He may be reached at ron@marmol-radziner.com

Architect-designed prefabricated housing fills a niche, providing thoughtfully designed homes not offered by traditional manufactured and modular home companies. While many traditional companies have mastered quick fabrication, they have not concerned themselves with design quality.

Architect-driven prefab can focus on space, light, proportion, and interaction with nature: elements important for any good piece of architecture. For example, we use steel frames as the primary structure to allow the greatest design flexibility within and across modules—enabling open plans and floor-to-ceiling glass for natural light and air, while decks encourage indoor-outdoor living. Our homes use prefabrication as a means to the end.

Because the traditional prefab industry has not focused on quality design, the public's perception is not always favorable. There is some stigma attached, harkening back to the traditional double-wide rather than the new crop of design-forward projects. Yet, we have seen an overwhelming response to the emergence of the modern prefab movement. Thousands of people have visited our prototype, national and international press covers the trends, and the enthusiasm of those contacting our office is remarkable.

We hope that, by continuing to create well-designed homes built with a high level of control, we can chip away at the negative perception. By removing the uncertainties of working on-site and moving production into the cover of our factory, we can control quality, timing, and waste. We no longer have rain delays or subcontractors who simply disappear. Our staff works in the factory day in and day out, constantly improving the quality and speed of execution. Particularly in modern design, which cannot hide poor craftsmanship or detailing behind crown molding, prefab demands careful quality control.

By centralizing production in one place, we also see environmental benefits. Residences consume one quarter of our nation's energy, and the average site-built home produces 8,000 pounds of waste, which ends up in a landfill. Since we produce our homes in one location, we can reuse and recycle excess material. Extra tiles, studs, and other materials re-enter our inventory for use in the next house that comes down our line. Also, centralizing trades under one roof reduces vehicular emissions from travel to construction sites.

Marrying efficient construction and thoughtful design lies at the core of the modern prefab movement. We hope that as architect-designed prefabricated housing grows, more people will be able to live in high-quality, green spaces that enable a modern, indoor-outdoor lifestyle.

A Community of Thought

Jennifer Siegal is founder and principal of Los Angeles-based Office of Mobile Design (OMD) and the inaugural Julius Shulman Institute Fellow at Woodbury University. She was 1997 architect-in-residence at the Chinati Foundation, a 2003 Loeb Fellow at Harvard University, and a 2004 Fellow at the MacDowell

Colony. She edited Mobile: the Art of Portable Architecture *(2002), and was founder and series editor of* Materials Monthly. *She may be reached at jennifer@designmobile.com.*

OMD was founded in 1998. In that year, I created our first modular classroom, Mobile Eco Lab, with my students at Woodbury University. Our first prefab house was designed in 2000.

I like the specificity of knowing what you can design with and the precision that prefab structures offer. Working with a modular or kit-of-parts system allows us to create precision-built homes in 2/3 of the time at 2/3 of the cost of a stick-built home. Ultimately, I will be able to offer high-end, architecturally designed houses for half the cost and time. I see it as a revolutionary way to build.

With Swellhouse, I was interested in developing a two-story kit-of-parts, a building method that could be flexible, easily multiplied, and modified. The design's panelized system does just that, using SIPS and structural steel frames. The materials include Polygal, with U-values comparable to insulating glass, resulting in fuel savings of up to 50%; Structural Insulative Panel System (SIPS), a highly thermally efficient wall assembly, which uses 80% less materials than conventional framing with no off-gassing; bamboo flooring, an extremely sustainable material; and, for interior siding, Homasote, made from post-consumer recycled paper and containing no asbestos or formaldehyde.

We have developed a working method that is easily described visually and intellectually to new clients. The building method has given them confidence in their decisions, and it helps them make choices more quickly, as the system and pre-selected finishes limit their options.

I see prefab building as a movement in time and the work at OMD as the next generation's thinking, having learned from the mid-century modern masters. I enjoy being a part of a community of like-minded thinkers who are pushing the possibilities. I believe that in the next five years 1/3 of all new construction in the U.S. will be prefabricated systems. In the near future, we will be building with robotic technologies, so that our houses will be manufactured the way automobiles are built.

Prefab NOW?

Kate Simonen, RA, SE, is COO of Parco Homes and Associate Professor at California College of the Arts. She may be reached at Kate.simonen@parcohomes.com.

Prefabricated homes of the post-war era looked to translate the technologies developed during WWII in aerospace and shipbuilding but were unable to compete with the cost and flexibility of conventional wood frame/stick built construction. The same issues are relevant today. In order to supplant the dominant production methods, a new technology must provide significant advantages in cost, performance, and design.

The existing prefabricated housing industry can be divided into three segments: components, low cost modular, and high design prefab. The component industry (most successfully metal plated wood trusses) has identified core elements of residential construction for which factory production provides a clear advantage—in time, cost and material efficiencies—over site-built work. Production modular homes have targeted the low end of the market, offering simple homes with compromises made to design and quality that are too great to make these products appropriate for developers or many homebuilders. High design prefab homes provide design improvements to the production models but generally do not provide either cost or performance advantages at a level competitive with conventional construction. Of these three segments, only the prefabricated component industry has been able to provide the disruptive technology necessary to transform the industry.

So is the current focus on prefab all hype? We believe not. In order to create improved and commercially viable modes of housing construction, critical evaluation and creative re-imagination of the materials, methods, and systems of housing design and construction must be employed. The conditions of culture, technology, and the environment make *now* the right time to launch a revolution in home building.

Current optimism towards technological solutions and customization makes the idea of prefabrication attractive to consumers. Mass customization has demonstrated the value of custom solutions created from a limited palette of options. At the same time, the escalation of property values and construction costs has limited the ability for most in the middle class to build their own homes. The ideal of prefabrication—lower cost, higher quality—becomes attractive.

Eco Hut by Parco Homes.

Yet the technological advances transforming the building industry have yet to make a significant impact on residential construction. The growing capabilities of digital linkage among design, analysis, fabrication, and construction enable a more integrated practice, more sophisticated performance modeling, and the opportunity for site and project customization, while maintaining the efficiencies of factory production. Integrating sophisticated electrical and mechanical systems can result in 'smart' homes that respond to use and climate.

The environmental impact of both construction and use of buildings is substantial. Maintaining the *status quo* in terms of production methods and building performance is no longer acceptable. As part of a team developing a customizable, prefabricated home system, we have been focusing on how to leverage current enthusiasm for the concept towards a true transformation of housing production and performance. Creating a technically sophisticated system with the ability to assess the full spectrum of performance (design, energy, cost, method, time, durability, etc.) through a digitally integrated production process will enable us to create cost competitive, site/client specific, high quality homes. We are pleased to be part of the community working to improve the way we build and live and are optimistic that with collective persistence we can make a significant impact on the environment. The time for that change is *now*.

A $40,000 price tag for an 800 square foot backyard house?

*Carol Troy lives in Orinda and St. Helena. She is an author (*Cheap Chic, Cheap Chic Update, *and* Online Trading*) and photojournalist whose work has appeared* Conde-Nast Traveler, *the* New York Times, *and* Vanity Fair.

I'm a troublemaker by lineage; my uncle Hugh Troy, so the story goes, was kicked out of Cornell Architecture in the 1920s, during the time of Nat Owings. So I am convinced an 800 square foot Cheap Chic Backyard House can be sold for $40,000 or $50,000, give or take. My plan relies on using the vast factories that churn out manufactured housing. In my corner, I quote novelist Tom Wolfe: "Trailers are the only successful form of prefabricated housing ever devised."

Architect-designed prefab housing is nice, indeed. But sturdy, off-the-rack trailer modules are even nicer, in my book, for 25% the price. I'd design them to be clean, simple, cheap, and elegant. With California's new law, we could plant one on every spacious and willing lot in the state that needed space for the in-laws, boomerang kids, or rental income; promoting suburban infill, saving resources like crazy, cutting back on commutes and getting a leg-up on the affordable housing dilemma without forcing communities to erect huge developments to meet their centrally-imposed quotas.

When I wrote the *Cheap Chic* books with Caterine Milinaire, the theory was that one could weave a certain magic around strong, inexpensive basics. The little black dress, for instance. You can dress it up, dress it down. With the Cheap Chic Backyard House, I would work with the manufactured housing industry—ideally, Clayton, whose founder is wildly creative—and design the ultimate Corbusier box. The client gets the floor plan, designs the kitchen and bath unit from a national manufacturer on-line. Off to the factory go the plans. 800 square feet. Boom. It arrives at your driveway. The Cheap Chic team installs it, no local permits or inspections required, since it's built to HUD-code. (The foundation, however, will bear local inspection.)

This is California. A state exploding with documented and undocumented immigrants. Exploding, here in the Napa Valley, with nurses, schoolteachers, and newspaper editors who can't afford a place to stay. Desperate to encourage new affordable housing, the state passed California Government Code 65852.2 to allow second-units in single and multi-family zones as of right. But it's going slowly, even in enthusiastic Santa Cruz, perhaps because of the difficult building process. (The only place near me that's crawling with chic factory-made backyard houses is Calistoga Ranch, an Auberge property, but that's another story.)

The Cheap Chic Backyard House short-circuits the building process and goes straight to the plug-and-play market. But the product still doesn't exist. Why? California encourages it. But other states, loathe to allow "trailer trash" in their pristine suburbs, aren't on the bandwagon. Economies of scale require a national market.

We can pay four times what we'd pay with a national manufacturer when we choose a

Rehabilitated Cheap Chic double-wide, St. Helena, photo by Carol Troy.

beautifully made architect's prefab. Or we can rehab: I'm living in a gutted and redesigned manufactured home, continuing my experiment in the Napa Valley, where most cool backyard houses are designed by architects such as St. Helena's Howard Backen. While wildly chic, these backyard houses are not meant to be cheap. And until we can get cheap in this state, we can't get affordable.

Taking Something Off It

Andrew Wagner became editor-in-chief of American Craft *magazine in late 2006. Prior to that, he was executive editor and founding managing editor of* Dwell, *which earned the American Society of Magazine Editors (ASME) General Excellence Award in 2005. He may be reached at awagner@craftcouncil.org.*

I've always thought of architecture as the last great American craft. After nearly seven years at *Dwell* magazine where we explored almost every feasible iteration of prefabricated architecture—from the Motohome to Frank Lloyd Wright's ill-fated American System Built Homes to our own prefab built in North Carolina by Resolution: 4 Architecture—I was continually amazed at how stubborn the architectural process was; it just seemed innately to reject industrialization.

This, of course, was a source of great annoyance to us, particularly during the struggles to get the *Dwell* Home I built in Pittsboro, but, in retrospect, I now have to smile. As the world barrels forward at a remarkable pace, there is something reassuring about a discipline so integral to our society's well being subtly telling us to slow down and smell the roses or, barring that, stop and enjoy the buildings surrounding us. It seems to be saying, "Hey, not everything has to move at break-neck speed and, in fact, the best things in life often don't." Architecture has always played a critical role in grounding communities, and it's nice to see that it still is. ◉

Walter Gropius and the (Not So) Endless Possibilities of Prefabrication

Dora Epstein Jones

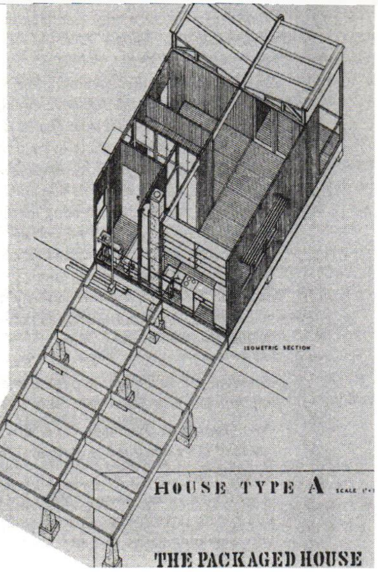
opposite: Courtesy of Resource Centre, Faculty of Architecture and Planning, Dalhousie University; above: Courtesy of www.axxio.net

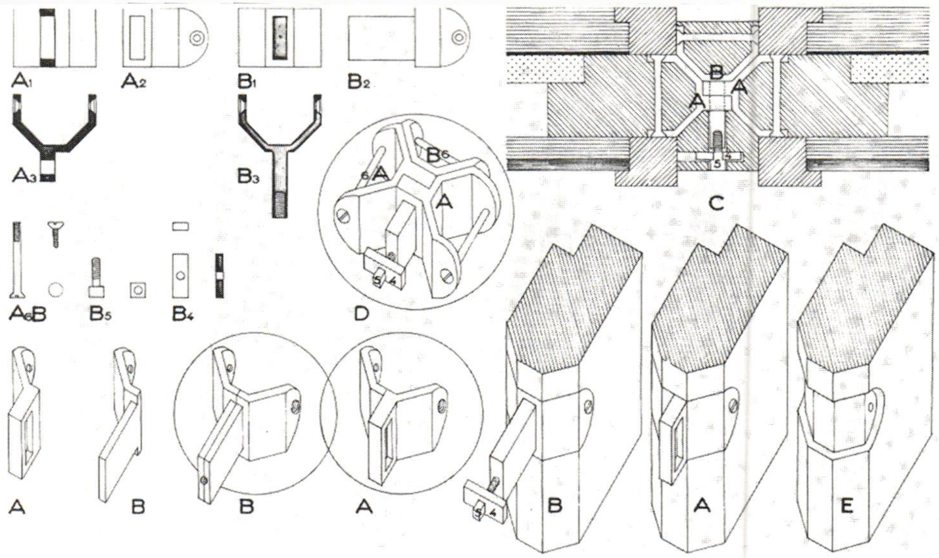
Walter Gropius was a prefabrication enthusiast. As early as 1910, while employed by Peter Behrens to intern and assist on various AEG projects, Gropius independently invented a system for prefabrication and, it is rumored, presented it to the AEG officials without the permission of Behrens. Behrens immediately dismissed the precocious young Gropius and altogether rejected Gropius's prefabrication system. But Walter Gropius clung to his dream and tenaciously developed several versions while at the helm of the Bauhaus, while holed up in England during the rise of Nazi Germany, and upon arrival in the United States immediately before the outbreak of WWII. In America, Gropius frequently spoke to members of the architecture profession and building industry, society dames, and art institutes of the need for construction industries to partner with architects and home-sellers to develop a comprehensive nationwide system of building based on prefabrication. Repeatedly, he prophesied,

> *On account of an extremely ramified integration, all the competing building industries will come to agree upon a reduced number of standard sizes for component parts of building. The designer and builder would then have at their disposal, say, a box of bricks to play with for adults, offering an infinite variety of such component parts for building which would be interchangeable.*

Finally, in 1942, Gropius was given his chance to develop and implement a prefabricated housing system with the General Panel Corporation. It turned out, however, that prefabrication was, and is, not so infinite.

It seems rather natural that a person who ran the Bauhaus at the apex of its engagement with the machine, who designed cars and trains, and who preached a platform of synthesis between art and technology would be enamored with the promise of prefabrication. This theme developed over the years, beginning with his 1910 proposal, to his research into standardized





"serial houses" at the Bauhaus in 1921, the Toerten Housing scheme of 1925, the prefabricated dwelling for the Stuttgart Weissenhofsiedlungen of 1927, the Hirsch-Kupfer copper prototype houses of 1931, and finally to the "Packaged House" for the General Panel Corporation. In each case, Gropius advocated the use of panels—made from steel, then copper, then wood—that would be manufactured in the factory, delivered by truck or train, and assembled into a house (or other small building) on the site. He quickly gravitated to the 4'x8' panel size, for ease of transportation (two can fit side-by-side on a flat-bed truck and still stay within the width of the standard highway or road) and because he envisioned a strong integration with builders and manufacturers, who were, by the 1920s, adopting a 4-inch to 4-foot industry standard.

For the General Panel Corporation, Gropius teamed with Konrad Wachsmann, an engineer and designer and a fellow émigré, to develop a complete panel system. The "Packaged House" was to employ ten panel types. Some panels had cut-outs for windows, some could be used as doors, others could be used for walls, floors, or ceilings. The adaptability and flexibility of the panels depended on the ingenious invention of the "wedge connector." The wedge connector was a small y-shaped channel piece made from a single metal die that could be fitted to other connectors on the same bolt. By inserting the panel edges into the wedge connectors, the panels could be connected side-by-side or at right angles to each other on either the short or long side. The effect, as envisioned by Wachsmann, was that the panels could be deployed in any three-dimensional direction, eliminating the need for any other construction system.

Gropius was against "total prefabrication" as too limiting. He recognized that formal variation is an architectural necessity; that it is what separates trailers, manufactured homes, and other mass-produced buildings from "architecture." Instead, he turned to the prefabrication of the part, rather than the whole, at a very early stage. The guiding principle, he stated, was "the greatest possible standardization with the greatest possible variation in form." Panels were a reasonable standardized component, and the wedge connector a perfect means for allowing variation without complicating the system. Restating his preference for the "box of bricks for adults" over trailers and other factory-produced buildings, Gropius claimed that the panel system could "overcome the monotonization of form" that had made previous prefabrication schemes fail.

Nonetheless, examples such as the Packaged House Type A (the first one promoted by General Panel) still show some formal limitations. The maximum free span of any room in a structure made from 4x8 panels is 16 feet. With the modernist flourish of the v-shaped roof, the width is brought down to less than 14 feet per volume. In the factory-produced building, the volume would be determined either by the size of the factory assembly floor or by the width of the truck or highway—generally rectangular with a varying length of 16 to over 40 feet and a tightly controlled width of 8 to 12 feet, with the possibility of double- and triple-wide options if assembled on-site. The advantage of the panel system was supposed to avoid these strict tectonic limitations. Yet, without the use of a column support, which would break the purity of the panel system, the limitations remain.

The equation is actually fairly simple: the larger the module, or the fewer module types and techniques, the fewer the possible tectonic outcomes. So, in an extreme example, if an architect is interested in using only shipping containers as a module, the (very large) size of that module and its repetition will only yield a limited set of configurations: end to end, on top of each other, offset cantilever, and the trilithon, or "Stonehenge" configuration. The architect may instead choose a smaller module, such as a panel, with the hope of achieving greater formal variation and tectonic outcomes, but even a modestly sized module

left page: images Courtesy of the Konrad Wachsmann archive, Academie der Kunste, Berlin; this page: Courtesy of Resource Centre, Faculty of Architecture and Planning, Dalhousie University.

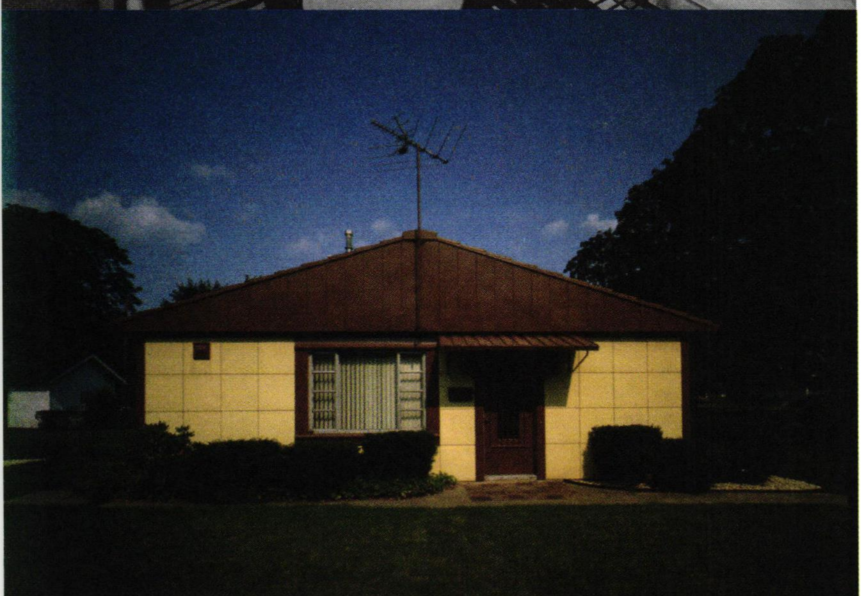
will impose tectonic limits based on its size, shape, and assembly. The Gropius example is instructive: the amount of free span and the rectangular shape of the panels would tend to yield 8-foot boxes. Of course, the module could become very small, or the assemblage varied, or one could introduce multiple systems, which would allow for wide formal variation, but doing so contradicts the point of prefabrication in the first place—that is, (inexpensive) expediency and ease of on-site assembly.

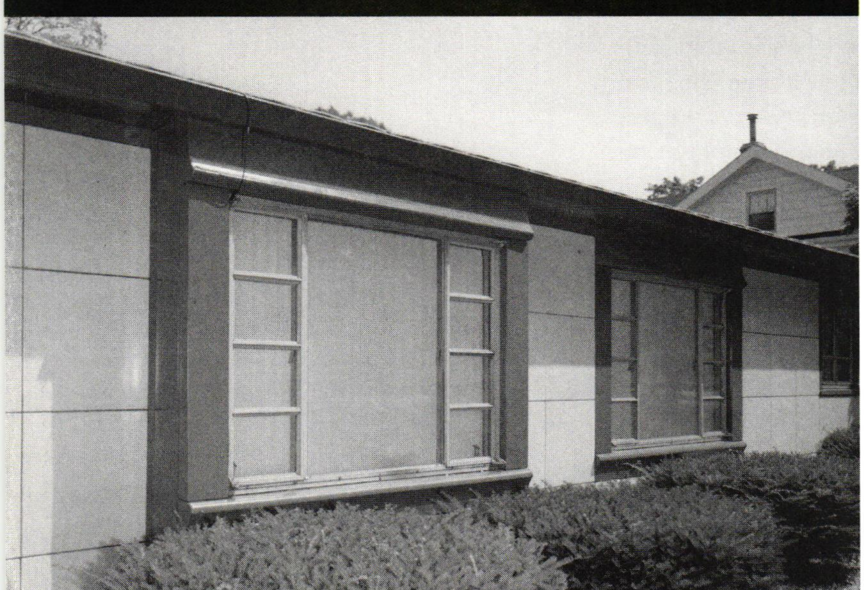
Even with advancing technology, limitations are part of the prefabrication game. There are certainly more and more examples of challenging panels on the market these days, with interesting surface forms and textures, but even these should remind architects of the limits imposed by module connection. No matter how gorgeous an interior panel may be, it is only as flexible as its track allows. And, without introducing another construction system or system of enclosure and structure, the panels are still just panels. In the Gropius example, the otherwise brilliant wedge connector makes for a fairly "dumb" box: right-angled connections enforce a strict orthagonality under an 8-foot by 4-foot proportional system.

For Gropius, however, the proportional system and strict orthagonality were in line with modernist doctrine—a distinct advantage of the system. In fact, he saw prefabrication not as an architectural endpoint, as it is often advertised today when we speak of this architect's prefab or that architect's prefab, but as a logical system preceding design. To this end, the panel system was an effective tool for promoting modernist sensibilities. Gropius often used his prefabrication system as a required technique in his design studios at Harvard. It was perhaps because of the necessary tectonic outcomes of the system and its strong modernist stylization that the Graduate School of Design became a recognized center of modernist architectural education.

More importantly, though—and especially from today's perspective—the use of prefabrication as a pedagogical tool also implied that Gropius intuited that even the most elegant system required the trained hand of the architect. Indeed, the more elegant the system, the more architecturally limited it will become, and hence, the more it will require control over constraints to deliver the greatest formal variation. Gropius encouraged other architects to design using his system—an article in *Architectural Forum* was devoted solely to the range of design possibilities offered by their hands, Richard Neutra among them. While still quite modern, and therefore stylistically limited, these designs do show configurations beyond Packaged House Type A. In other words, prefabrication may not be infinite, but shines a clear light on the role of the architect in producing what, in the end, is "architecture."

Walter Gropius remained a prefabrication enthusiast throughout his life, despite the fact that the Packaged House venture did not survive in the postwar housing boom. But, when speaking of it in 1953, Gropius was quick to remind us of the lesson learned, "What is called the 'freedom of the artist' does not imply the unlimited command of a wide variety of different techniques and media, but simply his ability to design freely within the pre-ordained limits." ◉





The Lustron Home

left top and middle: Lustron House, 104 State Park Road, Beverly Shores, Porter County, Indiana; photograph courtesy of the Library of Congress; left bottom: Lustron House, 411 Bowser Avenue, Chesterton, Porter County, Indiana; photograph courtesy of the Library of Congress

David Thurman, AIA

Excerpted from a full-length article in ***arcCA*** *02.3, "Building Value."*

Architects have historically embraced the cause of residential prefabrication with vigor, designing a wide variety of futuristic "concept" homes intended for mass production. Among elite examples are Buckminster Fuller's "Dymaxion" house (1929-46), Albert Frey and Laurence Kocher's "Aluminaire" house (1931), and Walter Gropius and Konrad Wachsmann's package prototypes (1941-50). All reflect the conviction that prefabrication can be fundamental to the production of single family housing, although none reached the mass market in any significant quantities.

Modern architects' longstanding affair with prefabrication serves as a useful backdrop for an interesting and mostly forgotten example, the "Lustron Home" (1947-50). This brief but significant building experiment resulted in the construction of nearly 2,500 units throughout the Midwest and Eastern Seaboard.

The modest Lustron Home was an unlikely protagonist in the century-spanning exploration of the idea of prefabrication. It was also a cultural by-product of innocent, *Popular Mechanics*-inspired notions of the future and the enthusiasm generated by wartime mass-production success. Promotional literature promised low maintenance costs, since all interior and exterior surfaces—including the roof—were constructed of porcelain enamel panels. The original, 31' x 35' (990 square foot) two bedroom house was priced at an affordable $7,000 and included built-in fixtures throughout. Among these fixtures were a combined clothes

and dishwasher, lighting and bathroom fixtures, automatic water heater, exhaust fans, plumbing, electrical equipment, a 275 gallon water heater, and radiant ceiling heating. The steel in each unit weighed 12.5 tons; the enamel weighed a ton. All 3,000 parts could be shipped from the factory in Columbus, Ohio, in a single, 35-foot tandem trailer and be site-assembled in 350 hours. Land costs were not included, and local dealers were set up to assist with customer orders and lot selection.

By the end of the company's short existence in May 1950 it had constructed a total of 2,489 houses, with a significant number of remaining back orders. While never reaching its break-even production rate of 35 houses per day (much less its projected rate of 400), in July 1949 it reached a peak production rate of 15 houses per day. When the company repeatedly failed to reach its predictions and required significant additional loans, bankruptcy followed.

Mass production efforts of private companies had played an important part in helping to win World War II. With such successes in mind, the U.S. government poured $37.5 million in loans into the Lustron Corporation. The company was the outgrowth of a Chicago firm whose decision to produce prefabricated houses was born out of a frustration with the lack of postwar steel for the company's principal product—porcelain enamel metal panels for gas stations—and the government's offer of support for firms that would address the serious shortage of housing for returning G.I.s.

While it lacked the visionary pizzazz of Buckminster Fuller's prototype, the Lustron Home reached the markets in numbers that few other experiments in prefabrication ever would. By the end of 1949, its distribution network included 234 dealers in 35 states, reaching from New York to Florida and South Carolina to Texas. North Carolina received the most houses (339), while Illinois (307), Ohio (275), and Indiana (142) were leaders. Even North Dakota (12) and Florida (16) were represented. Not surprisingly, a large number of Lustron Homes still exists. Current owners' documentation of repair strategies, original sales information, and other historical details recall the impact of the experiment. They also remind us of the Lustron's strange mix of visionary and pragmatic influences and the dream of a technologically advanced domicile for a new and better world. ◉

Prefab Webography

Principal prefab sites:

Fab Prefab: the most robust site out there, and the best for the prefab researcher, as far as we know; strictly neo-modern: *www.fabprefab.com*

Prefabcosm: more casual (and less well designed) than Fab Prefab; while its featured projects are also all neo-modern, its links take you quickly into the broader world of, loosely speaking, "non-architect-designed" prefab homes: *prefabcosm.com*

Prefabs.com: a good compromise, its main (right-hand) column has something of the focus of Fab Prefab, while its left-hand column of paid ads takes you into the rawer commercial world: *www.prefabs.com*

Broader sites that cover prefab:

Inhabitat: "a weblog devoted to the future of design, tracking the innovations in technology, practices and materials that are pushing architecture and home design towards a smarter and more sustainable future": *www.inhabitat.com/category/top-10-prefabs/*

The Value of Architecture: **arcCA** author and realtor Brian Linder's "showcase for architectural properties around the world" has recently featured several architect-designed prefabricated houses: *thevalueofarchitecture.com*

Shipping container buildings:

Shipping Container Architecture: the most robust site for links: *home.comcast.net/~plutarch/*

Shipping Container Housing Guide: slimmer but worth a visit: *www.shipping-container-housing.com*

Tempo Housing: a proprietary site, "temporary housing based on global standards that can be set up virtually overnight in any situation": *www.tempohousing.com*

Bob Vila, "Building with Shipping Containers": yes, the *This Old House* guy: *www.bobvila.com/BVTV/Bob_Vila/Video-0201-03-1.html*

Prefab history:

Tiffany Connors, "How Prefab Houses Work": *http://home.howstuffworks.com/prefab-house1.htm*

"Fast and Affordable: a Century of Prefab Housing," exhibit, Albert R. Mann Library, Cornell University: *http://exhibits.mannlib.cornell.edu/prefabhousing/index.html*

H. Gruenwald, "Industrialization and Architecture" timeline, University of Oklahoma College of Architecture (cached): *http://www.ou.edu/class/hgruenwald/teach/5970/597212.htm*

The Old House Web: *http://www.oldhouseweb.com/stories/Detailed/12270.shtml*

More from one of this issue's authors:

Carol Burns, "Manufactured Housing: a Double Wide Analysis": *www.gsd.harvard.edu/studios/s97/burns/index.html*

Carol Burns, interview with Bruce Mau and the Institute Without Borders: *www.massivechange.com/2006/06/27/carol-burns-february-24-2004/*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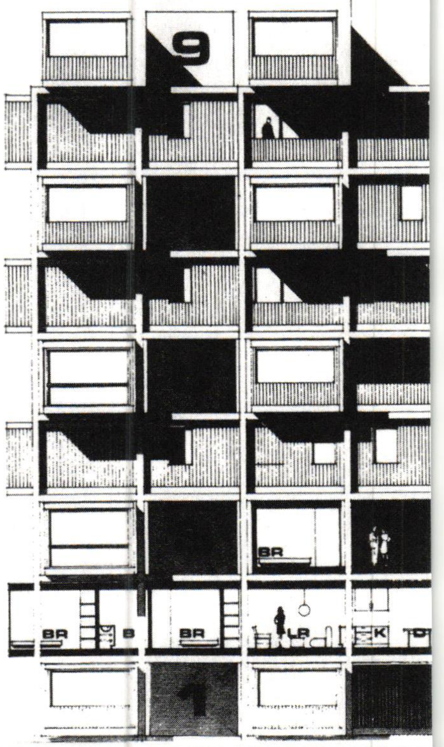
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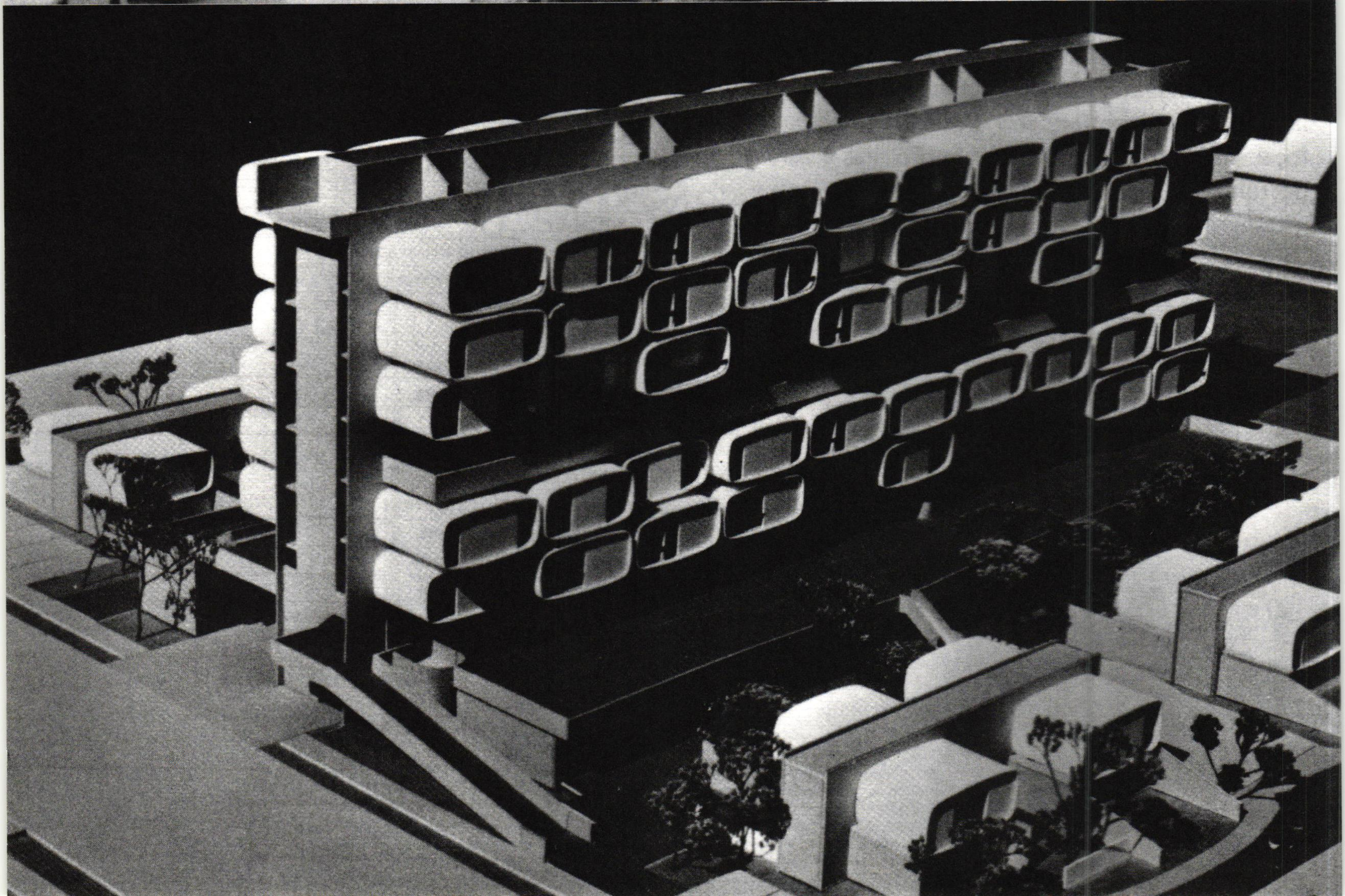


Looking Back
at Operation Breakthrough

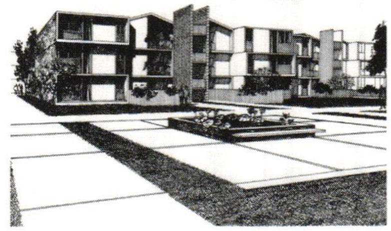
Operation Breakthrough was a program of the US Department of Housing and Urban Development, authorized by the Housing Law of 1968. Under HUD Secretary George Romney, former chairman of American Motors Corporation, it combined a competition to identify promising approaches to industrialized building with a federal effort to aggregate a market for these new models of housing.

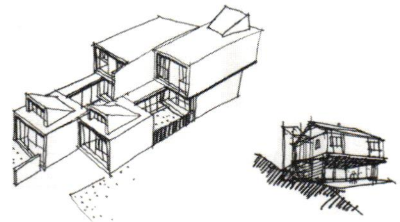
***arcCA** spoke recently with Richard Bender, architect, planner, and author of* A Crack in the Rear-View Mirror: a View of Industrialized Building *(NY: Litton Educational Publishing, Inc., 1973); architect and urban planner Larry Dodge, and UC Berkeley associate professor Nicholas deMonchaux about Operation Breakthrough and its lessons for prefabricated building today.*

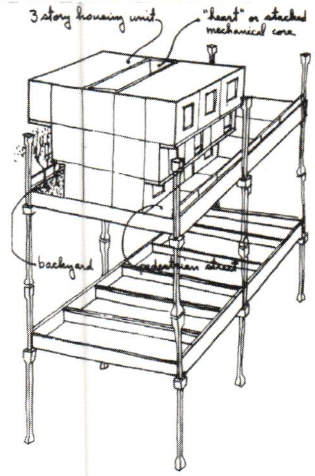
NdM: My interest in how prefab was being conceived in the '70s has to do with an investigation I'm doing, an architectural history of the Apollo XI spacesuit. Our enormous military industrial complex, with its vast expertise in systems and management, failed when it came to the task of making a spacesuit. Their hard, one-piece systems, which looked beautiful, failed, and the actual Apollo XI spacesuit was made by the Playtex bra company. It was a twenty-one layered, messy assemblage of different fabrics, only one of which was specifically designed to go into space. It was all adaptation and softness and messiness—the qualities that a lot of human landscapes have.

When I first got into the book, I thought there would be only a conceptual link to human landscapes, but it was interesting to discover that Bernard Schreiber—a developer of the ICBM—ended up founding Urban Systems Associates, a consulting firm for urban problems; or that Jay Forrester, who invented the Whirlwind computer at MIT, which ran a lot of the simulation systems used in the Cold War, wrote one of his last books on urban systems; that Harold B. Finger, who was an administrator at NASA, went to HUD, where he was a principal manager of Project Breakthrough. And not only did he go to HUD but, by the time the Apollo program was wind-

top, left and right, Operation Breakthrough proposal by The Commodore Corporation; bottom, spun fiberglass proposal by Spuntech Housing Corporation.







ing down and NASA was downscaling, a lot of NASA's state of the art physical technology was rolled down Constitution Avenue into Marcel Breuer's HUD building, and people tried to figure out how to apply it to the problems of the city.

One of the more interesting parts of the current conversation about digital technology is the notion of parametric design, which can allow you, instead of designing objects, to design systems to design objects. So, based on local conditions on a facade, for instance, a louver can be milled in a particular way. And my limited research into Operation Breakthrough teaches me that none of these ideas are actually new.

RB: The title *A Crack in the Rear-View Mirror* came from the fact that a lot of what we're speculating for the future is actually happening around us, and we don't see it. For example, some of the companies that were submitting for Operation Breakthrough had been in existence during World War II. There had been a program then, preparing for after the war, in which the government solicited proposals for prefabricated housing. If you go back to early San Francisco, you'll find prefabricated churches (shipped from Boston) during the Gold Rush.

RB: Building Systems Development's School Construction Systems Development project was a precedent for Breakthrough. There's a picture in *A Crack in the Rear-View Mirror* of a helicopter putting an air-conditioning unit on the roof of the first test building, the first unit made to go on a roof. It came out of the building systems design process, and it revolutionized the way air-conditioning is done in industrial roofs. It was designed for schools as a way to be more flexible.

The idea was to get manufacturers to make things they wouldn't make otherwise, by first aggregating enough schools with a similar need. A second idea was to make performance specifications for significant parts, like the air-conditioning, and to tell people that if you can make a system that meets these specifications, there would be a big enough market to try it.

LD: BSD also did an industrialized housing project for HUD, which served as a model for Breakthrough, a bunch of small, scattered sites—I can't recall the number, maybe 2,000 units scattered throughout 200 sites in East St. Louis, Illinois. The response was not to make whole units but to be as efficient as we could in off-site fabrication that would still be responsive to particular site conditions. We tried to fabricate smaller scale elements of commonality off-site—plumbing walls, for instance. There's a tendency, however—whether to make more money, or to demonstrate a difference from somebody else for marketing purposes—to make things bigger and simpler for the producer. So even though I thought we had been too crude, when it got transferred to Breakthrough it was cruder yet.

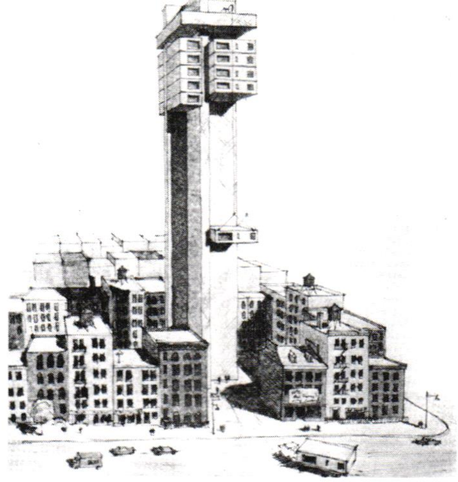
Subsequently, we worked on one housing producer's Breakthrough project that envisioned spinning Fiberglass housing modules in shapes with inherent strength. But the next step was: well, these are going to be for low-income folk, and the constraints were enormous. You couldn't stigmatize the poor by doing some weird-shaped house.

RB: The best way to introduce innovation is from the top down. If you build prefabricated luxury houses, then eventually it becomes acceptable. If you introduce an innovation at the lowest economic level, there's a feeling that you're experimenting. And you are. The Katrina trailers are an example. They found out after families lived in them for a while that they poisoned people.

When you talk about the low end of the market, very often the advantage is not in the factory but in the way things are financed. As you put more into the module, you put more into the mortgage. When I was young, the refrigerator didn't come with the house; if you go back further, the closets didn't. We put more into the mortgage, and you finance the dishwasher and the refrigerator over a thirty-year period, and they don't last more than five years. So you're still paying for that first refrigerator. If you put less in the building and let people accumulate and finish it later, you may have a better strategy for making low-income housing than to try to build a finished house.

LD: Another problem was that the military thought in terms of a single housing market





left to right: cover of *Architectural Design*, November 1971, showing members of the Building Systems Design team; Breakthrough proposal by TRW Systems; proposal by Townland; astronaut James Aldrin in the Apollo XI spacesuit; Breakthrough proposal by Alcoa.

and one product. That wasn't a response to the varied conditions of each project. It was too far away—a kind of space-view of the project.

NdM: That's one of the points of my book. When it came to the individual bodies of the astronauts, one of the biggest battles that Playtex fought was to be able to size individual elements of the spacesuit to small, medium, and large for each astronaut. Even the slightest tailoring modification didn't work in the institutional context.

RB: Boeing came to us at the time the supersonic jet was canceled. They had big layoffs, and they were trying to get into housing through Breakthrough. Boeing was fascinating: they were making the wings in Kansas and the body in Seattle, some of the engines were made by Rolls Royce, they all had to come together, and they were all working on them at the same time. That's one of the keys with prefabrication, the idea that different people can make complex products in different ways but with the same interfaces.

NdM: A lot of this can be traced to the ICBM development. You had an engine system and a fueling system and a gyroscope, systems so sophisticated that they needed to be developed separately. So systems engineers became interface designers, the new profession that came out of that process.

But even though the ICBM was complicated, it was in a way simple. This thing has to go up, it has to come down, it needs to hit the right spot and blow up. It's rare that you get a problem that has a line drawn around it so clearly. One of the dangers in the systems approach, at least in the context of the military, was to say, "All these lessons we learned on this simple problem, we're going to apply to things where the line is much harder to draw."

LD: I feel I was a Neanderthal in a lot of ways, because I thought we were inventing rules, as though we can invent rules, or I know what's best and it's brand new. There's something erroneous about the way industrial society has sliced up the world and then assembled new rules, whether it's religion, or the Congress, or us inventing a new way of doing something, instead of seeing what happens and responding.

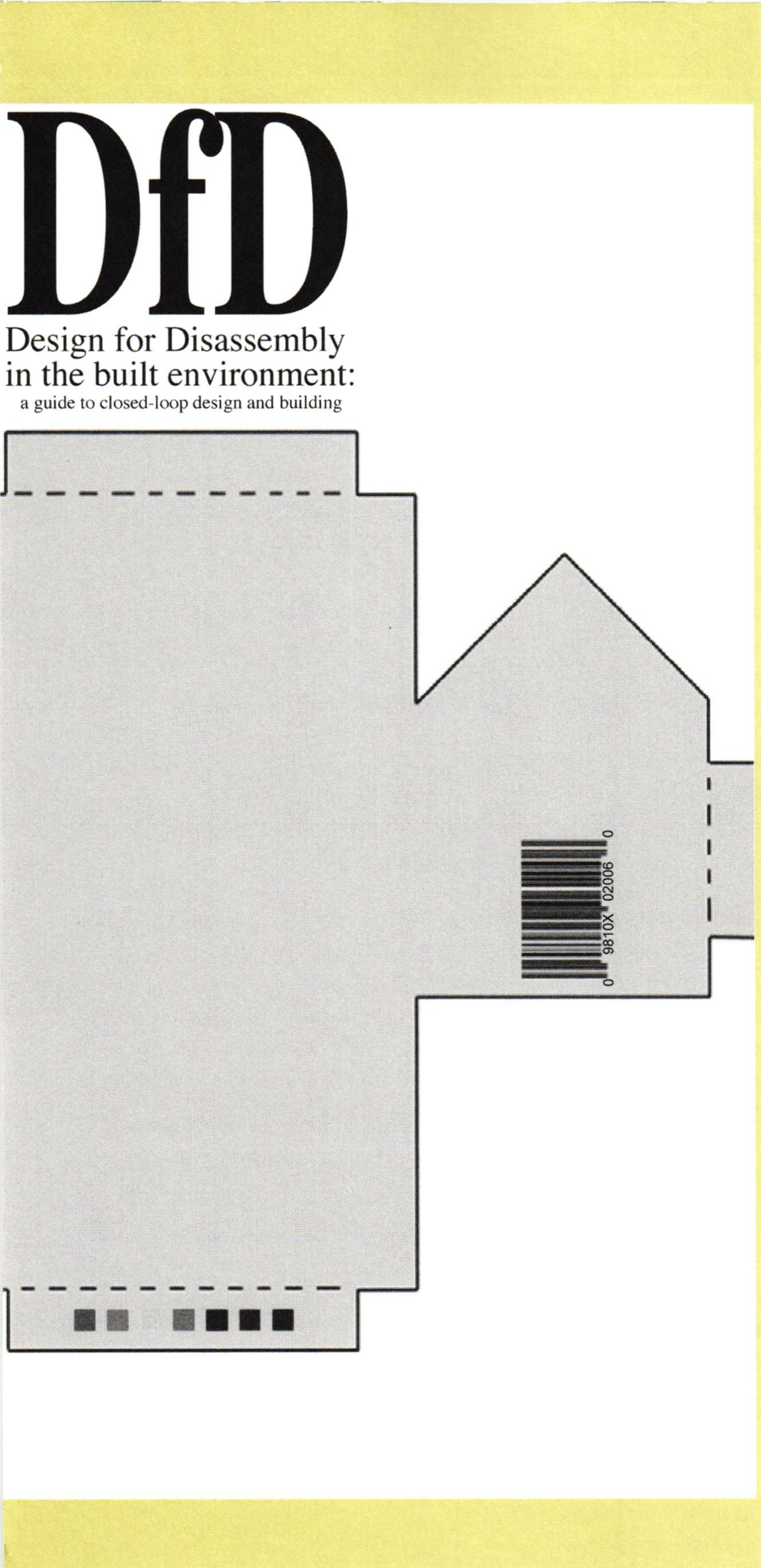
That there has to be a picture of the end product is the bane of every project. It could be because of financing, it could be land use organization, it could be somebody saying, "Well, we have to ensure a certain level of quality for the future."

RB: A preoccupation of mine in this regard is evolution. The state of the art in evolutionary thinking focuses less on the traditional notion of evolution in search of optima, and instead on the idea of the best adjacent possibilities. That's how systems change. A lot of what we're talking about in the design of these systems is optima. Well, even if we identify what is optimal, we may not be able to get there from where we are. So we might look instead for possibilities that are better than where we are and adjacent to where we are, and we might look for systems to manage change.

Siegried Giedion said that architecture begins with construction and ends with city planning. I started my career as a civil engineer. In New York, you could make a flat slab in an apartment house six inches thick and in a twenty-story apartment house get an extra floor. And you could just paint it. I realized architects were doing all the interesting work, so I went into architecture.

But one of the things you find out is, if you want to do low-income housing, you have to build a lot of houses. And when you're talking about a lot of houses, you're going to need to become a planner, because everyone says, "That's a good idea, but not here." So my career moved from construction to planning before I realized it.

LD: If you look at things in a systems way, the end product is anywhere along the line. Everything is a component of some larger system. If you look at the world that way, then what's the product? There isn't any isolated product. ◉



Review

DfD - Design for Disassembly in the Built Environment: A Guide to Closed-Loop Design and Building
Brad Guy and Nicholas Ciarimboli

Marc L'Italien, AIA

Prepared on behalf of the City of Seattle, King County, Washington, and Resource Venture, Inc. by the Hamer Center for Community Design, The Pennsylvania State University. Available at http://www.metrokc.gov/dnrp/swd/greenbuilding/construction-recycling/disassembly.asp.

Today's deconstruction bears no relation to either the Deconstructivist Architecture exhibit launched by The Museum of Modern Art in 1988 or the short-lived architecture movement that followed in its wake. (Although Philip Johnson himself declared it neither a style nor a movement, it turned out to be both.)

Far from a stylistic pursuit, deconstruction today is about planning the fullest lives for buildings and giving proper consideration to their ultimate demise. The term "disassembly," used interchangeably with "deconstruction," also refers to products. In the context of buildings, it is an emerging field that has received scant attention until now. *DfD / Design for Disassembly in the Built Environment: A Guide to Closed-Loop Design and Building*, a recently published guide written by Brad Guy and Nicholas Ciarimboli, asks us to see buildings as a strategy with a dynamic life. This broad view begins with the way architects design. Ripe with potential and quickly gaining acceptance, this thinking is long overdue.

The construction industry consumes 60 percent of all materials moving within the U.S. economy. It is predicted that 27 percent of all buildings that existed in the year 2000 will be replaced before 2030.

By 2030, over 50 percent of buildings will have been built after the year 2000. It's our choice to either devise a plan for how to dispose of all the waste, or consider seriously the principles of *DfD* for extending buildings' lives and planning an environmentally sensitive way to repair, renovate, and eliminate.

Consider the products deployed into the marketplace today and how they differ from those of just 20 to 30 years ago. Today we purchase cheaply constructed, non-recyclable products that have a short useful life. When they break, we dispose of them and purchase replacements. We don't think about the embodied energy in replacements when we cash in on those warranties, nor do we think about the landfill our discarded models will eventually call home. Now consider buying quality machines and appliances, such as blenders, designed for longer lives with interchangeable, recyclable components. Preventative maintenance and periodic repairs become the bread and butter of a local repair shop industry. In the process, we utilize far fewer natural resources and, for a fraction of the cost, get many more years out of our trusty blender. This is how it used to be—but we've gotten far away from it. We often find tomorrow's answers by looking to the past. Now let's apply this same thinking to buildings.

As the world moves away from the twentieth century's industrial extract-consume-dispose approach to natural resources, *DfD* supports knowledge-based design and challenges architects to use their creativity to close the design loop. Why? Because our planet can't continue to provide the resources for buildings as we know them today. Tomorrow's buildings—like yesterday's appliances—should be built to last and designed for adaptability. They should be easier to repair, and functioning components should be easily disassembled and earmarked for other uses at the end of a building's life.

The obstacles to *DfD* are: the speculative nature of buildings; negative perceptions and beliefs in systems designed for deconstruction; composites and petroleum-based products; coatings and layers of finish; connection methods that are difficult to undo; loss of craft skills to create aesthetically pleasing connections and fasteners; and the labor costs to deconstruct and sort. Many municipalities nationwide are proving that sorting is quickly becoming commonplace. Altering the rest is up to architects and the construction industry.

Guy and Ciarimboli cite examples from a simpler time, when people relied on disassembly for their very existence, exemplified by the North American teepee and the craft-oriented joinery of traditional Japanese architecture. They also show success stories of today's planning for future adaptability. The Wal-Mart in Lawrence, Kansas, was designed by William McDonough + Partners to outlive its current program and convert to housing by supporting a future second level. In San Francisco, the current home for the California College of the Arts, designed by Tanner Leddy Maytum Stacy, is the successful transformation of a former Greyhound maintenance facility that SOM designed in 1951.

The *DfD* guide was intended for owners, architects, and builders. Although impeccably researched, this trailblazing document reads more like a call to action. The strategies come off far more complicated than they are, as one labors through its long text, endless lists, and numerous bullet points. Its format could be improved with better diagrams and larger photos that more clearly illustrate the concepts. Packaging aside, there's a lot to draw from.

Simplicity is clearly a key concept of *DfD*. Simple frame buildings are suggested with exposed fasteners and, in some cases, directions for disassembly are clearly noted at the connection point. Disassembly documents are also suggested as a future method for deconstructing buildings. This seems like overkill, because these documents would describe means and methods. Any contractor who understands record construction drawings can figure out how to take a building apart. Disassembly allows us to retool the demolition process as we know it today. Easy: no manuals, additional drawings, or dynamite required—and no liability for architects.

Still, I can't help but wonder if these ideas will ever translate to larger, more complicated building programs and wet assemblies (components constructed for a specific project at a specific site and less readily separated out at the end of life—concrete shear walls for example), and if so, how? The guide doesn't get us there, so that's where our ingenuity takes over. Let's focus our energy on changing those systems we take for granted, systems we know will have to be replaced long before the end of a building's life, such as window and finish attachment details—inside and out. While we're at it, we could look into designing large concrete floor decks for disassembly and future resale. Doing so would eliminate the energy required to reconstitute the components and would save the energy required to pour new decks all over again.

The reliance on landfill still lurks beneath the pages of the guide, when we consider that a material's potential decreases with each cycle. A tremendous amount of energy is required to recycle and reconstitute products for their next market. I feel the emphasis should be first on adaptability, with disassembly only as a last resort. Designing exclusively for longevity and reuse is a much more challenging prospect. If successful, we ultimately eliminate resource depletion and arrive at what the 2006 Factor 10 manifesto calls dematerialization. Architects now have an opportunity, through design, to help chart the future course of how buildings are built and envision a future industry brokering reused building components on a massive and unprecedented scale.

Make no mistake—our need to change is our biggest threat. This change will recognize a new design process in which architects ponder distant program scenarios far into the future. By laying down the rhythm track, they will provide the early foundation for the number and, thereby, set the stage for a future jam session. This could be a deal breaker for strong egos.

DfD is the future. Many bugs need to be worked out before it gains more widespread acceptance. The authors force us to look hard at the status quo, challenging us to alter our perceptions and change the way buildings go together. Thanks to Guy and Ciarimboli for getting us thinking. ◉

Norma Sklarek, FAIA, Honored by the California State Legislature

Lori Reed

Norma Sklarek, FAIA, is a woman of many firsts. She is the first African-American woman licensed as an architect in the United States, the first to have Fellowship bestowed upon her by the AIA, and the first to form an architectural firm. Because of these and other pioneering accomplishments in the architectural profession, she was recognized and honored on the floors of the California State Senate and State Assembly on August 20, 2007.

Norma Merrick Sklarek was born in 1928. She was raised in New York at the edge of Harlem. From an early age, she exhibited solid artistic talents and excelled in school – especially in math. Her mother was a homemaker and her father was a physician. They instilled in Norma the strong belief that she could succeed in a profession, and in life, through hard work, education, and a positive attitude.

Her grades were always excellent, and she took the time to give serious thought to what she wanted to be when she grew up. She accompanied her father on his house calls during her adolescence. From that experience, she determined that medicine was not for her. She decided to merge her love of art and math and pursue architecture as a career.

She was accepted at Columbia's School of Architecture in 1946, but first had to prove her academic worth by taking her freshman year at Barnard College in Liberal Arts. She then entered Columbia and graduated in 1950 as the first African-American woman ever awarded a Bachelor of Architecture Degree.

Norma passed her licensing exam on her first try and quickly became well known for her skills in the technical side of the architectural profession. She also began to tutor other architectural graduates in the ways and means of passing the licensing exam—eventually coaching hundreds of successful licensing recipients.

Norma was the first black female architect registered and licensed in New York—and the United States—in 1954. In 1962 she moved to California, where she became the first black female architect licensed here.

She worked from 1960-1980 as head of the architectural department of Gruen Associates in Los Angeles. Among the many projects for which she was responsible during that time were the Fox Plaza in San Francisco, the American Embassy Building in Tokyo, and the Queens Fashion Mall in New York.

From 1980-1985, she served as Vice President of Welton Becket and Associates, where her major project was the Terminal One Building at Los Angeles International Airport.

In 1985, she became the first black female to form and manage an architectural firm, Siegel, Sklarek, Diamond, which was at its formation the largest woman-owned architectural firm in the United States. From 1989 to her semi-retirement in 1996, Norma was a principal with Jon Jerde Associates, where she was involved with major architectural projects throughout the world, including the Mall of America, the largest shopping center in the U.S.

In addition to a career record of significant professional achievements and technical excellence, Norma has balanced family life, teaching at UCLA, lecturing at many architecture schools, and non-stop mentoring and coaching of younger colleagues.

Over the years, she has served the profession and public in many capacities, serving as a member of the Architectural Guild of USC, an NCARB Master Juror, a member and chair of the AIA Ethics Committee, and a member of Goodwill Industries' Board of Governors. She has just completed a term as a Governor-appointed member of the California Architects Board.

Norma has received awards, honors, and testimonials from countless professional and community groups over the course of her impressive career. Among these are recognition from NCARB, AIA, the California State University, Turner Broadcasting, Association of Black Women Entrepreneurs, Goodwill Industries, National Organization of Minority Architects, Hampton University, Association for Women in Architecture, and the Y.W.C.A.

Norma's peers recognized her as a Fellow of the American Institute of Architects in 1980, the first black woman to be so honored. In 2007, the AIA California Council and State Senator Sheila James Kuehl (D-Santa Monica) arranged for Norma to be honored by the State Legislature.

"As a woman, I am personally touched and impressed by what Norma has achieved in the practice of architecture, as well as by what she has given back to the profession through her service. This recognition could not go to a more deserving person. She is a role model for all current and future architects," said Pamela Touschner, AIA, 2007 AIA California Council President.

"Norma Sklarek, FAIA, has been a trailblazer in the architectural profession in so many ways. AIA National is excited to see the California Legislature honor Ms. Sklarek's accomplishments, and we extend our warmest congratulations to her for an impressive lifetime of achievement," added Paul Mendelsohn, AIA Vice President, Government and Community Relations.

Norma is enjoying her semi-retirement while continuing to work as a consultant to professional colleagues. ◉

Editor's note: As we were going to press, we were delighted to learn that Norma Sklarek, FAIA, has been awarded the AIA Whitney M. Young, Jr. Award. This award, in honor of the late Whitney M. Young Jr., who challenged the architectural profession to assume its responsibility toward current social issues, is conferred by the AIA Board of Directors on an architect or architecturally oriented organization in recognition of a significant contribution toward meeting this responsibility.

Under the Radar

Six
La Jolla
Sebastian Mariscal Studio, San Diego

Eric Naslund, FAIA

Sebastian Mariscal Studio has been slowly building a portfolio of well-regarded contemporary housing projects throughout the city of San Diego. Their latest is Six, a rowhouse project just a block from the beach in La Jolla, one of San Diego's most desirable and expensive neighborhoods. As with all of these projects, Mariscal is the developer, architect, and contractor.

Six sits on a sloping lot on a curving street, a topographic condition made subtly evident as the apparently identical units curve and drop with the terrain. The rowhouses sit atop an underground garage accessible from the side street on the low side of the site; they address the sidewalk through a small gate in a hedge that provides privacy to the open units beyond.

Each rowhouse is composed of two parts that are expressed in their finish materials. Service elements (stairs, elevators, storage, and the like) are placed in limestone-clad pylons that act as sound gaskets between the units. All living spaces are contained in wood boxes that bridge between the stone pylons. The wood boxes—clad completely in ipe—contain bedrooms at the second and third floors. Under the wood box, a large loft-like space for the kitchen and living areas extends into gardens on both ends. This connection is made seamless by the use of fold-away glass doors that completely open both ends of the room. Ipe flooring runs outside as decking in both directions, connecting the garden and terrace areas to the interior. In fact, this "slipping" of inside to out is so effective that, when the doors are folded back, you feel as

though you are in a covered exterior space.

Six is a quintessentially Southern California housing scheme that builds on a legacy of seamless connections between house and garden. The real genius of Six is that it accomplishes this with such a deceptively simple kit-of-parts. ◉

Project Team:

Developer-Designer-Builder:
Sebastian Mariscal Studio

Project Manager:
Jeff Svitak

Structural Engineer:
Omar Mobayed

Photos by Pavlina Ilieva and Jeff Svitak

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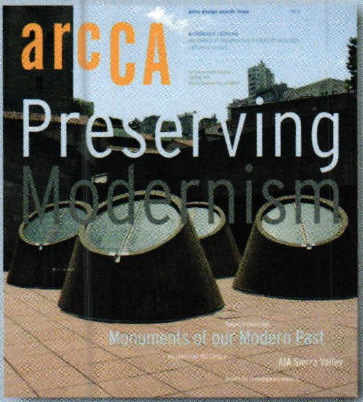

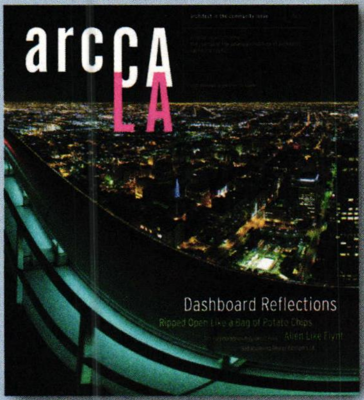

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David Meckel, FAIA

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Wachsmann, *The Turning Point of Building: Structure and Design*, Reinhold Publishing, 1961

Jandl, Burns & Auer, *Yesterday's Houses of Tomorrow: Innovative American Homes* 1850-1950, Preservation Press, 1991

Benedikt and Steinegger, *Jean Prouve: Prefabrication, Structures and Elements*, Pall Mall Press, 1971

www.library.cca.edu

Market Segments of PreFab Products (listed from least to most on-site labor)

Manufactured Homes (5% of prefab market)
Built entirely in a factory, usually referred to as HUD-Code or Mobile Homes

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Panelized Homes (45% of prefab market)
Constructed with factory-built panels for whole walls

Pre-Cut Homes (included in the panelized home percentage)
Kit homes, log homes, and dome homes

Production Builders (43% of prefab market)
Use factory fabricated roof trusses and other components

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Four Magazines You Probably Don't Read

Building Systems Magazine
Automated Builder
Manufactured Home Merchandiser
Modern Homes Development
www.calcat.org

Buckminster (Bucky) Fuller on PreFab Structures

"Conventional mobile homes are in effect extruded through tunnels and bridges, which restricts their size and shape."

Courtesy of Jay Baldwin, CCA Industrial Design Faculty
www.cca.edu

Recent Downtrend of Manufactured Housing Units (annual US production figures)

1998 | 350,000 (peak)
2005 | 146,000 (including FEMA-Katrina bump of 17,000)
www.housingzone.com

Five Largest US Factory-Built Home Manufacturers

CMH Manufacturing (TN)
Champion Enterprises (MI)
Palm Harbor Homes (TX)
Fleetwood Enterprises (CA)
Skyline Corporation (IN)
www.probuilder.com

Price to Purchase Plans for a Lowe's Katrina Cottage

$700
www.lowes.com/lowes/lkn?action=pg&p=2006_landing/Katrina_Cottage/KatrinaCottage.html

Bucky's Dymaxion Witchita House

Weighed and cost the same per pound as a 1946 Cadillac limo (6,000 lbs) and, like a car, was meant to be paid off in five years

Courtesy of Jay Baldwin, CCA Industrial Design Faculty
www.cca.edu

First Mail Order Kit Homes

Sears Roebuck & Co., which sold houses through its catalogs and sales offices to nearly 100,000 clients between 1908 and 1940. Priced from $650 to $2,500, each "Houses by Mail" kit included lumber, nails, shingles, windows, doors, hardware, and house paint. From *PREFAB* by Allison Arieff and Bryan Burkhart, Gibbs Smith, 2002.
www.library.cca.edu

Your Tax Dollars at Work

Everything you ever wanted to know about PreFab and other housing types:

www.pathnet.org (Partnership for Advancing Technology in Housing)
www.toolbase.org (Technical information on products, materials, technologies, and housing systems)

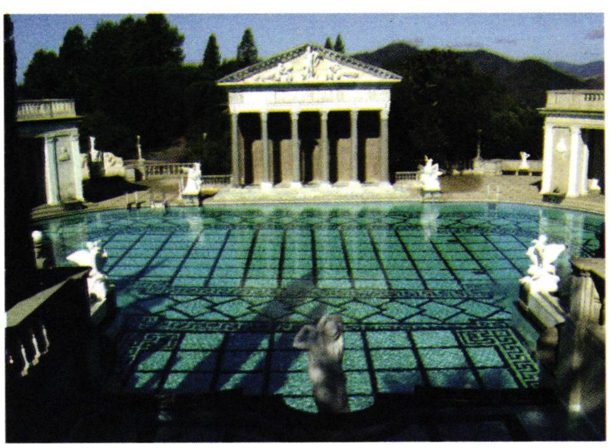
The Castles of Cambria

Eric Naslund, FAIA

This fall, I found myself on a family vacation along California's Central Coast and stopped over in Cambria for a couple of nights. The purpose of the stop—beyond enjoying the town and its beautiful coast—was to take my sons to Hearst Castle. What I had forgotten was that Cambria is also home to another idiosyncratic, visionary residence now open for tours. As it turned out, we saw both homes in the same day, and the comparisons proved as enlightening as the tours themselves.

The other residence is Nitt Witt Ridge (California Historic Landmark 939), the home and inhabited folk artwork of the late Art Beal, who hand built his home over more than fifty years using the cast-offs of others. Apparently, Art was once Cambria's trash collector and was rumored to have worked on William Randolph Hearst's place just up the road. Along the way he made use of old tires, washing machines, beer cans, car rims, toilets, broken tile, abalone shells—you name it—to inhabit his 2-1/2 acre hillside site. The result was a collage of found and appropriated objects that are somehow spun into shelter.

Nitt Witt Ridge is often referred to as the "poor man's Hearst Castle," and for good reason. Both residences are curated collections of what their makers found valuable. Hearst collected things already understood to be valuable and important, things thus available to him because of his vast wealth. Beal, in contrast, elevated the discards of his neighbors to something that seemed beautiful to him. In a world increasingly concerned about our environmental condition and dwindling resources, perhaps there is an important lesson for us. ◉



photography by Eric Naslund, FAIA