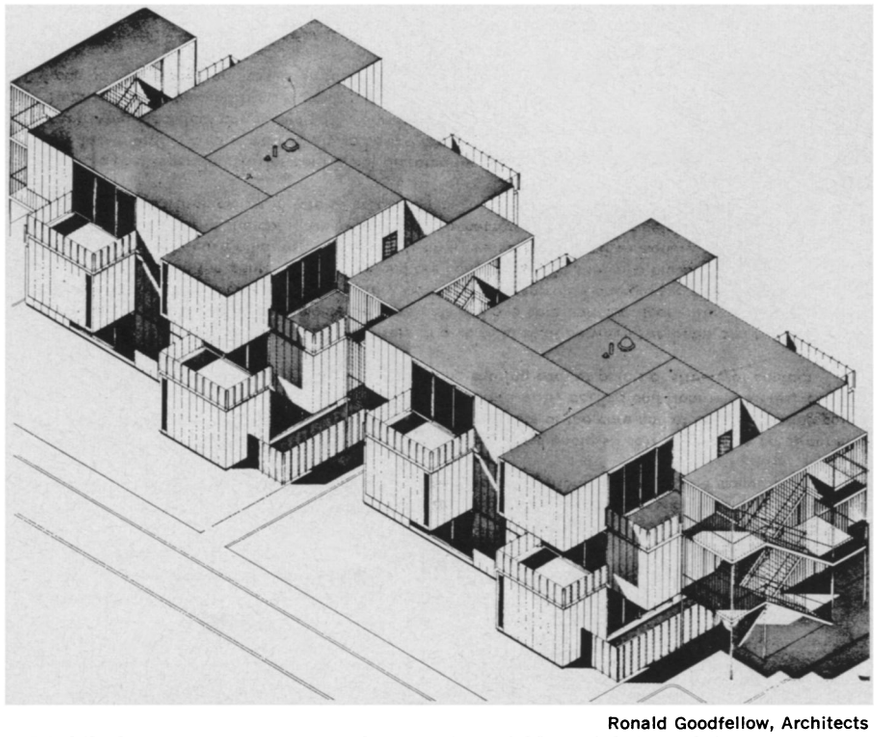
U.S. Department of Housing and Urban Development

Pre-assembled kitchen unit provides fast slum rehabilitation (see cover).

CONSTRUCTION ENGINEERING

Releasing low cost building technology



Ronald Goodfellow, Architects

Mobile-home apartment complex consists of 12 prefabricated 4-room units.

Using present building technology, it is estimated, the urban slums of the United States could be rebuilt by an expenditure of 10 percent of the U.S. national income for five years, or about $300 billion.

Ralph J. Johnson, staff vice president, NAHB Research Foundation, Inc., subsidiary of the National Association of Home Builders, states that, "In large urban areas, it may be possible to achieve in the order of 10 to 15 percent reduction in direct construction costs if the constraints of codes and restrictive labor practices are removed and if the industry is allowed to produce as efficiently as it knows how."

Johnson's cost saving estimate is based on presently-available technology. How much higher the figure could go with as yet untested or undeveloped techniques is anybody's guess.

James Gavin, chairman of the board of Arthur D. Little, Inc., in his book "Crisis Now," estimates that the savings could reach 50 percent if all the restraints on the introduction of new technology and management innovations for low cost construction were removed.

What are the restraints?

Thomas F. Rogers, Director of the Office of Urban Technology and Research of the Federal Department of Housing and Urban Development cites these: "zoning ordinances, codes, craft labor rules, financial policies, city administrative practices, lack of well developed mechanisms for dissemination and implementation of new ideas."

Many building experts point the main finger of blame at building codes and labor practices.

Paul Achenbach, Deputy Chief of the National Bureau of Standards' Building Technology Division, gives two reasons why codes are the major roadblock. "One reason," he says "is the great number of codes that exist around the country: four model codes, endless variations of the model codes, and thousands of other codes. Another is that almost all codes are specification codes rather than performance codes."

A specification code tells, in effect, how to do a given building activity, while a performance code specifies the objective of the activity but not how to accomplish it. For example, the specification code for a wall might state that the wall is to be constructed of 2x4-inch studs on 16-inch centers. The performance code, on the other hand, would state that it must be designed to withstand a specified vertical load and wind force and a given level of insulation against heat and sound. As long as the wall met performance criteria such as these, it could be made of any material, using any method of construction, and permit the builder limitless innovation.

Specification codes, says Achenbach, make a manufacturer less concerned about whether a new product will sell than with the trouble involved in getting it past code inspectors, since new materials and technology are only reluctantly approved. Meanwhile, manufacturers outside the building industry are also discouraged from introducing new products. For example, the aerospace industry might get into low-cost housing in a big way if large scale prefabrication and new methods and materials were permissible in most urban areas.

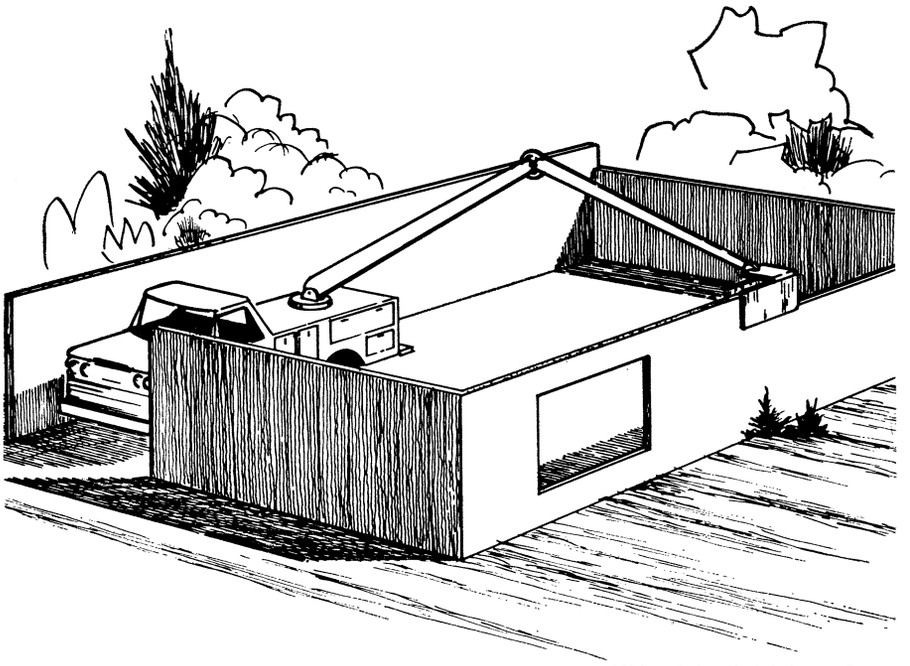
Standing in the way of a performance code—national or local—is the almost total lack of data upon which to build such a code. A complete performance code requires performance data for all building activities. For example, determining the performance required of a wall would mean determining the amount of vertical load and wind force to be withstood, plus other criteria such as impermeability to heat and sound and the degree of fire resistance. Also necessary is a description of the standard tests that building inspectors could use to determine if the wall met the required criteria. All code inspectors would subject the wall to the same test procedure.

While some performance data are being generated by the National Bureau of Standards and private industry, progress is slow. Says Achenbach, "At the present rate, it will take a decade or more before we have the data for a comprehensive performance code."

Also blocking a performance code are the lobbying pressures of traditional building product manufacturers, such as, for example, brick manufacturers who see performance codes as a way of letting in all sorts of competition for brick. Adding to this is the equally extensive lobbying pressure of building trade unions who fear their work skills will be in less demand if new materials are introduced on a wide scale.

Finding ways to circumvent or eliminate all these built-in pressures for the status quo in building technology has become a concern in Congress. Pressure is building for the establishment of a Federal building code to replace all existing codes throughout the country. What action, if any, Congress should take is now under study by the National Commission on Urban Problems. The commission is studying the pros and cons of a Federal code versus a national code. The Federal code would be mandatory, while the national code would be accepted on a voluntary basis as a replacement for existing codes around the country.

The commission is also weighing the advantages of a performance code—

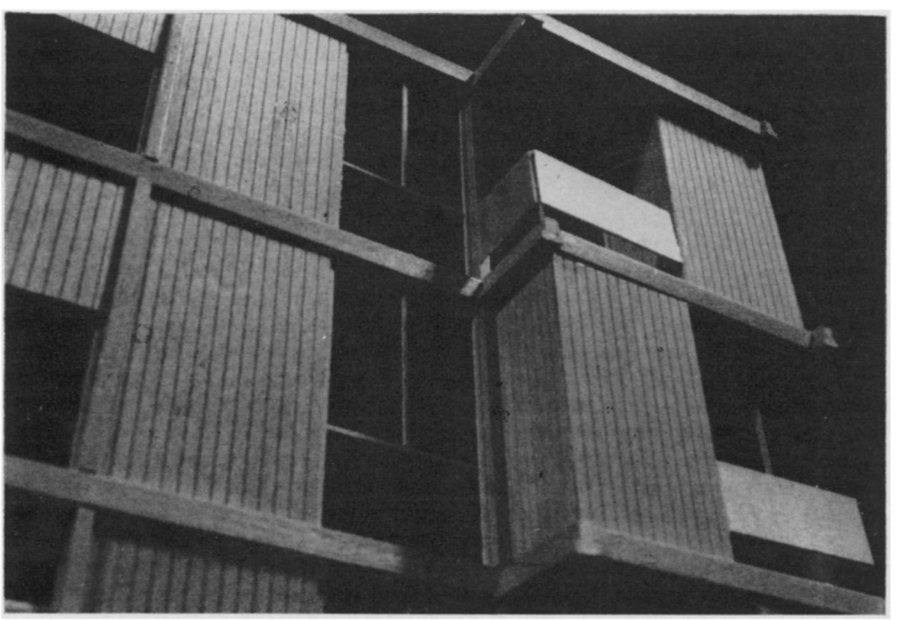


Midwest Applied Science Corp.

Building walls are extruded continuously of a foamed-in-place material.

A web of restraints ties up new technology, but the status quo is coming under attack

by John Van Deventer



Ronald Goodfellow, Architects

Each apartment in mobile home complex has two porches and two stairways.

. . . construction technology hampered

Federal or national—over a specification code. Its recommendations are expected before the end of the year.

A national performance code administered by a private organization such as the National Academy of Engineering is a strong possibility, according to Achenbach.

Meanwhile, during its one year of existence, the Office of Urban Technology and Research in HUD has taken a few oblique approaches to the codes problem, still staying within the confinements of the present situation.

For example, Rogers wanted to conduct an experimental project in Detroit without regard to the city's building code. The purpose of the project was to test a new construction method that consists of a system of columns, beams and planks precast from low-density foamed concrete. The City of Detroit felt the system might be unsafe. To convince city officials it wasn't, Rogers had exhaustive structural tests conducted on the components and on the entire building system by the National Bureau of Standards. The results satisfied the officials; the project is under way.

Rogers plans to use this approach to introduce other new methods and materials in cities around the country. Once a system of construction has been accepted by one large city, such as in Detroit, other large cities are more favorably disposed towards it, says Rogers.

But this is a piecemeal approach to a major national problem crying for fast action. A basic question still begs for an answer: Would sufficient incentives to industry be unleashed by removing restraints to innovation in new building technology—particularly codes—to stimulate some dramatic developments in low cost housing?

A pessimistic "no" to this question is expressed by Ralph Johnson of NAHB, who says, "I do not believe that, if unreasonable code and union barriers to innovation were substantially eliminated, the conventional building systems of today would be largely replaced within the next decade by radically different systems. Certainly, there would be a number of changes. For example, more plastic pipe would be used. Footings would be designed for the bearing capacity of the soil and the live and dead loads of the building. Walls would be engineered to a required thickness, not a specification one.

"But I know of no reason other than blind faith in technological research to believe that radically different materials and systems would replace existing systems and materials."

Johnson allows, however, that he may be wrong. "That's why I'm in favor of the In-Cities Project of HUD," he says. "The project will shed some light on the significance of building restraints." The multi-million dollar project, to run through 1970, will see thousands of low-cost family units in more than 10 cities constructed, using the latest technology, to see which factors affect the rapid introduction of innovative techniques.

It does seem unlikely, however, that industry—particularly industry outside the building industry—will find sufficient incentive to invest heavily in the development of low-cost building technology until after the restraints are removed.

HUD

Rogers: too many restraints.

Meanwhile, insight into the potential for low-cost housing technology can be gained by looking at some of today's innovative construction ideas, many of which have not even been tested yet.

One revolutionary new construction technique is to continuously extrude a structure—the walls, roof, partitions—rather than piece the structure together from components. The technique, developed by Midwest Applied Science Corp., in West Lafayette, Ind., uses an epoxy resin material which can be foamed in place, and a mobile, truck-mounted erector system. The rapidly foamed-in-place structures would be permanent, of constant quality, not easily damaged by weather or age, and unusually economical. With the technique, a 1,000 sq. ft. building can be erected in six hours by a crew of two at a cost of $3,800, or $3.80 a square foot.

A room module concept is under study at Cornell University in Ithaca,

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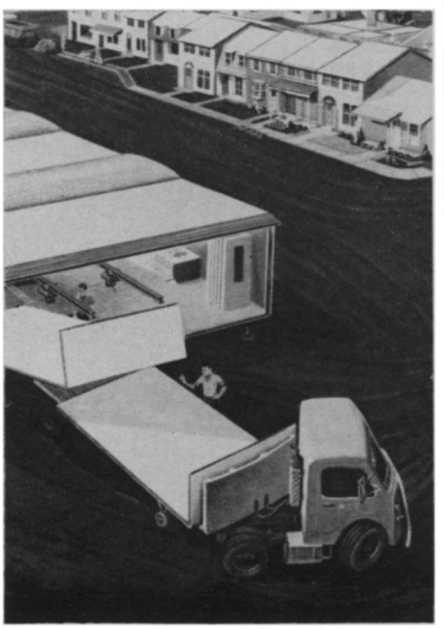
. . . building technology

N.Y. It is aimed at furnished, factory-built rooms or modules for both houses and apartments, joined together at the site like building blocks. For apartments, a utility tower with plumbing, electrical cores, and waste disposal facilities would be erected first. Then modules would be stacked up and down the tower, which would serve as a spine.

A related concept is the use of mobile factories for building pre-fabricated sections at the construction site. This is the central feature of an approach to building houses that General Electric Company's Missile and Space Division



General Electric Co.

On-site mobile factory for prefabs.

in Philadelphia has developed for the Department of Defense's Office of Family Housing. The portable plant produces finished sections of floors, walls, ceilings and roofs on site, manufacturing those items which cost-effectiveness studies show are better not shipped. The factory can produce about 1,000 dwellings a year. It can later be broken up into trailers and hauled to the next job.

Another approach to low-cost housing is the mobile-home apartment complex, developed by Housing Research, Inc., Michigan City, Ind. Each apartment consists of two 12-ft. by 30-ft. factory-prefabricated boxes, grouped around a utility core containing kitchen appliances and bathrooms. Each 12 by 12-ft. utility core serves two apartments. The apartment has two porches and is served by two prefabricated steel stairways. Mobile-home complexes are under construction in Michigan City, Ind., Vicksburg, Miss., and Amherst, Mass.