An Open Building Strategy for Converting Obsolete Office Buildings to Residential Uses

Dr. Stephen Kendall, RA, CIB[1]

ABSTRACT

This paper reports on a study of a strategy for the conversion of obsolete office buildings to residential use. We use a case study method with an existing historic structure in Detroit, the Kales Building, designed in 1924 by the famous architect Albert Kahn. The building, typical of many in downtown urban centers in the United States, is planned for conversion into 108 residential units. We compare an open building strategy to the conventional approach.

Our study involves architectural and engineering design methods, new business forms, supply chain and information management, trades, and construction management. The study is intended as a demonstration of an open building approach that can be applied to many similar multi-unit buildings as well as to new construction. The ultimate goal is the creation of an Indiana company making integrated fit-out product bundles, thus taking this innovative process into the market.

This open building strategy has several elements that are congruent with lean construction principles, not the least of which is deep rethinking of supply channel management, logistics reordering, and just-in-time services.

KEY WORDS

Open building, conversion, product bundling, supply chains, lean construction, industrial ecology

---

[1] Director, Building Futures Institute, College of Architecture and Planning, Ball State University, Muncie, IN., 47306. TEL: 765.285.1911. EMAIL: skendall@bsu.edu. Website: www.bsu.edu/cap/bfi

INTRODUCTION

This study reports on an innovative strategy for the conversion of obsolete office buildings to residential use, including a new way of outfitting residential units by means of fit-out packages. A fit-out package allows the rapid installation of partitions, heating and air conditioning, kitchen and bath equipment and finishes with all the piping, wiring and ductwork related to this equipment. Installation is done per unit according to the floor plan selected for that specific unit.

The fit-out approach is of interest for two reasons. First, it offers an individualized approach to large residential conversion or new projects. Second, it is also economically competitive compared to existing strategies of outfitting dwelling units, while offering much needed decision flexibility and quality control. It thus combines a breakthrough combining improved decision flexibility and individuality with more efficient production.

The study uses an existing historic office building structure in Detroit, the Kales Building, designed in 1924 by the famous architect Albert Kahn as the Kresge Company offices. The building is being converted into 108 residential units.

Our study involves architectural and engineering design, new business models[2], supply chain and information management, trades, and construction management. The research is intended as a demonstration of an open building approach that can be applied to many similar multi-unit buildings as well as to new construction. The ultimate goal is a plan for commercialization of a new kind of "product - service" company delivering just-in-time integrated interior fit-out by an Indiana company, thus taking this innovative process into the market.

THE CONVENTIONAL APPROACH

The conventional approach to large building conversion to residential use requires that a developer "pro-forma" of unit sizes and layouts be made, based on projected market demand, with building design and estimating following. This presents difficulties because the time between decision to convert and actual lease-up or sale can take several years, during which time the market, interest rates, investments, prices on construction and labor costs and other factors inevitably change. Since the conventional process assumes a fixed "program" of detailed decisions about unit layouts and equipment, it does not easily allow for changes to these specifications either during the development process nor in the future, thus making the entire process overly rigid and prone to waste, conflict and excess costs. This process also assumes no place in investment decisions for individual occupants, thus keeping this process outside the consumer market where it should be.

In this conventional process, it is not unusual for the unit mix and unit layouts to change several times before construction begins, requiring extra work for the design team,

---

[2] Yashiro, Tomonari. "Leasing of infill components – New business model development for dematerialization of building related industry." Unpublished paper, Institute of Industrial Science, University of Tokyo. 2002.

estimators, and developer. Knowing that these changes are inevitable, only schematic work is done requiring many "rules of thumb" for estimating purposes and excessive dependence on guesswork. Delaying the building's technical decisions until the last minute produces conflict, waste, mistakes and increased quality control problems.

These problems arise because the design and decision process tries to make the building an integrated whole that is entirely "fixed". All decisions – those at the level of the building and at the level of the individual units - are tightly interdependent. The decision process is unable to account for the individual dwelling unit as the basic "decision unit" on which decisions could and should be made - matching the basic social unit of the household.

This rigidity is unfortunate because inevitably, a multi-unit residential building is an assembly of individual units (leased or sold) in a framework of common spaces and elements. In the conventional way of working, decisions about one dwelling unit are excessively inter- dependent on decisions about other units. The decisions about unit mix, size and layouts on one floor are dependent on the layout decisions of adjacent floors.

Three years ago, the development company began assembling the financing - a mix of state and national historic tax credits and bank loans. Early in this process, it conducted a market analysis to determine a unit count, mix and layouts, as well as the rents. Based on these projections, an architect began to design the conversion. Cost estimates were made based on schematic architectural and engineering designs.

Difficulties were encountered in the financing scheme, and other conditions in the market changed, such as interest rates and competition in the local market. These uncontrollable changes forced the marketing plan for the building to change. The architect completely revised the unit mix and floor plans, with the normal consequences to the mechanical, electrical and plumbing designs and cost estimates. This process of revising the building's design and engineering occurred three times. At a certain point, a decision was made to "freeze" the design, to enable construction bids to be obtained and construction undertaken. Construction is expected to take 12 months. (Figure 1: The Kales Building, Detroit)

AN OPEN BUILDING APPROACH

The process we are studying is radically different. It has five objectives:

1. Offer the developer decision flexibility in meeting current and future markets.
2. Enable the developer to defer decisions about unit mix and layouts without risk, by making each dwelling unit as autonomous as possible.

3. Address the extremely limited space on the site for logistics of construction.
4. Develop a process that enables maximum use of off-site "controlled environment" facilities to prepare ready-to-install "integrated interior fit-out kits".
5. Enable subsequent adjustments to the building to be done on a one-unit-at-a-time basis, including conversion to condominium units for sale, while assuring that improvements to the base building will minimally affect individual units.

A TECHNICAL DEFINITION OF OPEN BUILDING

Open building is the term used to indicate a number of ideas about the design and construction of buildings including: the idea that users as well as professionals may make design decisions; that the shared part of a multi-occupant building should be carefully distinguished from the parts decided for each individual occupant; the idea that the interface between technical systems should allow the replacement of one system with another performing the same function (as with different fit-out systems applied in the same base building); and the idea that the built environment is in constant transformation requiring that change be understood by professionals, to make accommodating and sustainable environments.[3]

Base Building – the more permanent part of the whole building, tied to the political, geotechnical, climatic and regulatory environment (structure, skin, public circulation, and main MEP systems)

Fit-Out – the more changeable part of the whole building, determined for each occupant space, with its own MEP systems, partitions, equipment, and fixtures.

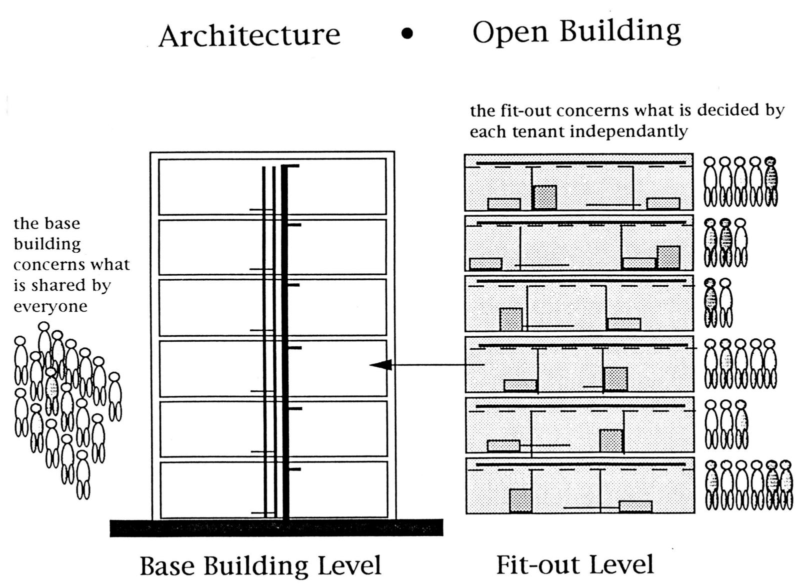

Figure 2: A diagram of open building (Kendall)

---

[3] Habraken, N. John. www.habraken.com/john/obintro

The first step in converting an existing building using an open building strategy involves a methodical design process in which a typical floor plate is analyzed to determine an optimum variety of unit sizes, given a “reasonable” range suited to the market. This involves a series of design studies in which vertical MEP “stacks” are positioned and the capacity of the space to accommodate a range of unit sizes and layouts is evaluated. These studies are done using a “test fit” process, in which accommodation capacity is evaluated given a number of constraints. Then, based on lessons learned, the MEP stacks are repositioned, and the “test-fit” process is repeated. This design process continues until agreement is reached about optimum unit mix and layout variety. At that point, a base building design is fixed.

This process is based on a principle of ”levels”, illustrated in the diagram above. A “level” is related to a certain physical environment under the control of a party – in this case the base building is controlled by a development company. The idea is that a “lower level”- in this case the individual “fit-out” - is freely decided in terms of its physical elements and their position at that level, within the constraints given by the higher level.

Here are drawings we made to demonstrate the accommodation capacity of the building. Here you see a typical floor of the building. Its structure and envelope – protected by historic guidelines – and the building’s elevators, fire stairs, central MEP shaft, and public corridors, are in blue. They have not changed. The “final” positions of the new vertical MEP shafts (shown in pink) are indicated.

We decided to retain as much of the existing building as possible. The existing vertical circulation, main MEP shafts, and public corridors are retained.

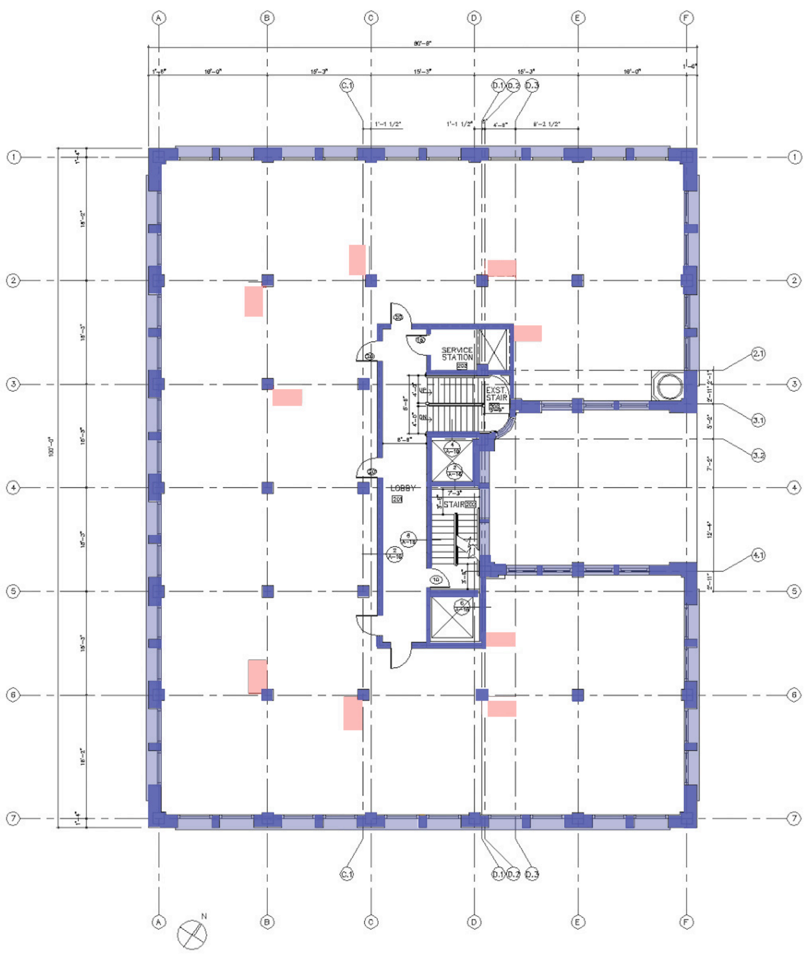

Figure 3: A typical floor showing the new plumbing cores and the existing building

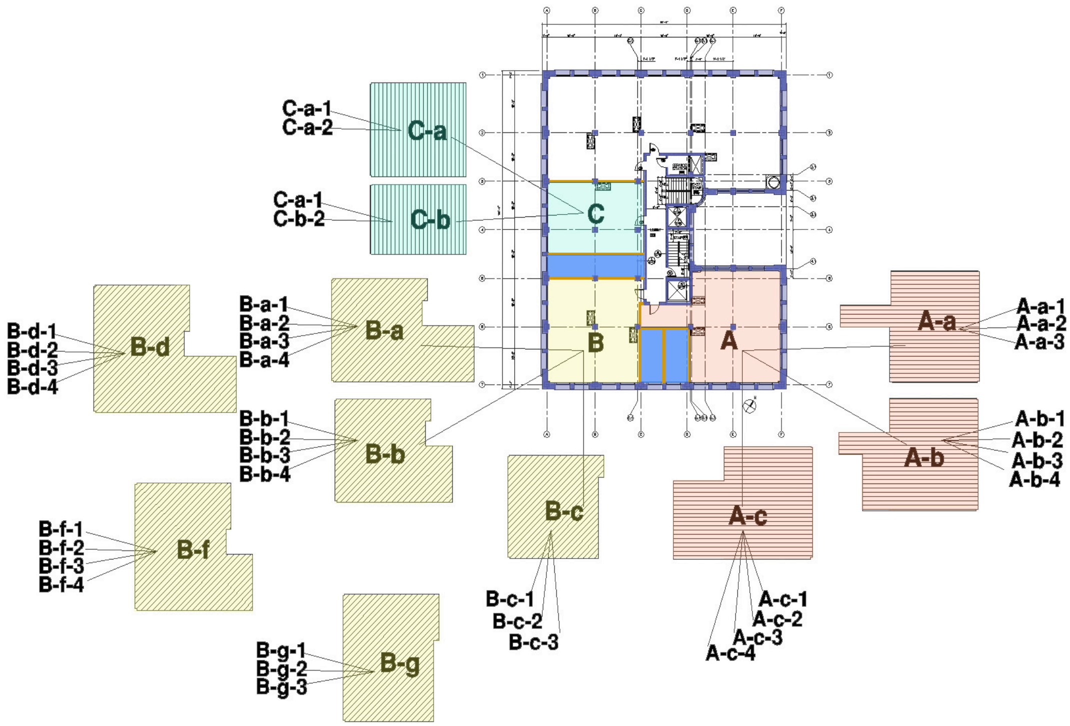

Figure 4: The capacity analysis of one typical floor of the building.

Given fixed vertical MEP stacks, a variety of dwelling unit sizes are possible and for each a variety of layouts can be made. A "margin" between units A and B and B and C, allows their respective sizes to vary.

This diagram shows the many unit size variants possible on any floor. Each unit (e.g. A-b) can easily accommodate a variety of floor plans. The following drawings show two. This means that the developer can offer a "menu" of choices (rented or owned) and can offer occupants the opportunity to make fully customized units exactly meeting individual preferences and budgets.

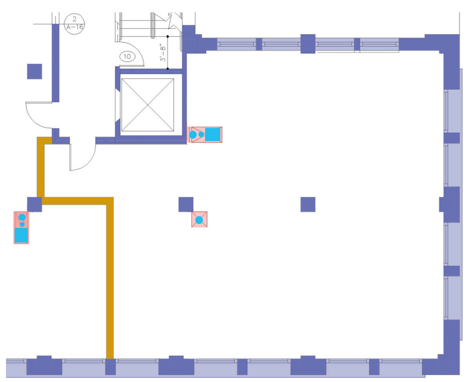

Figure 5: Unit A-b

This drawing shows unit A-b empty. The parts in blue are base building elements, including two MEP shafts. The demising wall separating units is yellow. Below are two variants and their specific horizontal plumbing systems in red. We have avoided any vertical penetrations except at the base building MEP stack. The result is that any unit's floor plan is entirely independent of any other, enabling design, pricing and "kitting" of each unit to be entirely independent.

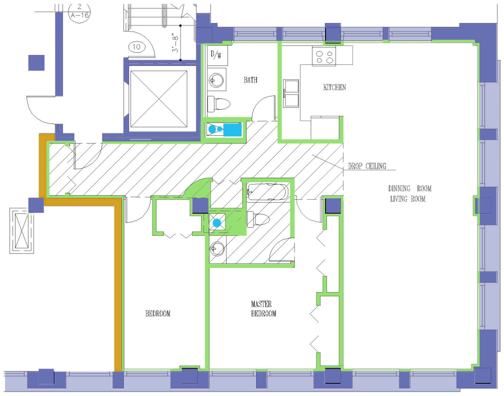

Figure 6: Variant A-b-1

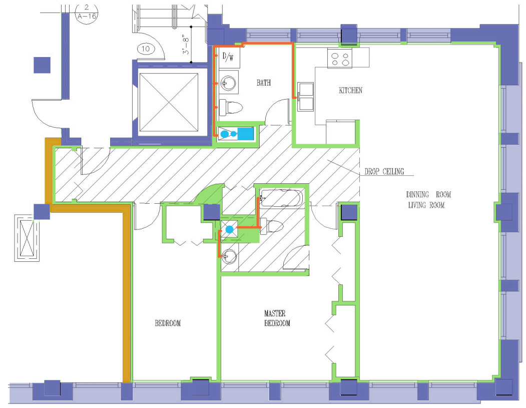

Figure 7: Variant A-b-1 w/ horizontal piping

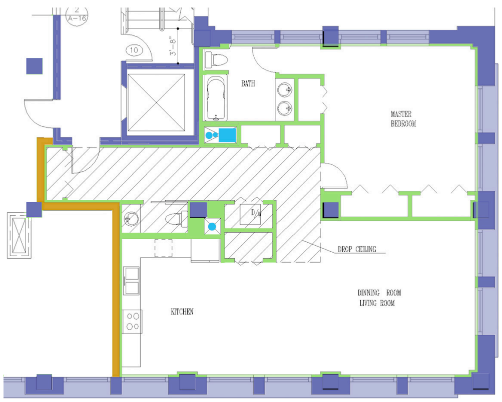

Figure 8: Variant A-b-2

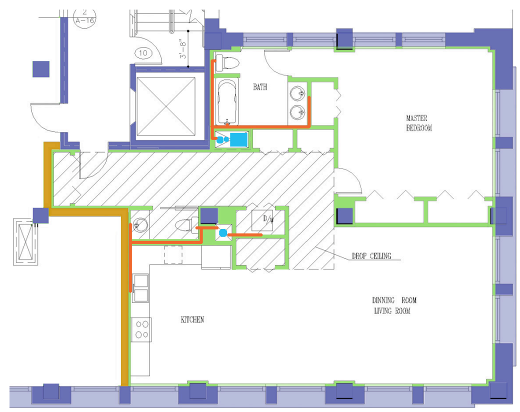

Figure 9: Variant A-b-2 w/ horizontal piping

ORGANIZATIONAL STRATEGY

The above discusses briefly the architectural design process needed to prepare an old building for fit-out on a unit-by-unit basis. It is a trial-and-error design process of fixing certain constraints (e.g. position of vertical piping chases) and, with additional constraints in mind, "exploring" the capacity of the constrained space to accommodate a variety of reasonable unit sizes and layouts. This process is repeated until agreement is reached that an optimum number of variants is possible.

I have also suggested that this process can be supported by the use of "integrated interior fit-out kits", prepared "ready-to-install" at a central distribution facility set up specifically for such "kitting" processes. The basic concept of design for supply channel management[4] is not new but has not been successfully implemented at the level of complexity this project entails.

[4] O'Brian, William. "A Call for Cost and Reference Models for Construction Supply Chains". IGLC – 11 White Paper, December 2002.

Two basic kinds of "kitting" currently can be observed in construction, one of which can be called "project independent" and the other "project dependent". The former is evident in kits found in any home project center (e.g. in the plumbing department, or in the RTA furniture department) in which products from a number of manufacturers are kitted by another company and offered to the market without foreknowledge of the specific project in which they will be used.

The kind of kitting we are developing here is "project dependent".

Once design specifications for a unit's fit-out (a "project) is known, the data is transferred to a fabrication center. Here, all parts needed for that "project" are prepared – cut to size, pre-assembled, or otherwise prepared in the correct number – and delivered to the building. This may be done in one container, or, in our case, the deliveries are made in several "packages", following an optimum site installation management schedule. Because of its urban location, the site has limited space for containers to remain in-place during the 2+ weeks needed to fit-out a unit. We project a sequence of JIT deliveries to the site from the fabrication facility.

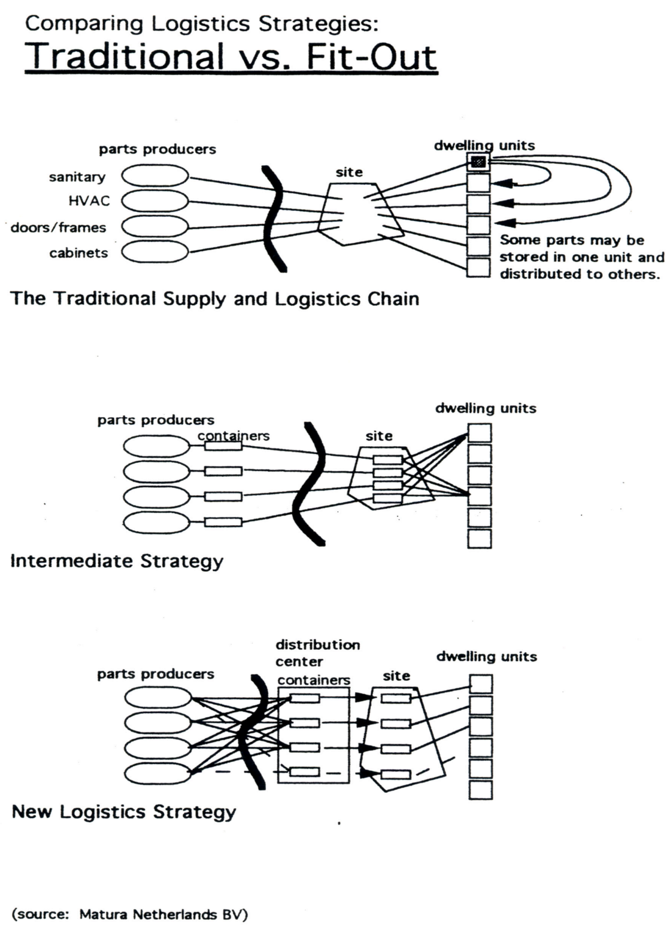

Figure 10: A diagram used to explain the Matura Infill System[5]

[5] van Randen, Age. Matura Infill System, BV product literature.

INFORMATION MANAGEMENT, SUPPLY CHAIN and LOGISTICS

The key to this strategy is information management. This is related to logistics control, and, as Figure 10 reveals, the supply chain management is also a key to success. In a conventional supply chain for providing parts for fitting out the empty shell of a converted building, each subcontractor is responsible for bringing the materials to the jobsite and for installing them, in the complex choreography we are familiar with. There is no central information management required nor would it be easily developed. The building is considered to be a one large, integrated project delivery and management process.

In a fit-out approach, the flow of information is different. Design, fabrication and installation are integrated per unit. This begins with a clear organization of the parts making up a fit-out package. We make a distinction between "element groups", "elements", and parts. We make a further distinction between project independent parts, elements, and element groups, and project dependent parts, elements, and element groups. This classification supports the management of information from the first interaction with the client and/or user of to the fabrication and installation procedures.

From the first interaction with the client, information is collected on the basis of design decisions and further processed by the fit-out company's technical designer, the result being a detailed list of instructions for the distribution/fabrication center and the installation crew. Some of that information flows back and forth between the client and the technical staff in relation to specifications and costs, resulting in a final installation contract.

CONCLUSIONS

Political, economic and social pressures for revitalizing our existing urban fabric continue to grow. Accompanying these pressures is a widespread trend to convert obsolete buildings into residential use, and to adjust older residential buildings to contemporary standards. This trend is national and international. In fact, this study is the second to be produced by the Building Futures Institute in cooperation with the International Cooperative Research and Development on Sustainable Urban Management with Conversion of Buildings, led by a research team at the University of Tokyo.

While the causes are many and varied, the general pattern, from the point of view of planning, architecture and construction, is one of reuse rather than replacement. From a tendency of "scrap and build" to the development of methods of "stock maintenance", we are witnessing the international sustainability agenda realized around the world in what we call "Open Building" practice.

These developments challenge architectural and engineering knowledge as well as business practices, construction management, supply channel logistics and information technology. The two basic questions all these fields now have to address is:

"How can we facilitate the conversion and upgrading of existing buildings in respect to both immediate political, economic and market requirements, as well the long term capacity of these upgraded buildings to accommodate inevitable future adjustments?"

"Second, how can we organize these processes with full recognition of the individual household – the basic social and economic unit of society – thus balancing the requirements of the larger community of interests with those of individual control of the immediate dwelling environment?"

Underlying our research – which is unapologetically practical in its orientation – are several problems that plague change agents in the building industry. The problems arise out of an understanding of the structure of the building industry and the way it improves itself over time. In large measure, these problems stem from the unique pattern of innovation diffusion in the building industry. This pattern is not like that in the automotive, high-tech, chemical, or other large industries. Again, a large literature exists on this subject, albeit a very fragmented literature[6].

Innovation in the building industry is constant, fine-grained, and ubiquitous. Because the locus of initiative and the dispersal of sources of influence are highly disaggregated, the sources of and patterns of diffusion of innovation are equally diverse and disaggregated. This is both the industry's strength and its weakness. Innovations are often embodied in products, sometimes in processes, but in all cases are difficult to "protect" for long.

New processes also are invented, and sometimes these are quite independent of specific products. For example, purchasing innovations involving new ways of bulk ordering or contract purchasing have been widespread. One notable change that is taking place today is increased concentration in all sectors. Large firms are acquiring other large firms and smaller specialized concerns, creating new opportunities and improvements in communication and laying the ground work for investment in research and development that is not possible in smaller firms. Best practices tend to "bubble up" during an acquisition. Yet while the big corporation can gain power it can also loose attention to the individual customer.

In general, success in product innovation is higher when the organizational or "process" dimension is not affected. Similarly, process innovation is less likely to meet resistance when it does not distort or implicate the products flowing through the processes involved.

Several questions have continued with us as we work, stemming primarily from recognition that we are involved in a diffusion of innovation process and that the innovation at this stage is almost entirely related to changes of process. Thus, we are asking: "How can we add value and contribute new knowledge without trying to control access?" "Who can appropriate the benefits or return on investment from the innovation that we are making?"

These are similar to the questions facing the "open source" developers working in the Linux model of software. We believe we are contributing to a process of innovation and seek benefits from our work, but we also want to achieve success without setting up barriers to widespread implementation of what we have learned.

---

[6] Barrett, Peter. "Innovation in Construction – What needs to change?" Proceedings 10th Annual Symposium Construction Innovation and Global Competitiveness. University of Cincinnati and CIB, September, 2002.

In addition to these goals, we have a second and equally important goal. This goal is to bring the approach reported on in this report several steps closer to implementation.

ACKNOWLEDGEMENTS

The Participants

This study builds on many years of experience by the principal investigator, and by the work of many colleagues in other countries whose careers are committed to overcoming the barriers to wider implementation of open building principles.

In addition, the work has been immeasurably strengthened by the active participation of several other local sources of expertise. First of all, three academic colleagues, one at Ball State University (Professor Erdogan Kumcu, Department of Marketing and Management) and two at Indiana University Purdue University / Purdue School of Technology (Dr. Chul Soo Kim and Professor Sally Frettinger-Devor) have added depth and breadth to the study. Second, three companies have committed staff to the project, giving us a measure of practical knowledge and experience without which the study would have remained academic despite our best efforts to ground the work on the constraints of practice (Mansur Residential Development, Gaylor Group, CS&M Mechanical Contractors). Third, four able students in the College of Architecture and Planning have contributed to the effort, in preparing technical drawings, delineating legal issues involved, in helping to prepare the design, visualization and animation to the study, and in bringing prior experience in business and manufacturing to the project (Jing Li, Ryan Suess, Mark Dieterlie, Christine Barton). And finally, a group of students in the MBA program at Ball State have used the project as a case study by producing the business plan outlined here (Mark Dieterle, John Johns, Robert Braun, Cindy Dooley)

Sources of Support

Funding for a graduate student came from the University of Tokyo Matsumura Laboratory in the Department of Architecture, with support from a grant-in-aid for the Development of Innovative Technology, which in turn is funded by the Ministry of Education, Culture, Sports and Technology of the government of Japan. Release time from teaching to enable the project director of lead the effort was granted by the Department of Architecture at Ball State University. In-kind support was made available by Mansur Construction Services, CS&M Contractors, and the Gaylor Group.

BIBLIOGRAPHY

Barrett, Peter. "Innovation in Construction – What needs to change?" Proceedings 10th Annual Symposium Construction Innovation and Global Competitiveness. University of Cincinnati and CIB, September, 2002.

Brand, Stewart. How Buildings Learn: What Happens After They Are Built. Viking, 1994.

O'Brian, William. "A Call for Cost and Reference Models for Construction Supply Chains". IGLC – 11 White Paper, December 2002.

Habraken, N. John. www.habraken.com/john/obintro

Kendall, Stephen "An Open Building Industry: Making Agile Buildings that Achieve Performance for Clients". Proceedings (vol 1 of 2) 10th Annual Symposium Construction Innovation and Global Competitiveness. University of Cincinnati and CIB, September, 2002.

Ibid. "Infill / Fit-Out Systems: Toward a Residential Infill Industry". (Guest editor) Open House International, vol. 26, no. 3, 2001

Ibid. "Toward Open Building: Practical Developments in Europe". Open House International, vol 25, no.4, 2001

Ibid. "Open Building: An Approach to Sustainable Architecture". Journal of Urban Technology, December, 1999.

Ibid. Residential Open Building. co-authored with Teicher. SPON, London, 1999.

Ibid. "Open Building: A New Multifamily Housing Paradigm". Urban Land, November, 1996.

Ibid. "Europe's 'Matura Infill System' Quickly Routes Utilities for Custom Remodeling"; Automated Builder, May 1996.

Yashiro, Tomonari. "Leasing of infill components – New business model development for dematerialization of building related industry." Unpublished paper, Institute of Industrial Science, University of Tokyo. 2002.

van Randen, Age. Matura Infill System, BV product literature.

This paper was prepared for the International Lean Construction Institute conference held in Blacksburg, VA, July 22-24, 2003