TWELVE BUILDING SYSTEMS

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Abstract

The workshop attempts to explore the potentials and limitations of building systems. Building systems offer a historic chance for a retarded industry, if they are used as part of systemic approaches. The multiple elements in the general process of building delivery are interlinked and behave as a complex system, affected by outside independent variables. Building systems as technical solutions have to be integrated into the structure of this system. Combined with managerial skills of systems building and backed by user needs analyses they can become effective tools in providing built environments responsive to social needs - offering initial flexibility and built-in adaptibility for future functional changes. To prepare the introduction and growth of building systems on an industrial scale in a competitive economy, several critical areas need attention: comprehensive and reliable data bases, interdisciplinary cooperation, future oriented research, incentives to accelerate innovation processes, market research and development, public information, and education.

Building Systems - Chances for a Retarded Industry

The building industry is notorious for failing to adapt to the needs of our century. Its means of providing for our built environment continue to be strangely out of date. Its production methods are antiquated, distribution is devious, and assembly disorganized. A network of building and zoning ordinances - often contradictory, and almost always obsolete - has to be negotiated, as do all the legal processes involving transfer of land titles, financing, etc. As a result of this archaic system of production, building prices are high, quality generally low, and output inadequate. (1)

Not only could building adopt modern means of production and organization, it also could adapt much better to the social conditions of our day and the needs of tomorrow. The emerging building industry, if to be successful, has to link its objectives to social goals. It has e.g. to become sensitive to the housing crisis existing in the wealthiest society the world has seen. In particular, ways have to be found that broaden its focus from the lucrative field of middle-income single family residences to new scales of operations involving the design and construction of whole communities, communities which will include large population segments now living in substandard housing and often chaotic environments. This new context will require a shift from an individual building oriented technology to a system oriented technology, where sets of components with rules for interaction are developed first, and then produced continuously, long before they are applied in unique combinations for unique solutions in unique situations.

Building systems can indeed match user needs as many application examples from the field of education facilities suggest. The various consortia based school building systems in Britain - CLASP, SEAC, SCOLA, etc. - are outstanding examples. They were developed with active participation of educators since their inception, are strongly user oriented and provide excellent facilities at controlled cost. School building systems on the American continent like SCSD, SEF, RAS, etc., or the Marburg University Building System in Germany, show similar characteristics. Their importance, however, goes beyond their initial matching of careful defined functional performance requirements. Functional needs within buildings, activity patterns, circulation, etc. do not remain constant and cannot be preplanned over the lifetime of a structure. The built-in adaptibility to future functional change, expansion, etc. makes these system-built facilities superior to conventional solutions where structures after having outlived their suitability are still used, but differently and with sacrifices to efficiency. By devising architectural forms that are open to use change, able to accomodate unknown functions in the future, designers can contribute to social development in a time noted for rapid change. Functional building types in the classical sense may decrease in importance, giving way to buildings with interchangeable functions that may introduce a new type of architecture, a building system-built environment that, because of its usefulness, will have a good chance to outlast our present generation.

The current disorganized state of the building industry, the scale of the urban housing crisis facing the nation and the necessity of a continuous adaption of the product to changing user requirements all call for a strong systems orientation of the building process.

Building Systems can be described as a set of rules which apply to the relationships between kits of parts (building components), developed or selected to function as a whole. It has become clear, however, that building systems as technical solutions alone cannot be expected to succeed in a competitive economy. Historic experience shows that "hardware" systems of building cannot resolve the socio-political problems connected with building. The building process has to be recognized as a complex network of interacting forces. Materials, products, production, management, labor, legislation, codes, real estate, financing, marketing, transportation, etc. are interdependent variables behaving as a system. A reasonable understanding of the complexity of this system should be a prerequisite for any organization considering to compete on the market place. A recent study identifies the structure of an important portion of the current U.S. building community: the growing industrialized housing industry (2). It provides potential building systems sponsors not only with the basic information for a market entry by identifying the linked elements of the industrialized housing industry in a network diagram, but also selects the most critical strategic points within the industry's structure that inhibit growth, and suggests ways how they could be resolved.

It is obvious that in order to become competitive, building systems should be developed in a coordinated Systems Approach, which can be described as a "strategy of problem definition and solution which emphasizes the interaction between problem elements and between the immediate problem and its larger context, and which specifically avoids traditional methods of independent or ad hoc treatment of the various elements"(3). The application of the systems approach to construction - Systems Building - results in "the organization of programming, planning, design, financing, manufacturing, construction, and evaluation of buildings under single, or highly coordinated, management into an efficient total process"(4). Systems building as a management tool, can be very effective in relating structures to User Needs, "those conditions which the user of a building considers necessary or desirable as environment and support for his activities, without particular references to how such conditions are to be physically produced"(5). User needs are transformed in Performance Specifications, "a set of specifications which prescribes a building system, subsystem, or component for bidding purposes not by its physical materials, shapes, dimensions, or other physical properties, but by the desired results; in other words, not by what it is, but by what it does"(6). By stating objectives in performance terms rather than in terms of particular technologies, alternatives can be compared in regard to their cost/effectiveness, which will take into account the continous maintenance and operating costs and costs for changing space layouts, which are essential for the lifetime economy of any facility.

Systems building, augmented by building systems may even see the return of the user as force in shaping his environment. Several models of active user involvement in an emerging housing industry have been suggested with the aim of adapting the building economically to the user rather than the user to the building (7,8). It is this notion (building systems combined with the managerial skills of systems building and a decided user needs orientation) that will let building systems contribute substantially to the shaping of a humane world.

Partially industrialized forms of building production concentrating on components with high technological content (electrical, mechanical, hydraulical) can exploit the benefits of mass production to the fullest. Subsystems that are compatible with conventional building techniques in particular have a good chance to succeed as they imply lower risk and may threaten the vested interests of the traditional operators in the building process to a much lesser degree than "total" building system packages. Recent developments seem to prepare the entry of components of that nature in international markets already(9). In the light of the fact that new buildings constitute the smaller part of our whole built environment and that much of the aged building stock is in dire need of rehabilitive modernisation, the market for these components could possibly be broadened substantially.

The future holds great promise but there is a long way to go. Public or private large scale private commitment to capital intensive building processes has yet to happen, but will become inevitable if the gigantic construction needs of the years ahead should be overcome. Mankind seems to have reached a doubling rate of 11 years for its urban population already (10), and the estimated housing need (alone) for the next 30 years is over 1 billion dwelling units (11), more than the total number mankind has built in its entire existence. The scale of necessary operations is unprecedented and requires the development of building systems for mass production on a scientific basis. Limited insights, concepts, preparation time, markets, and resources so far generated limited solutions with limited public acceptance. Some of the failures were and are spectacular and should serve an educational purpose. We would, however, miss a major opportunity in history by not exploiting to the fullest the potential capabilities of science and technology to advance the processes for realizing major improvements in building's delivery time, performance characteristics and cost control.

To this end several critical areas need attention:

- Comprehensive automated data bases for the building industry - depositories of information with automatic selection and updating of information - can provide the planner with a wealth of manipulable information as to facts and their interrelationships. Easy accessible, these data banks will cause multiple technical and managerial developments.
- The building code system is currently undergoing major overhauls regarding scope, content, uniformity, computerization and enforcing processes (12). Deliberate efforts can be made to prevent codes from acting as a brake on development by basing them on performance concepts and by stipulating periodical revisions.
- Professional societies, trade organizations, labor unions, manufacturer organizations, and the like, now largely fragmented and organized around distinct technologies, should open and provide frequent problem oriented forums for crossdisciplinary interaction. The active participation of multiprofessional groups in formulating and implementing medium and long range national building goals would be only logical.
- The systematic use of technological forecasting techniques could assist not only in the articulation of national objectives but also in the definition of technological research requirements in areas where existing research programs are inadequate. However, as the general business horizon rarely extends much farther than the aim of maximizing profits - and as the private economic sector is likely to dominate the development of building systems in the foreseeable future - needs of people and society have to be given sufficient attention in the allocation of r&d funds. Contextual maps with subject matter organized in modules could serve as a basis for cross-support of interrelated projects.
- While most segments of American business and industry respond rapidly to any advances in science and technology and invest much of their manpower and resources in planned experimentation and development, the building industry is notorious for being much less innovative. Judged by standards of the industrial community, building's allocation of funds for research is far underdeveloped. However, even in a situation of scarce financial resources, innovation can be accomplished focusing on technology transfer, the diffusion of existing technology; new ways of applying products and processes, developed in other areas, to particular problems in building (13). The method is by far less costly and time consuming than original research and development (14,15). A recent government announced

program seems to prepare federal efforts to mount a national program of innovation incentive mechanisms to overcome existing barriers in the civilian sector (16). The building systems industry would be well advised to participate.

· As far as innovative marketing and process management is concerned, industrialized building as a capital intensive activity can learn much from other major industries, which pioneered e.g. with product individualization, or which reduced required investment by being only concerned with design, assembly and marketing, while subcontracting out the actual manufacture of components. Scientific marketing techniques for building systems have to be developed based on a thorough understanding of historical inertia, recognition of acceptance cycles, correct assessment of economic requirements, trend extrapolation, demand aggregation, etc. Matching of industrial objectives with social goals, and continuous economic monitoring with cost/benefit and cost/effectiveness analyses, will essentially guide building systems into a future of mass production and mass markets.

· International or corporate competition may well accelerate the growth of building systems, as may social disequilibria, the ecology movement, or plain challenge. Probabilistic assessments of alternative futures will certainly stimulate and somehow guide the technological development (17). The public, however, is presently ill informed on alternative futures or not at all. Not a single TV station or newspaper has a technology "daily". Building systems as a study object for design professions is only beginning, to some extent, to intrigue this country's academic community, leaving leaders in the field with only a scant basis of competent personnel for years to come.

To set general building goals without relating them to specific implementation plans helps little. Major political commitments that would ensure such conditions for long-term production in building that it would be easier to plan ahead are nonexistent. In the face of such uncertainty the task of improving the productivity of the building process in this country is formidable. Any systemic and industrial approach for building has to be scientifically prepared. A successful planning of a future of building with systems will largely depend on more effective cooperation between government agencies, industries, labor, finance institutions, business, mass media, user groups, educational institutions and research centers. Management technologies, which play a crucial role in accelerating the pace of progress, are available, distribution, transportation and communication systems exist or can be improved, techniques can be learned, and attitudes can be developed. It is not too late and it may well be an historic chance.

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THE BUILDING BLOCK SYSTEM: A RESEARCH AND DESIGN STUDY FOR MODULAR RELOCATABLE FACILITIES

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Abstract

In July 1971 the USAF Civil Engineering Center (CE Center) contracted with Rensselaer Polytechnic Institute, for its Center for Architectural Research, to undertake a Research and Design Study for developing a Building System for Modular Relocatable Facilities. The Building Block Research and Design Study, its official name, is designed to provide research and design guidance for a system of modular relocatable facilities which can accommodate a variety of uses, which can be utilized in a variety of circumstances, which can be recovered and relocated, and which can provide the necessary cost, time and quality performance.

The Need

As part of its total mission, the CE Center is concerned with providing habitable facilities which are both rapid-response and variable-term in nature. In addition to their instant-response facility program (Bare Base Mobility), and their conventional construction program (which takes years to place a facility) there is a need for a program which provides facilities within 6 months or less, facilities which can be shipped anywhere around the globe, facilities which can remain in place for unspecified lengths of time, but can be moved, relocated, and reconfigured several times over the buildings life-time. Facility types include dispensaries, offices, dining halls, schools, bachelor quarters, laboratories and are used for military requirements as well as emergencies and disasters (floods, hurricans, etc.) for both military and the civilian sectors.

Over the past 7 years the CE Center has provided these types of facilities and gained considerable experience pertaining to modular relocatable facilities. In addition many problems remained unsolved especially in the areas of environmental quality, manufacturing, shipping, storage, erection and general facility use. As a result the CE Center requested a research and design study which would result in a building system representing a "quantum jump" for both modular relocatable facilities and building system developments. The following general design criteria was established: (1) facilities had to be deliverable within 6 months or less; (2) the building system had to be of a quality equal to permanent type of construction; (3) one building system had to work for at least nine different facility types (theaters, libraries, dining halls, officers mess, laboratories, offices, bachelor living quarters, schools, and dispensaries); (4) the building system had to be capable of being shipped by land, sea and sometimes air, and erected anywhere around the globe between the arctic and antarctic circle; (5) it had to be erected using semi-skilled labor; (6) it had to use off-the-shelf technology;

(7) components and subsystems had to be manufactured in the U.S. to minimize the "gold flow"; (8) it had to be of reasonable cost; (9) it had to be procured using the existing delivery/logistic system of the Armed Services procurement.

The Building Block System

While space does not permit a detailed description of the methodology used in developing the Building Block System, the study team developed a basic design concept which allows for a "free" open space (which can be configured and reconfigured in many ways) within a structural frame, and with services distributed from above and below the "free" space. The mechanical and electrical services are connected to utility mains at the periphery of the facility which in turn connect to a separate energy-producing module at the exterior of the facility.

For the design of the system itself we selected the erector-set approach. This approach is one where the Building Block System is a kit of parts which can be put together in erector set fashion, according to a set of rules, allowing for a variety of configurations, facility types, and under a variety of conditions. It is possible to add, delete, and move parts around, disassemble the parts; pack them, ship them to new locations and (perhaps adding or subtracting parts) re-erect them as required. It is critical to point out that the size of the ELEMENTS (the parts) had to be segmented to fit into a 8'x8'x40' shipping container.

We recognized that the "quantum jump" of building system development had to come about thru maximizing the physical integration of subsystems. We had to go beyond the level of integration of lighting/ceiling, atmosphere, and interior partitions as achieved in the SCSD project.

The study team designed a series of building hardware elements, which are used to provide the necessary facilities. An element is a relatively large piece of hardware which, more often than not, integrates parts of a number of functional subsystems which serve as the basis for determining building performance. For example one of the elements, the horizontal sandwich, integrates components of the following subsystems: structure, lighting/ceiling, electric/electronic, atmosphere, plumbing, and finishes. The elements are based on a 5'x5' planning module, and a 20'x30' and 30'x30' structural module. A total of 64 elements have been developed and are aggregated into four element groups: (1) the Structural Element Group, (2) the Enclosure Element Group, (3) the Energy Element Group, and (4) the Equipment Element Group.

The elements are designed with existing components and/or subsystems which are delivered to a central manufacturing point, are assembled, packaged, and shipped to the site and erected without further subsystem integration. Erection is limited to connecting elements to each other according to an assembly guideline. Elements can be installed in various configurations, positions, and slope conditions.

Basically the Building Block System is a steel frame type structure, limited to two stories, and utilizing pier type foundations. A maximum building width of 120' and an unlimited building length establish the overall configuration. The first floor of each facility is always located four feet above finished grade or the highest elevation point.

The Structural Element Group: This group containes 22 elements. There are two types of steel columns (4' and 12' in length), three types of primary trusses (10', 20' and 30'), five types of horizontal sandwiches, five types of horizontal mains (peripheral utility lines) and two vertical mains (vertical utility connections). In addition there are a few smaller elements which complete the structural requirements. The quantum jump of this system is in the horizontal sandwiches. Sandwiches are elements 5' wide, 2' high and all of them are 30' in length. The sandwiches integrate components, of the structural, lighting/ceiling, atmosphere, electric/electronic, plumbing and finishes subsystems. Thru a hinged panel located at the top of a sandwich, each sandwich covers a floor area of 300S.F. Each sandwich is independently controlled and spans between the primary trusses. Sandwiches are connected end to end and are serviced by the horizontal main which is secured to the structural frame and functions as a main utility spine, located at the periphery of the building. Each 10' section of the horizontal main can serve two sandwiches end to end and by locating a horizontal main at both sides of the building a maximum building width of 120' is possible. The upper surface of the sandwiches functions as a subfloor ready to receive a removable floor finish, or a roof surface taped with a removable joint cover. The vertical mains connect to the horizontal mains and thus provide linkage to the energy modules which house all of the mechanical equipments, also located outside of any facility.

The Enclosure Elements: 13 elements are included in the enclosure elements. Essentially these elements enclose the facility and make it operational. Twelve different wall panels facilitate different appearances, fenestrations, and forms of access. Enclosure panels are located between the columns, and are integrated with the 5'x5' planning module. Wall joints can be reinforced to accommodate wind velocities of 180 mph. In addition a standard fascia panel is provided to enclose exposed trusses, and horizontal mains. As stated previously the roof enclosure is part of the horizontal sandwich which basically is a fiberglass skin, and the joints are covered with a Hypalon tape. This tape can be cut in relocation and retaped in subsequent erections.

The Energy Element Group: Five different energy elements are provided. The energy elements are 8'x8'x20' containers designed to serve various sandwich combinations. They are modularized to facilitate various atmospheric options as well as various utility load conditions.

The Equipment Element Group: This group containes all the elements necessary to configure the interior volume of the various facility types. It includes partitions, various bathroom types and wet spaces, kitchens and storage modules, plumbing electric and atmospheric columnettes, and stair elements. Each element in this group can be moved within the "free" space. Stairs are located at the periphery of the building and can be open or enclosed.

Summary: The Building Block System with its 64 elements, and assembly rules, not only represents a quantum jump for the Modular Facilities Program of the Air Force but for the general Building System Developments as well. It is a quantum jump because subsystems integration were increased and site erection reduced.

THE DEVELOPMENT OF AN OUTPATIENT PHARMACEUTICAL DISPENSARY UNIT BASED ON TASK-ORIENTED AND HUMAN-ENGINEERING DESIGN APPROACHES 12.2

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Abstract

The author was retained by the Research Institute of Pharmaceutical Sciences, School of Pharmacy, University of Mississippi, Oxford, Mississippi, to participate in a project to design a model outpatient pharmacy for a 200-bed non-teaching general hospital, under a grant from General Equipment Manufacturing Company of Crystal Springs, Mississippi. The planning process discussed in this paper introduces the author's concept of planning based on his "human-engineering" and "task-oriented" techniques. He outlines the total design process of data collection, problem analysis, design development, model investigation, prototype planning and the final production of an innovative design for an outpatient pharmacy unit.

Problem Definition

The Research Institute personnel and the architect were convinced that new pharmaceutical facilities should be planned to enable people to perform their tasks with comfort and efficiency in which a breakthrough in basic attitudes was mandatory. The pharmacy facility planners emphasized the elimination of function obsolescence of design, equipment, and fixtures. The architectural design team then began intensive orientation to the planning parameters already established by the Institute which included a review of filmed facilities in the United States and of national surveys of hospital pharmacy facilities. As a member of the planning team, the author also began an investigation of the drug dispensing system and the emerging role of the pharmacist as specialist, counselor, and administrator. Continued problem definition specified functional task centers in a hospital pharmacy facility which would be required for maximum performance. The environmental task centers, the planning team concluded, must enable the pharmacy personnel to accomplish assigned tasks, provide for adequate storage to control all work, and provide communications to coordinate all activities.

Concept Development

In his approach to the design solution, the author advanced the basic parameter that man must be the scale for all planning and that design must be related to human behavior. In developing the design for the pharmacist's task, he utilized "human-engineering" principles and "task-oriented" standards to enable the pharmacist to assume his proper and best role. Continuing with the functional program completed by the Research Institute, the architectural design team evolved the experimental "task-oriented module concept" for a model outpatient dispensary. Instead of creating new equipment for the unit, they combined a group of total environments including counters, equipment, walls, seating, and lights with each fixture characterized by its own configuration. The outpatient center thus developed as a self-contained module with interrelated space use that included counters, acoustical panels, rotary drug files, communications, adjustable shelves, client identification board, sink with work space, etc.

Model Development

The initial module design was recycled by the pharmaceutical researchers and architects who spent numerous hours evaluating the task center as a self-contained unit. As the team explored the potential of the module unit, better space utilization was developed for pharmacists and patients accompanied by better drug distribution and control of prescriptions. A second outpatient dispensing module design was completed with further improvements such as a two-station pharmacist module, and innovative six-foot diameter drug storage area equal to 48 linear feet of conventional pharmaceutical storage space. After agreeing to accept the design concept, the production of a full-scale mock-up to test the effectiveness of the outpatient dispensing module design began. Following completion of the factory mock-up, team members from the Research Institute, the architectural firm and selected pharmacists refined and evaluated the module. The final prototype was circular in form and was transferred to the Research Institute for terminal refinement with final evaluation and testing by pharmacists and pharmacy students among others.

Production modules have been patented under the trademark "SystaModule" with a pharmacy dispensing function. The area of the module is approximately 100 square feet, although the marketing information stresses the adaptability of the module or modules into interchangeable units with several space combinations. Unit "A" is described as a service and consultation window with a work counter, narcotics control cabinet, communications system and adjustable gravity-fed and flat shelving. Unit "B" is a shelf unit with gravity-fed adjustable shelving and having dimensions of a 96 1/2 inch width and an 84 inch height. Unit "C" is a utility unit with a 3.3 cubic foot refrigerator, stainless steel lavatory sink, adjustable flat shelving, and electrical and water conduits. The height of the unit is also 84 inches. Unit "D" is a reserve storage area with adjustable flat shelving finished in natural woodgrain vinyl with two sets of double doors. The unit has the same outside dimensions and is interchangeable as Units "A" and "B". Other significant features of the module unit include patient privacy areas, built-in utility systems as described in the four units, stain-resistant, washable vinyl exteriors, a packaged power unit with AC outlets, lighting, heating, and ventilation, and ceiling structure of an acoustical, egg-crate design. The sales prospects also offer as optional equipment sit-stand perch chairs, patient seating, cashier cubicle, etc. The highly versatile module system can be installed in new or existing space without requiring structural changes.

Project Summary

In conclusion, the author believes that the above program and effective results has established his concept of task-oriented and human-engineering in spatial planning as a valid technique.

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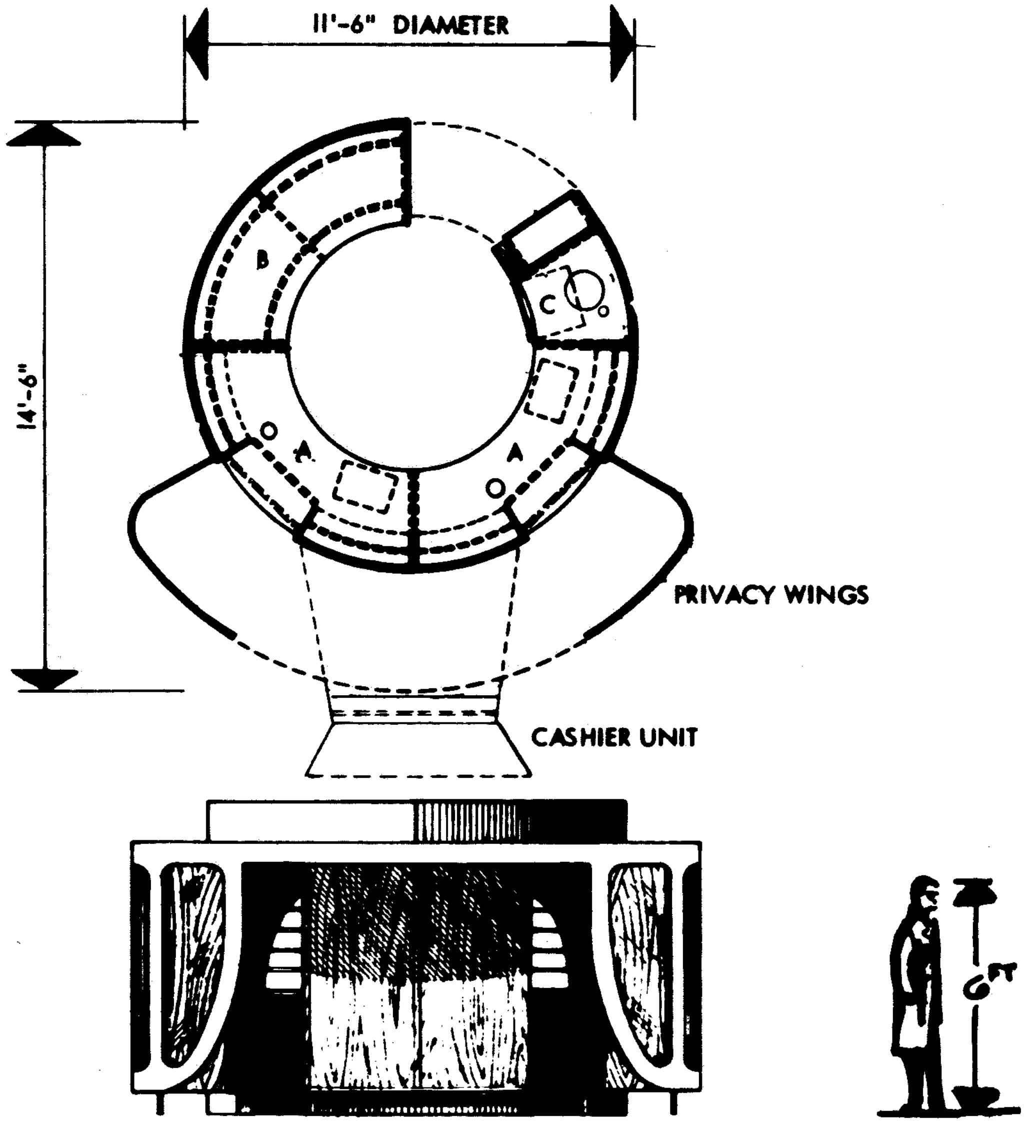

PHARMACEUTICAL DISPENSING MODULE

SCALE: 1/4" = 1'-0"

THE MILIEU FOR SYSTEMS BUILDING, 1980

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INTRODUCTION

The following scenario was developed from information gathered from 30 building industry experts and generalists. These persons, serving on a Delphi Panel as part of a larger study for a building industry trade association, evaluated the probability of 43 events, mostly related to construction, happening by 1980. The events from this previous study deemed significant form this paper. Additional information is available on request from the author.

THE BUILDING INDUSTRY, 1980

Traditional contractors and subcontractors are facing increasing difficulty in marketing their services, due to the fact that well over half of the buildings procured are through systems building, the management technique that took hold in the seventies. More importantly, legislation to prohibit traditional, cost increasing labor practices has been stopped since systems building continues to gain ground and the quality of workmanship associated with it has forced traditional builders to improve their product also.

Adoption of federal building codes on the state level has also given systems building a boost by encouraging the manufacturers of building systems to get a "seal of approval" that allows nationwide distribution. Modular core units, preassembled wet walls, integrated electrical systems, CATV, low-voltage and pneumatic controls are just a few of the products that have been developed in conjunction with building systems.

Owner/user building associations, perhaps a spin-off of the consumerism movement, are now asking contractors to use systems building methods for their jobs. As organizations, they have become a powerful economic and political force.

Initial union reluctance on a local level to systems building has practically ceased as their work jurisdiction has changed; field *vs.* factory is no longer a battle line. The blurring of this line has been aided, in part, by the establishment of junior college and private educational firm apprenticeship programs.

Computer assisted management, design and cost estimating mathods are widespread. Owner/user associations rely on the cost estimating techniques and many times give labor-only contracts. Pre-award liaison between design firms and contractors, as well as others, is encouraged to reduce costs.

Consumers have been demanding longer warranties and higher quality standards to the point where some contractors have become original equipment manufacturers' (OEM) representatives for building subsystems.

Of special note is the ingenious application of solid state devices to many applications formerly requiring high power. This has allowed better utilization of energy and a chance to lessen the energy crisis. The rise of solid state devices and favorable rulings on cable television has opened this medium as a nationwide market. Home installed CATV centers have computer, copier, bill paying and other home management and entertainment devices built in. Many forward looking corporations are installing home "work consoles" for employees to reduce unneeded centralization (costing the corporation more money in office space than for the home consoles!) and as their contribution towards keeping unneeded automobile pollution down.

An increased reliance on government solutions to intra-industry problems has been the "court" to which other industry segments have brought complaints about too much vertical and horizontal integration of contractors and subcontractors. Some fear this merger trend will in the end put building back into the position of the 1970's when rising costs brought on systems building as a panacea. Now some fear the tail will wag the dog and are lobbying for yet another solution to the rising costs of building.

EVENTS WITH PROBABLE OCCURRENCE BY 1980 OR 1985 AS PERCEIVED BY THE DELPHI PANEL

Vertical integration of firms

Non-construction firms buy construction firms

Innovative contracting methods replace traditional

C/M becomes the major method of building

Computer assisted methods reduce subbids to labor only

OEM strengthen through life cycle servicing

Adoption of national urban and rural growth policy

Adoption of federal building codes and standards

Special investment tax credit given to the industry

Increased government spending in construction and rehabilitation

Performance codes with "seals of approval" will be common

Owner/user associations emerge

Life cycle costing promotes life maintenance by the manufacturer

Warranty and quality standards demanded by consumers

Continuing shortage of energy

Factory produced assemblies replace onsite assemblies

Sophisticated solid state controls require skilled technicians

Decreased interest in overtime eases acceptance of building subsystems

Legislation prohibits traditional practices where new methods emerge

Bidding competition intensifies with pre-award liaisons