Academic Building Systems (ABS) is an architectural planning and design method which allows the construction owner to respond to the need for less expensive structures, economically adaptable to the changing conditions of the academic world, by providing the owner with the maximum controls over the variable cost factors in educational facility construction. In the ABS open system, more than one manufacturer can supply each of the components of the building system. This is felt to offer the best potential for reducing construction, maintenance, and remodeling costs and for improving the usefulness of academic facilities. The systems approach provides a high degree of coordination of the building components. It takes into consideration standard and repetitive features, life costs of complex buildings, adaptability of station utilization, tradeoffs of higher first costs versus lower life costs, and shorter construction time. The major innovation in the fixed elements is the space module, which is a repetitive unit used throughout the structure and which reduces construction costs by making possible the use of standard units of heating, ventilation, and air conditioning to service each module. (LBH)
ACADEMIC BUILDING SYSTEMS
A Technique to Maximize Control of Construction Costs
By Donald H. Clark

Many factors have contributed to major academic construc-
tion cost increases in the past decade:
(a) Labor. The percentage increase in labor costs has been
and probably will be, the single largest component of inflation. The better qualified labor is higher; therefore, the
organization and coordination of labor forces costs more.
(b) Materials. Continuing complex housing needs and the
architect's growing need for lighting and electrical systems
must mean a higher price for equivalents.
(c) Time. The construction time is longer.
(d) Design. Elaborate expense designs become necessary
to meet the program demand.
(e) Excessive change orders.
(f) Quotas: Custom items are not standard.
(g) Trade-offs to change for costs.
(h) Precise time length: Time is spent unnecessarily on
programming, financing, and preparing architectural
drawings. All done consecutively.
(i) Excessive change orders.
(j) Quotas: Custom items are not standard.
(k) Labor productivity: On-site labor productivity is
relatively low compared with factory production.
(l) Lack of repetitive features: Everything is different
and therefore everything is a pioneering effort or an
expensive prototype.
(m) Profit. After the competitive bidding, the contractor's
knowledge is used primarily for his own benefit.
(n) Practicalities in design. The contractor's expertise is
not used on features of building during design. Thus, their
expertise cannot give maximum benefit to the owner.
Factors of inflation, overall demand, labor union poli-
cies, and low on-site production are not controllable by
the individual owner. Academic Building Systems, includ-
ing Contract Management, is an attempt to give the owner
the necessary tools to respond to the need for less expen-
sive structures economically adaptable to the changing
conditions of the academic world, by providing the owner
with the measuring controls over the variable cost factors.

The History of Academic Building Systems

The first California-Indiana Study in 1963 initiated cooper-
tion in analyzing ways to reduce construction costs while
at the same time providing better academic facilities. This
study took place from 1964 to 1966. But it was on that the
legislators of the two States first must be attempted. As a result, they approved a joint project by the University of California and Indiana University. The goal was to show that the change from
conventional planning and design to these system approach
offers the best potential for reducing construction, mainte-
nance and remodeling costs, and improving the usefulness
of academic facilities. This approach is based on an open
system. There are two major types of building systems:
open and closed. In the closed system one manufacturer
supplies all of the components, in the Academic Building
Systems (ABS) open system more than one manufacturer
can supply each of the components.

The idea for systems building achieved an important break-
through in 1963. In that year, thirteen California school
districts united School Construction System Development
(SCSD) the first large-scale effort in the United States to systemize construction for one-story buildings on
a component basis.

The current California-Indiana study began in 1966
through the cooperation of Elmo Morgan, then University
of California Vice President for Physical Planning and
Construction, Harold Goues and Jonathan King of Educa-
tional Facilities Laboratories, and myself $1.200,000 in

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portion of the ABS Study described above.
funding for this research project came from the following sources: the United States Office of Education, $600,000; the States of California and Indiana, $200,000 each for a total of $400,000, and Educational Facilities Laboratories, $200,000. The principal research consultant was Building Systems Development, a San Francisco architectural firm whose principals also headed the California School Construction System Development.

Academic Building Systems is an architectural planning and design method directed toward attaining an adaptable building through "a high degree of coordination of the components that make up a building, plus concepts and procedures that have been tested in other situations." It has been described as "excellent optimization" by the Assistant Director of Research at Facilities Engineering and Construction Agency (FECA).

The Facts of Life Cost

A major factor too often overlooked, is the life cost of a structure. In a comprehensive study of science buildings, the rehabilitation cost of older structures often exceeds twice the original cost. No dollar evaluation has been set for the disruption costs of space surrounding the area being remodeled. The adaptability of the ABS buildings will materially reduce the time necessary to complete the change and the savings from minimized disruption in adjacent space also will be of great value.

Two of the major objectives of the Academic Building Systems Study are to reduce costs and to provide better academic facilities. The ABS results offer potentials which give the owner maximum ability to manage the controllable high cost areas for both first and life costs. At the same time, it builds in adaptability to provide the desired better academic environment for the future.

Design: Standard and Repetitive Features

The building system consists of conventional components which can reduce design time, can be mass produced to reduce construction time and costs, and can have specified performance standards related to the real needs of the user. From these components, a wide variety of buildings—in size, shape and appearance—can be created to answer specific requirements.

The building system approach has evolved more recently into the conceptualization of the total building process as a system. Thus, other phases of the construction process which ABS is studying include new methods of programming the needs of users in relation to budgeting constraints and ways of reducing the total time of developing a building, from initiation of planning to completion of construction.

Complex Building: Life Costs

As the study of construction continued, it became apparent that a major question concerning building designs that had disturbed administrators in the past demanded greater attention in the future. This question involves the fact that heating, ventilating, air conditioning, and electrical systems in buildings have become more and more complicated and are taking an increasingly higher percentage of the total construction budget. These problems become even greater in size when one couples the original high cost with the knowledge that during the structure's lifetime these sub-systems will have to be replaced, some parts several times at the future inflated cost levels. This emphatically suggests the increasing importance of using a structural design that facilitates access to the expensive utilities and machinery, thus reducing future remodeling and repair costs.

We also find that not nearly enough has been done to meet the challenge of the relatively poor station utilization caused, at least partially, by fixed structures. For example, if a laboratory is in use five hours a day, this means a room utilization of 5 hours * 5 days, or 25 hours out of 40 hours per week (62.5 percent room utilization). If the room has 30 student stations and has an average of 20 occupied, this is a 66 percent station utilization when the room is in use. The actual station utilization then becomes 66 percent * 62.5 percent or 41.25 percent.

Adaptability: Station Utilization

In the past, the size of the laboratory has been inflexible. If it were designed for 30 students, it was prohibitively expensive to enlarge it to accommodate 40 students, or reduce it to accommodate only 20. This inflexibility prevented the introduction of new and better teaching techniques for different sized classes and, in effect, placed a limit on faculty ingenuity and efficiency. The building could not be easily revised to accommodate a multi-purpose laboratory, or changed to individual study laboratories in order to meet any other future needs. ABS adaptability makes it possible to meet changing conditions efficiently.
Therefore, new needs can be met and potentially greater station utilization can be realized economically.

For existing buildings, the cost to both institutions and granting agencies for converting laboratory facilities to accommodate research projects has been astronomical. In some instances a single mobile faculty member has used two or three grants to complete his laboratory designed to meet his research requirements at each of the two or three institutions to which he has moved within a ten-year span. In turn, the laboratory from which he has moved has again been remodeled for his successor. Investigation reveals that these rather minor remodeling projects have cost from $100,000 to $250,000 or more. They are minor in the amount of space required, but major in terms of dollars.

In addition to delaying the scientific results, the faculty member's time has occasionally been lost for a longer period than either the institution, or the granting agency desire through the slow remodeling process.

If a laboratory or classroom building can be planned to eliminate much of the loss of inefficient station utilization as well as the need for excessive remodeling, the potential future savings can be great. In addition, major immediate savings are visible. For instance, by building in semester-to-semester adaptability, it is estimated that the academic program can be met with 20 percent fewer lab stations. In the Science Engineering Technology Building in Indianapolis (Indiana-Purdue Universities), 10 percent of the total cost of the originally proposed structure will be saved through space reduction agreed to by the faculty, who recognized that adaptability will meet their needs with less space.

To assure the best academic environment, a major research project within the ABS program was recently conducted by Building Systems Development, Inc. This involved an evaluation of present facilities by the faculties of the University of California and the four state-supported universities in Indiana (Ball State, Indiana State, Purdue and Indiana), coupled with cost analysis of three major buildings in California and three in Indiana.

Trade-Offs: Higher First Costs vs. Lower Life Costs

User criticisms revealed that at times an apparent economy is actually very wasteful (e.g., the use of less expensive partitions where their sound control was so ineffective as to interfere with proper room use). The technique of the building system design should assist in alleviating this type of problem since it permits the owner and the architect to make the best cost decisions for the lifetime of the building.

Shorter Time for the Project

One of the major ways that savings can result from the use of Academic Building Systems is by accelerated planning. It is no longer necessary to have completed academic programs and completed architectural plans before bidding and construction begins. The flexibility of the structure permits changes late in the construction period, with predictable cost. In addition, the following diagram shows how ABS works with phase design and construction to save time:

![Diagram showing phased design and construction vs. conventional project]

**Lower Life Cost**

Lower life cost permits planning, architectural drawings, and the actual construction work all to proceed simultaneously. Adaptability before the structure is erected is just as valuable and dollar-saving as it is during the life of the completed structure. Flexibility is especially valuable for structures on developing campuses. That the campus has changing needs through the next five or ten years is obvious to all. These needs are almost as strong on more established campuses, but much less obvious.

In the next ten years there will not be the same requirements for language classrooms, for laboratories, etc. Because of research, the needs of the future will be much different from the needs of the past. The language laboratory of today is markedly different from the French or Latin classroom of forty years ago. Surely, even greater future changes will occur. A structure that will facilitate these future changes will provide its owner with the maximum future advantage, as opposed to the liabilities of most of today's construction methods which resist change by making it expensive in both cost and time.

The importance of adaptable elements in ABS cannot be underestimated. The future savings resulting from the ability to adapt to the existing demands inexpensively will prolong the structure's effective life and will tend to insure maximum utility for the future. The adaptable elements include:

1. Utility distribution laterals and drops to rooms
2. Heating, ventilating, air conditioning (HVAC) zone duct work and controls
3. Ceiling panels, lighting, and HVAC diffusers
4. Partitions
5. Casework

It should be emphasized that the cost of altering an academic building over its assumed forty to fifty year life may be as much as double the contract cost of the original construction. Furthermore, the lack of funds usually dic-
There were several systems of high cost where the user requirements were not met. or these areas:

- Heating, ventilating, air conditioning
- Plumbing
- Electrical
- Exterior skin
- Elevators
- Other
- General contractor

There were several systems of high cost where the user requirements were not met. or where the user requirements were changed subsequent to the construction. This information is reported in detail in Volume 2 of the ABS publication, "Cost Performance Study."

The greatest value of this cost analysis is that the owner can stress performance in the most critical area and, if necessary, control costs in other less critical areas. Another advantage accruing to owners and architects is the users rating of the products which have been used in past construction. This technique of computing costs by subsystems gives the owners and architects better cost control during the architect's design time. If lower costs are necessary, the changes can be made with full knowledge of the costs by subsystems.

HEW Data Available

The Department of Health, Education and Welfare has committed itself to the systematic observance of cost, time, and quality in the design and construction of facilities. As follows. To ensure that, despite the current escalation of construction costs, quality levels will be maintained or improved at no sacrifice in the lifetime costs of the facility, to reduce design and construction time so that the facility is available for use at an earlier date, and to permit ease of physical modification as the functional and operational requirements change. Toward that commitment, these circulars are HEW position papers offering creative solutions in the areas of interpreting user requirements, planning, and use of facilities.

The Building Information Circular series covers the following subjects.

1. Comprehensive planning
2. Value analysis
3. Systems building
   a) Academic Building System (ABS)—Higher Education
   b) Systems Building in Elementary Secondary Schools—SSP Experience
4. Construction Management Phased Design and Construction

The use of the findings of the ABS Study incorporating "Construction Management Phased Design and Construction" offers the university or college an opportunity for a better academic environment over a longer period of time with lower initial and life costs and with a considerable savings of time for the project.

This study is available from either University of California, Office of Vice President Planning, 641 University Hall Berkeley, California 94720, or Indiana University, Assistant Vice President-Treasurer’s Office, 219 Bryan Hall Bloomington, Indiana 47401. The first copy of the three volume publication is free to a university or governmental agency. Each additional copy to a university and each copy to an architectural firm is $20.