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ABSTRACT

This feasibility study was made to determine the impact of agencies and organizations that review and apply codes and standards to new construction and major renovation projects affecting the ability of colleges and universities to use and conserve energy. The program involved a survey of four representative states--California for a moderate climate, Maryland for a moderate climate, Michigan for a cold climate, and Texas for a warm climate. Within each state, four institutions were analyzed, one from each of the following types: two-year public community or junior college, four-year public college, public university, and four-year private college or university. Among the conclusions are that the process of planning, design, and construction varies widely and has an undetermined impact on energy use and conservation; that public agencies and organizations impact by interpreting and applying specific codes and standards in use; and that the univeristy or college physical plant director or facilities planner has an impact through application of written construction guidelines or established practices during the process of planning, design, and construction. (Author/IRT)

A Feasibility Study on The Impact of Agencies and Codes On University and College Energy Use

Prepared for

United States
Energy Research and Development Administration
Division of Buildings and Community Systems

Prepared by

The Association of Physical Plant Administrators
of Universities and Colleges
Energy Project Office

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Volume I: Executive Summary

NOTICE

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Introduction

This report is a feasibility study to determine the impact of administrators, agencies or organizations who review building plans on the ability of colleges and universities to use and conserve energy.

The study was initiated by the Division of Building and Community Systems of the Energy Research and Development Administration (ERDA) and by the Joint Committee for Energy Conservation and Schools, established November 22, 1976. David Pellish, Director of the Division of Building and Community Systems, and Howard Ross, Program Manager, have administered this study.

The study was conducted and this report was prepared by the Energy Committee of the Association of Physical Plant Administrators of Universities and Colleges (APPA). To gain a national perspective vital to the study, the APPA Energy Committee worked closely and coordinated with the American Council on Education (ACE) and the National Association of College and Business Officers (NACUBO), as fellow members of the Energy Task Force Committee.

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Program Objective

The Association of Physical Plant Administrators of Universities and Colleges (APPA) was asked to assist the Energy Research and Development Administration (ERDA) in a feasibility study to determine the impact of agencies and organizations which review and apply codes and standards to new construction and major renovation projects affecting colleges' and universities' ability to use and conserve energy.

To assure compliance of project activities with ERDA's defined objectives, close liaison has been maintained with the American Association of School Administrators, which is conducting a similar study for the elementary and secondary education sector.

A questionnaire was prepared, setting forth two theoretical models -- Major Building exceeding $2,000,000, and a Major Renovation exceeding $100,000 -- and used as a basis for information gathering.

The program involved a survey of four representative states: (1) California - moderate climate, West Coast; (2) Maryland - moderate climate, East Coast; (3) Michigan - cold climate/heating region, North; and (4) Texas - warm climate/cooling region, South.

Within each State, four institutions were analyzed, one from each of the following types: (1) two year public community or junior college; (2) four year public college; (3) public university; (4) four year private college/university.

The recommendations and conclusions of the survey are contained in the Executive Summary, Volume I. The Source Data is set forth in Volume II.

Recommendations

1. THAT THE RESULT OF THIS FEASIBILITY SURVEY AND STUDY BE VALIDATED THROUGH THE INITIATION OF AN EXPANDED STUDY PROVIDING:

   - Information on the relative magnitude of the impact areas outlined in the conclusion.
   - An examination of the specific magnitude of codes and standards on energy use and conservation.

2. THAT MECHANISMS BE DEVELOPED TO ASSIST USERS AND CODE OFFICIALS IN THE ANALYSIS AND APPLICATION OF CURRENT CODES AND STANDARDS AFFECTING ENERGY CONSERVATION.

3. THAT DEVELOPMENT OF UNIFORM ENERGY CONSERVATION CONSTRUCTION STANDARDS BE ENCOURAGED.

Conclusions

(1) The process of planning, design and construction varies widely and has an undetermined impact on energy use and conservation. (Refer to Table I.)

(2) The codes and/or standards in effect have a direct impact, but they vary widely between jurisdictions and are in a state of change. (Refer to Table II.)

(3) Public agencies and/or organizations impact by interpreting and applying specific codes and/or standards in use.

(4) The university/college physical plant director or facilities planner has an impact through application of written construction guidelines or established practices during the process of planning, design and construction.

(5) The academic community has a varied impact, but the level of that impact is undetermined.

(6) The architect/engineer has an impact during the process of planning, design and construction. This impact varies according to the selection process of the architect/engineer and the planning guidelines given to the architect/engineer.

(7) The source of funds has an impact.

TABLE I*

VARIATIONS IN UNIVERSITY AND COLLEGE CONSTRUCTION

PLANNING PROCEDURES AND DESIGN GUIDELINES

	INSTITUTION[1]	(A) CONSTRUCTION PLANNING PROCEDURES (STEPS)	(B) CONSTRUCTION DESIGN GUIDELINES	(C) STIPULATED ENERGY RELATED GUIDELINES
CALIFORNIA	California State Universities and Colleges (19)	Written manual, used system-wide.	Written, used system-wide.	Pending state code followed voluntarily.
	University of California (9)	Written manual, used system-wide.	Written by each campus.	Pending state code followed voluntarily.
	California Community Colleges (104)	Written manual, used system-wide.	Vary by campus; some written.	Vary by district.
	Stanford University	Written manual.	Written, incorporated in (A).	Separate written guidelines.
MARYLAND	Towson State College	Written.	None; uses manual of State Department of General Services.	College defers to state-appointed architect.
	University of Maryland	Written manual.	Written draft subject to state approval; oral checklist of standards.	(B) directs physical plant to provide architect with energy conservation goals.
	Catonsville Community College	Written steps.	None; intuitive guidelines are based on past experience.	Written.
	Johns Hopkins University	None written.	None; intuitive guidelines are based on past experience and University Master Plan.	Informal use of ASHRAE 90-75 and other guidelines based on past experience.
MICHIGAN	Grand Valley State College	None written.	Written notes only, not distributed.	College expects architect to get advisory assistance from State Bureau of Facilities.
	Michigan State University	Written manual.	Written, incorporated in (A).	Voluntarily includes list of state standards in (A).
	Lansing Community College	Written steps.	None, except University Master Plan. See column (C)	College relies on outside architectural firm.
	Andrews University	None written; university uses own construction firm.	None. Some buildings constructed by separate Enterprises Division.	Informal use of ASHRAE 90-75.
TEXAS	Texas State University (4)	Written steps, used system-wide, for projects $25,000+.	Written, used system-wide.	List of standards provided to architect.
	University of Texas (17)	Written steps, used system-wide.	Written, used system-wide.	Written, detailed energy criteria.
	Tarrant County Junior College (3)	None written.	Written set of educational specifications only.	ASHRAE 90-75 and other guidelines incorporated in (B).
	Southern Methodist University	None written.	Being developed.	To be included in (B).

* Based on information contained in Section III of Volume II.

[1] The number in parentheses indicates the number of campuses in the system.

TABLE II*

VARIATIONS IN FEDERAL AND SELECTED STATE STANDARDS:

AIR POLLUTION (COAL-BURNING FURNACES) & CLASSROOM VENTILATION/LIGHTING

	AIR POLLUTION:	CLASSROOM DESIGN:	
	MAXIMUM ALLOWABLE STACK EMISSION OF COAL PARTICULATES	VENTILATION (cfm = cubic feet per minute per occupant)	LIGHTING (FC = Foot Candles)
FEDERAL			
CURRENT:	Large boilers: 0.1 pounds/ million BTU generated.	No uniform standard; subject to granting agency's interpretation.	No uniform standard; subject to granting agency's interpretation.
FUTURE:	Same, plus standards for smaller boilers.	P.L. 94-385.	P.L. 94-385.
CALIFORNIA			
CURRENT:	No statewide standard. County or multi-county standards vary.	No state standard. Guidelines for state colleges.[1]	No state standard. Guidelines for state colleges.[1]
FUTURE:	No expected change.	10-15 cfm total air; minimum 5 cfm outside air.	70 ESI FC recommended. 50 (conventional) FC minimum.
MARYLAND			
CURRENT:	Large boilers: 0.03 grains/ cubic foot of effluent. Smaller boilers: existing, 0.05 grains; new installations, prohibited.	Either[2] (a) 10 cfm total air, minimum 5 cfm outside air; or (b) Minimum 7 1/2 cfm outside air.	Either[2] (a) 50 FC minimum, 70 FC in example; or (b) 30-100 FC range (formula variations).
FUTURE:	No expected change.	No expected change.	No expected change.
MICHIGAN			
CURRENT:	Varies:[3] (a) Federal; (b) 0.19-0.65 pounds/ 1000 pounds of effluent; (c) case-by-case.	Minimum 7 1/2 cfm outside air.	30-100 FC range (formula variations).
FUTURE:	To be more stringent.	10 cfm total air; minimum 5 cfm outside air.	50 FC minimum, 70 FC in example.
TEXAS			
CURRENT:	Varies:[4] (a) Federal; (b) 0.3 pounds/million BTU; (c) case-by-case.	5 cfm.	50 FC minimum, 70 FC in example.
FUTURE:	No expected change.	10 cfm total air; minimum 5 cfm outside air.	3.7 watts/square foot.

* Based on information contained in Section V of Volume II.

[1] Office of State Architect has no jurisdiction over the University of California system, the community college system, or private universities.

[2] Maryland uses two different written codes for state construction.

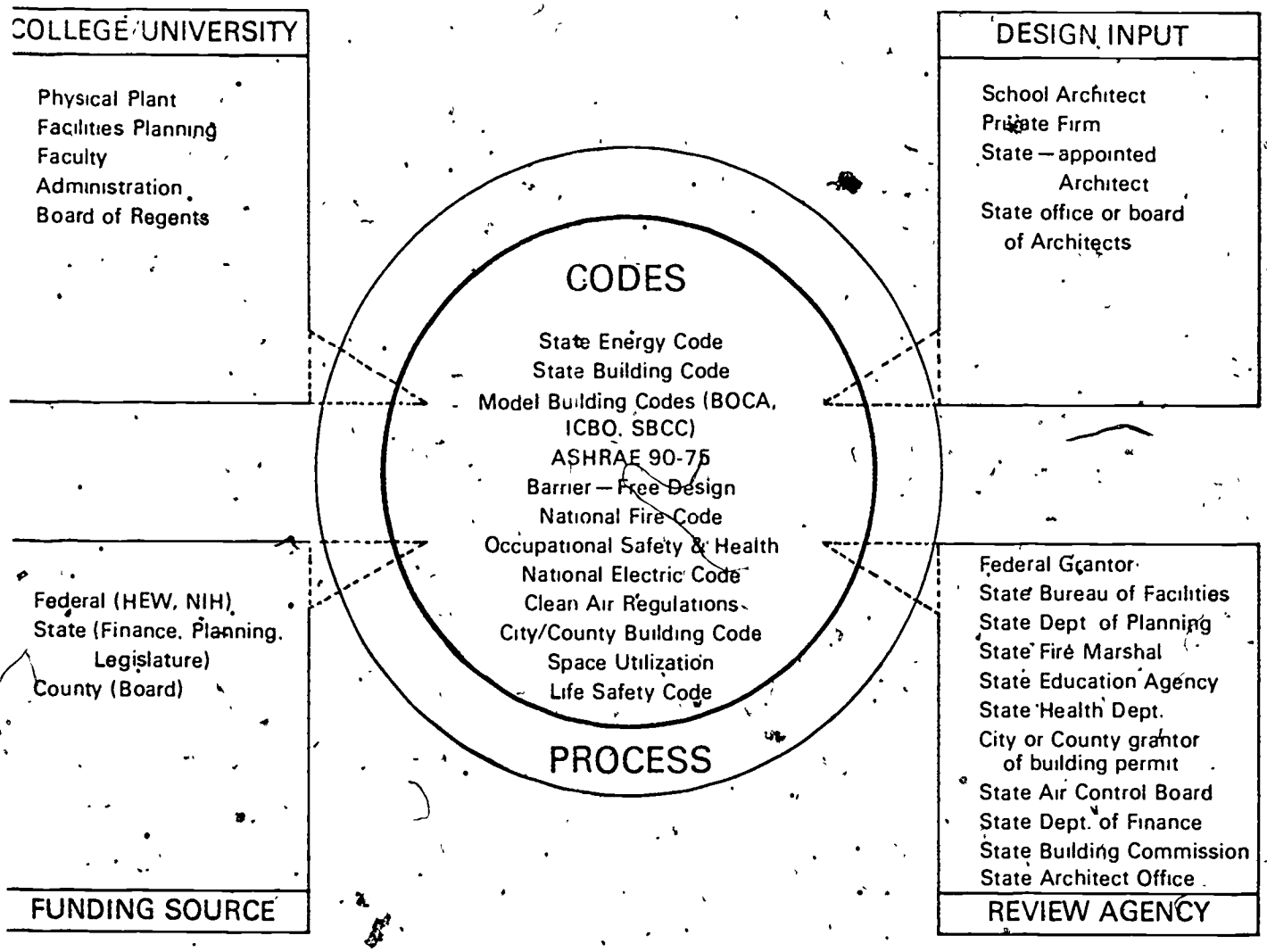
[3] New, large boilers are subject to EPA standards; allowable particulates for others depends on size of furnace and mode of firing, with the largest subject to specific limits set by the state Air Pollution Control Commission.

[4] New, large boilers are subject to EPA standards; all other new boilers handled on case-by-case basis when permits requested. Only existing boilers are subject to condition (b).

Overview to Conclusions:

The many agencies and organizations that have been found to impact on energy use in college/university construction can be readily classified and neatly organized, (Chart I).

CHART I: IMPACT AREAS IN THE PROCESS OF PLANNING AND CONSTRUCTION



Support Evidence for Conclusions

(1) The process of planning, design and construction varies widely and has an undetermined impact on energy use and conservation.

The process varies widely among colleges and universities. Table I shows some of the variations in formal planning procedures and design guidelines at all the institutions surveyed, together with the manner in which campuses specify energy standards.

Some institutions have lengthy, detailed construction guidelines (for example, Michigan State University, Stanford University). Some have an established step-by-step procedure from project conception through completion of construction (for example, Lansing Community College, Catonsville Community College). Others have no formal guidelines or procedures (for example, Andrews University, Southern Methodist University).

Because of the limited scope of this study, it was not possible to determine the full impact the process has on energy use and conservation. The presence of written procedures does not in itself appear to assure a greater or more positive impact. Procedures at one state college, for example, give the faculty more input than physical plant personnel into the initial program document, resulting in academic specifications that frequently act counter to energy conservation sought by the physical plant director.

Similarly, absence of written procedures does not necessarily lessen the impact of energy conservation efforts. At some institutions (for example, Johns Hopkins University, Andrews University), it is common to find a physical plant director (or facilities planner) who has held his position for many years and who personally becomes involved at all stages in a project, informally using energy-saving guidelines that have proved most effective in other projects.

(2) The codes and/or standards in effect have a direct impact, but they vary widely between jurisdictions and are in a state of change.

Building codes and other health and safety standards impact directly by imposing specific requirements in new construction--for example, in illumination, ventilation, insulation, heating and wiring systems--that affect the level of energy use. Some of these specific requirements are illustrated in Table II.

Table II also suggests the wide variation in federal and state standards. One variation is the level specified. For classroom ventilation, four different levels are shown: 5, 7 1/2, 10, and 10-15 cfm. Another variation is the measurement used. Classroom lighting is variously expressed in conventional Foot Candles, ESI Foot Candles, and watts per square foot. Allowable coal particulates are expressed in terms of heat generated, volume of effluent, and weight of effluent.

Where building permits are required--at roughly half the colleges and universities surveyed--cities and counties may introduce additional jurisdictional variations by requiring compliance with their own codes.

Stanford University, for example, must comply with both city and county codes because its buildings lie in both jurisdictions. According to the physical plant department's "Facility Design Standards," the county applies an earlier edition of the Uniform Building Code than does the city. The city, in turn, has adopted an amended version of that code, which puts it at variance not only with the county but with the state as well.

When federal funds are used, different standards are applied depending on the nature of the facility to be constructed. General facilities are covered by one set of guidelines, hospital and medical facilities by another, and cancer research facilities by a third. Since none of the institutions surveyed reported any current or recent projects using federal funds, the full extent of variations between federal and other standards is undetermined.

Finally, the codes themselves are in a state of change. In the next several months, state-wide energy codes will go into effect in three of the four states surveyed. Although all three codes are based on ASHRAE 90-75, only Michigan adopts it without major modification. California and Texas will have different standards for illumination. (See Table II.) While ventilation standards will be the same in these three states, ASHRAE 90-75 notes that its recommended minimum air circulation levels must give way to local codes that call for more outside air. At the federal level, in response to P.L. 94-385, which calls on HUD to develop an energy standard for all new federal construction, ERDA and the three model code groups are presently working to adapt ASHRAE 90-75 standards. It is too early to foresee what effect this effort will have on uniformity in state or local codes.

(3) Public agencies and/or organizations impact by interpreting and applying specific codes and/or standards in use.

Through the survey, it was determined that the vital impact of agencies outside the universities and colleges lies in agency interpretation and application of building codes and related standards. This impact becomes especially important when agencies must choose between conflicting standards.

In Maryland, the Department of State Planning approves planning criteria and sets forth guidelines for space utilization. Because the Department expressly rejects "rigid and inflexible application," it must interpret space planning guidelines to determine the total amount of space, by room use classifications, at the University of Maryland and at the state colleges. (See Volume II, Appendix B.) The Maryland Department of General Services, which is responsible for construction and funding of all state buildings, includes two separate building codes, BOCA and ASHRAE 90-75, in its procedural manual for design. Where the two codes differ, it is expected that the more stringent standard will be applied, but this may be a matter of interpretation, requiring case by case judgments. The line for Maryland in Table II shows the differences in ventilation and illumination standards between the two codes.

In California, the state building code has been amended to include energy conservation standards (presently under court injunction), which the California Energy Resources and Development Commission will be called upon to apply to all new non-residential buildings in the state. The Commission will have to interpret the new standards, which closely parallel ASHRAE 90-75 where any differences arise with provisions of

the Uniform Building Code (ICBO), which is already incorporated in the state building code.

In Michigan, a state energy code goes into effect June 22, 1977, which gives counties the responsibility for enforcing ASHRAE 90-75. The rules "make compliance determinable in the preconstruction stage before the issuance of the building permit." (See Volume II, Appendix K.) Since the State Bureau of Facilities monitors several other standards for state-owned buildings, including a state School Building Code, it is not clear how conflicts between codes would be resolved by the two jurisdictions.

In Texas, space standards are applied on a cost-per-square-foot basis by the Coordinating Board of Texas Colleges and Universities. The State Building Commission applies barrier-free design standards to all school buildings. The Commission has also been empowered to develop and apply a mandatory energy standard for all new buildings; the standard is expected to be completed in April, 1977. Within the state's educational system, however, many public institutions are self-regulated and thereby exempted from compliance. At one of these, the University of Texas, the Office of Facilities Planning and Construction has developed a uniform set of energy guidelines which it applies to every construction project in the system. It also appears that other public and private institutions in Texas may be exempted from compliance if they adopt a reasonable matching standard. Because of the exemptions, the full role of the State Building Commission in applying and interpreting the forthcoming state standard is unclear.

(4) The university/college physical plant director or facilities planner has an impact through application of written construction guidelines or established practices during the process of planning, design and construction.

As Table I indicates, most of the institutions surveyed have written construction guidelines or established practices based on intuitive guidelines, which the physical plant director or facilities planner applies at each campus during the construction process. A slight variation occurs at three of the five state-wide systems, where system-wide written guidelines are applied. In these three cases, the impact of the physical plant director is clearly not as great, but the extent of that impact has not been determined in this limited study.

An example of the involvement of the campus physical plant department is the University of Maryland, where guidelines written by the department provide the state-appointed architect with checklists of standards and specifications, including energy conservation goals. A member of the physical plant department is designated as a Deputy State Inspector at the initiation conference on construction. At subsequent stages in the process, he works with the State Department of General Services.

Two examples of institutions where no written procedures are set forth are Andrews University and Johns Hopkins University. The physical plant director follows established practices, including application of ASHRAE 90-75, that have proved beneficial in energy conservation programs undertaken previously. Since the physical plant director's actions at these two universities meet with no formal review, the impact of his unwritten procedures depends on his own experience and on how personally involved he becomes at all stages.

At another institution, where the physical plant department was not directly involved in the process, the director took a negative view of the procedures followed, indicating that they tend to work against energy conservation. At Andrews University, some construction is handled by a separate "Enterprises Division," with no input from the physical plant department on building specifications.

At the University of Texas, one of the three systems with system-wide written guidelines, an Office of Facilities Planning and Construction has written energy guidelines which it applies to design at six distinct steps in the formal process: pre-design conference, development of conceptual studies, design development review, preparation of preliminary plans, authorization of final plans, and review of final plans.

At the University of California, one of the two systems where construction guidelines are written by each campus, Systemwide Administration capital improvements planning staff reviews a project planning guide for each project. Preliminary plans and working drawings are reviewed by professional architectural and engineering staff at each campus and adherence to energy conservation standards is checked.

As these examples show, the physical plant or facilities planning director plays an important role in the process. Because of the limited scope of this study, the full extent of that role has not been determined.

(5) The academic community has a varied impact, but the level of that impact is undetermined.

At the universities and colleges surveyed, the faculty initially has an impact by specifying space allocations, enrollment requirements, and educational specifications. Thereafter, the faculty involvement varies, so its specific level of impact on energy use and conservation could not be determined in this limited study. No institution contacted reported any faculty-written design standards.

The varied involvement of the faculty in the planning process is shown in the following three examples. At Towson State College, an academic program document is prepared by the faculty group proposing a project, before physical plant personnel become involved. At Catonsville Community College, by contrast, the physical plant may make modifications in the program document while the faculty is preparing it. Under a "team" approach specified in procedures at Lansing Community College, an academic dean heads the planning committee throughout the process and is responsible for the economy of the completed structure.

Elsewhere, faculty impact on energy use and conservation is less apparent or less direct. An example of the first is the University of Texas System, where written procedures place the Office of Facilities Planning and Construction in the sole technical advisory role at so many stages of the process that faculty influence appears minimal. An example of the second is Stanford University, where written procedures include notification of a designated anthropology professor, who is to be "alerted to all subsurface activities," allowed to send a representative during excavation, and consulted during preparation of the Environmental

Impact Statement, for any findings of archeological or historical significance. In both cases, faculty impact on energy use is undetermined.

Special mention must be made of the situation at Johns Hopkins University. Although the physical plant department directs the planning process, members of the science faculty may greatly influence the design of laboratories for research. The major reason for this faculty impact, not only at Johns Hopkins but also at other large universities throughout the country, is the extensive grant programs, which fund the work of designated professors. Such professors may be in a position to insist on certain laboratory specifications which run counter to energy conservation. This example underscores the need for a level of impact measurement, which a future study could determine.

(6) The architect/engineer has an impact during the process of planning, design and construction. This impact varies according to the selection process of the architect/engineer and the planning guidelines given to the architect/engineer.

The institutions surveyed illustrate different procedures for architect selection. In Maryland, the State Department of General Services appoints the architect for all construction projects at the state colleges and at the University of Maryland. In Michigan, the State Bureau of Facilities must concur in an institution's selection of an architect for a project using state funds. In California and Texas, where there is no state participation in selection of the architect, the

public colleges maintain closer control of the outside architect. In the California State University and College System, for example, selection criteria include energy expertise. At the private institutions, the selection process may be keener. At Johns Hopkins University, for example, a special fund supports a stringent selection process which includes submission of drawings and a personal interview. As a result, the university receives several quality designs for each project and retains close monitoring of subsequent design specifications.

As the selection process itself varies, so do guidelines provided to the architect. State-appointed architects in Maryland are required to follow a state procedural manual which includes design standards. While the University of Maryland adds its own lengthy written conditions and specifications to the state manual, Towson State College does not do so. The architect for Towson has somewhat more leeway than the architect for the University of Matyland. According to the physical plant director at Towson, state guidelines provided to the architect stress cost per square foot and fail to consider energy-using equipment. A tendency to cut unseen corners in construction, including low-cost mechanical systems, impacts adversely on operating expenses and energy conservation capabilities.

In Michigan, state design standards are less comprehensive than in Maryland and are not mandatory. Differences in the institutions' own guidelines thus serve to determine the impact of the architect. At one extreme, Michigan State University has a lengthy list of construction standards written by the university engineer. Although adherence to them is not mandatory, any deviations are reviewed with the university

architect and the university engineer for approval. At the other extreme, Lansing Community College has no written guidelines and the outside architect clearly plays a pivotal role. The physical plant director reports that "within all phases, the involvement of the architect serves as a monitoring device to evaluate existing codes, regulations and feasibility of design concept." (Volume II, Appendix H.) The physical plant director attributes this key role to the college's retention of the same architectural firm for the past twenty years, contrary to common practices at the state colleges in Michigan, which hire different firms for different projects.

(7) The source of funds has an impact.

The funding source inpacts in several ways. First it affects the very process of planning, design and construction. When funding comes only from private sources, the process tends not to be elaborate or complicated. Three of the four private institutions surveyed have no formal written procedures; the fourth, Stanford University, has a one-page "Review Checklist" which lists only fifteen separate steps.

With county, state or federal funding, the process becomes more complex since the number of different steps greatly increases. At Catonsville Community College, construction procedures are set forth in a list of eighty-six steps. Thirty-nine additional steps involve the county, and seven separate steps include an agency of the state of Maryland. When federal funds are used at the colleges, fourteen more steps, all requiring formal approvals, are added to the list.

There may be negative side-effects to such expanded procedures. According to the physical plant director at Towson State College, the process of review by agencies for state-funded projects may take up to two years, rendering project specifications outdated. At Catonsville Community College, federal funding has been declined when the federal share was considered too small to warrant the time-consuming compliance requirements.

The funding source may impact in a second way by specifying some of the codes and standards which are to be applied. When state funds are used in Michigan, for example, the State Bureau of Facilities monitors a host of state-adopted standards, including space utilization, the Life Safety Code, Occupational Safety and Health, the National Fire Code, the National Electric Code, plus state codes for plumbing, elevators, and school buildings. When federal funding (HEW) is used, one or more of three different written construction guidelines may apply. General HEW-construction guidelines set forth a list of standards, plus monitoring instructions for HEW regional offices during the construction phase. Guidelines for federally-funded hospital and medical facilities contain several additional standards. Guidelines for cancer research facilities have separate standards, some of which are not contained in the other two.

Suggestions for Further Study

The recommendations call for further study of aspects that were not resolved in the present survey.

Listed below are some aspects that were not addressed in the Program Objective. These issues may also deserve attention in an expanded study.

- The impact of agencies and organizations that help to create codes and standards: What role do manufacturers, insurance companies, legislative bodies and other groups play?

- The impact of location and climate on creation of codes and standards: Are broad regional variations in standards desirable?

- The impact of bidding practices and contract negotiations upon energy conservation efforts.

- The impact of first-cost compared to life-cycle costing on energy consumption.

- The impact of variations in codes within a given jurisdiction.

- The impact of codes and standards other than energy or general building codes.

List of Reporting Institutions

California

2-year public:	California Community Colleges
4-year public:	California State University & Colleges
4-year private:	Stanford University
public university:	University of California

Maryland

2-year public:	Catonsville Community College
4-year public:	Towson State College
4-year private:	Johns Hopkins University
public university:	University of Maryland

Michigan

2-year public:	Lansing Community College
4-year public:	Grand Valley State College
4-year private:	Andrews University
public university:	Michigan State University

Texas

2-year public:	Tarrant County Junior College (District)
4-year public:	Texas State University System
4-year private:	Southern Methodist University
public university:	University of Texas State System

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