DOCUMENT RESUME

ED 470 379 EF 006 156

TITLE	School Design.
INSTITUTION	Georgia Governor's Office, Atlanta.
PUB DATE	2000-11-28
NOTE	45p.; Produced by the Georgia Governor's Education Reform Study Commission, Education Facilities Committee.
AVAILABLE FROM	For full text: http://www.ganet.org/governor/ edreform_2000/issues_facilities.html.
PUB TYPE	Reports - Evaluative (142)
EDRS PRICE	EDRS Price MF01/PC02 Plus Postage.
DESCRIPTORS	Design Requirements; *Educational Facilities Design; Elementary Secondary Education; Public Schools; School Buildings; School Construction; State Action
IDENTIFIERS	*Georgia

ABSTRACT

This paper discusses five key issues in the design phase of a construction project that can improve the quality, cost, or time of construction. These five ways are: education specifications, design standards, prototype designs, value engineering, and selecting a qualified architect. To facilitate discussion, the background section of this paper first explains the overall project delivery process. In the background section educational specifications, design standards, prototypes, value engineering, and selecting an architect are defined and each is discussed based on current best practices. Then there is a discussion of the level of input a state may have when implementing each of these practices. Next, in the "Current Conditions" section, the paper explains what is currently being done regarding each of the five topics in Georgia and nationally. The third section of the paper highlights key findings about these topics. The final section of the paper presents various alternatives for each topic discussed. (EV)

Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 470 379

SCHOOL DESIGN

Governor's Education Reform Study Commission

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☒ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

T. Gandy

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

1

Education Facilities Committee

November 28, 2000

BEST COPY AVAILABLE

EF 006 156

Full text available at:
http://www.ganet.org/governor/edreform_2000/issues_facilities.html

ERIC

EXECUTIVE SUMMARY

The design phase is the most important phase in any construction process. During this phase priorities can be easily modified to meet both the needs of the local system and community. Of all the phases of the construction process, the design phase is where costs can be easily controlled and the construction process may be accelerated. School facilities across the state vary greatly in cost, quality, and function because the current policy allows local school systems maximum control of the design and construction. Though the state has one of the lowest costs for construction, there is always room for improvement. However in efforts to lower costs, improve quality or build more schools faster, policy makers will encounter trade-offs.

Since the state pays between 75 and 90 percent of eligible costs for school construction, the state has a role and vested interest in the success of school design and construction. This paper addresses five topics and ways that the state could potentially assume a greater role in the design phase and assist local school systems. These five topics are:

1. Education Specifications: A document that lists the square footage of rooms and the purpose for which that space will be used. It also describes all of the educational programs, unique curriculum needs, and number of personnel to be housed in the structure.

2. Design Standards: The type of materials, equipment, and systems to be used in the construction of the facility. The design standards also include the minimum standards for quality of materials, performance of building systems, and/or equipment used in construction of a project.

3. Prototype Designs: A standard plan or general scheme that serves as a model for design and construction. A prototype design is designed once and built over and over, with adaptations to make the plan fit the site.

4. Value Engineering: The process of looking at each component of the design and construction process and finding ways to reduce costs while at the same time not reducing value.

5. Selecting a Qualified Architect: The process of hiring an architect that will provide quality services and represent the owner well.

In Georgia, education specifications and design standards are the responsibility of the local school system. The state does provide minimum square footage requirements for different types of rooms, but the local system ultimately determines the number and type of rooms. The details of the education specifications vary by school system. The state does not have mandated design standards, instead allowing the local school system maximum control. The local system (with or without an architect) determines the design specifications.

ERIC

Many local school systems currently use prototype designs or reuse previous plans. The ten largest school systems account for nearly two-thirds of all new school construction in the state. Most of these systems have found greater economy and control of their design process by reusing plans. A prototype design must be modified to account for variables including site, soil, elevation, sewer and water, utilities, and climate. Options for developing prototype designs for use statewide include developing several basic models or expanding the library of plans currently housed at the Georgia Department of Education. Alternatively, the state could develop and set minimum performance standards for school facilities, leaving the decision of how to meet the standards to each system.

Value engineering, if properly done, can assist local school systems in coordinating the many components of the design process and reduce the number of change orders in the construction phase by catching errors. Some larger school systems are currently doing limited value engineering of construction documents with in-house staff. Others are assigning this process to architectural firms, project managers, or construction managers – or not doing it at all. Currently, value engineering is only done if the owner requires it or the project is over budget.

Design professionals and engineers are chosen by the local boards of education with no input from the Georgia Department of Education. There is no formalized statewide evaluation process used. The larger schools systems tend to have a formal selection procedure. However, the process of selecting design professionals is difficult for the small local school system not familiar with construction contracts and/or managing a major construction project.

There are a number of alternatives the state can consider, most of which would mean taking a greater role in the design process. Options include requiring education specifications, design standards, and/or value engineering – or, alternatively, instituting the use of prototypes. The state could take an active role in the development or approval of the various specifications/standards (including a architect selection process), or simply mandate that they be developed and used. Cost, time, and quality are all important, but trade offs are inevitable.

TABLE OF CONTENTS

INTRODUCTION	1
BACKGROUND	2
CURRENT CONDITIONS	19
FINDINGS	27
ALTERNATIVES	29

ERIC Full Text Provided by ERIC

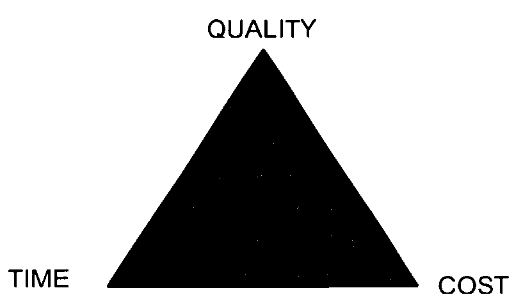
I. INTRODUCTION

The design phase is the most important phase in any construction process. During this phase priorities can be easily modified to meet both the needs of the local system and community. Of all the phases of the construction process, the design phase is where costs can be easily controlled and the construction process may be accelerated. School facilities across the state vary greatly in cost, quality, and function because the current policy allows local school systems maximum control of the design and construction. Though the state has one of the lowest costs for construction, there is always room for improvement. However in efforts to lower costs, improve quality, or build more schools faster, policy makers will encounter trade-offs.

> "The design of school facilities should be learning centered, developmentally and age appropriate, safe, comfortable, accessible, flexible, equitable and cost effective."

Quality, Cost, and Time

The trade-offs in any construction project are characterized by three variables, as shown in the following figure: quality, cost, and time. In general, you can optimize any two of these variables to the detriment of the third. For example, you can get a high quality project done quickly, but it will cost you a lot of money. Likewise, you can get your project done quickly and under budget, but in general this will require a compromise in the quality of the finished product. Finally, if you are willing to allow a lot of time for construction to be completed, you can get a high quality project at a lower price because you can afford to wait for the most convenient time for contractors to provide their services.



This paper will discuss five key issues in the design phase of a construction project that can improve the quality, cost, or time of construction. These five ways are:

1. Education specifications
2. Design standards
3. Prototype designs
4. Value engineering
5. Selecting a qualified architect

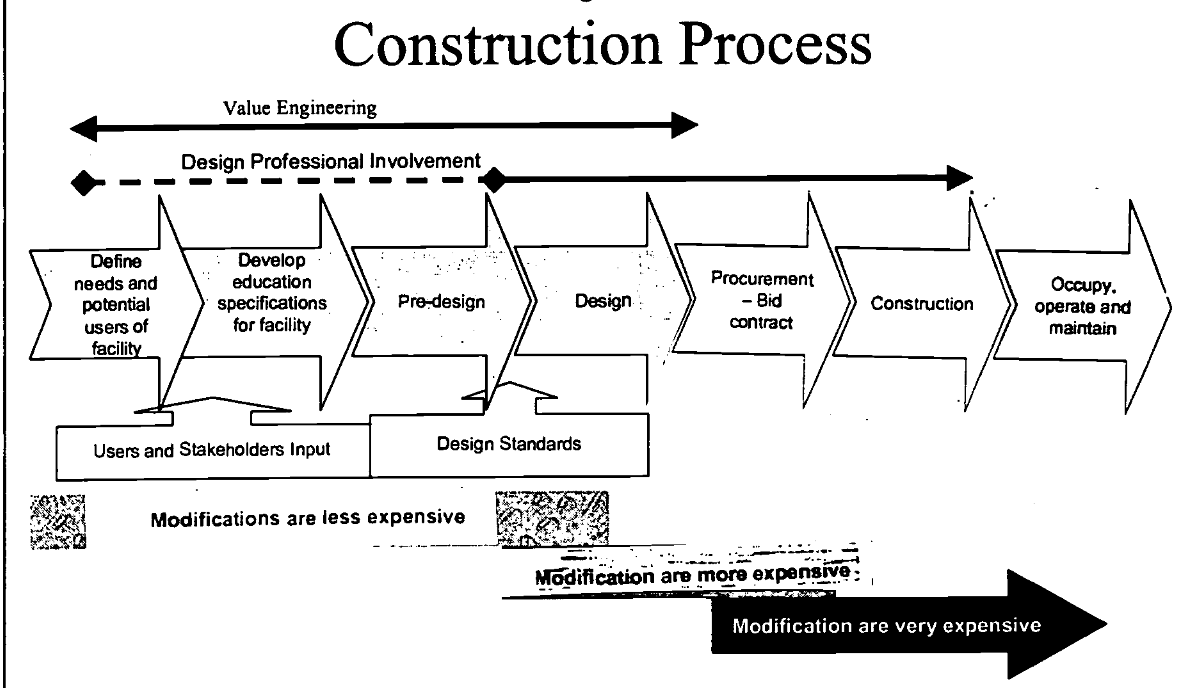
To facilitate discussion, the background section of this paper first explains the overall project delivery process. In the background section educational specifications, design standards, prototypes, value engineering, and selecting an architect are defined and each is discussed based on current best practices. Then there is a discussion of the level of input the state may have when implementing each of these practices. Next, in the current conditions section, the paper explains what is currently being done regarding each of the five topics in Georgia and nationally. The third section of the paper highlights key findings about these topics. The final section of the paper presents various alternatives for each topic discussed.

II. BACKGROUND

This section is intended to educate the reader about the construction process and the topics of educational specifications (ed specs), design standards, prototype plans, value engineering, and selecting an architect. These topics are defined and discussed as if they were real world practices. The current condition of these topics in Georgia is discussed later in the paper.

Figure 1 below illustrates the various steps in the construction process. The first four steps comprise the design phase. The design phase is the most important phase in any construction process. In the ideal world, during this phase stakeholders, including

Figure 1



faculty, staff, administration, students, parents, community leaders, and design and construction experts provide input on the design and plans. During this phase priorities can be easily modified to meet both the needs of the local system and community. Factors such as materials, equipment, short-term and long-term needs, use, and cost should be weighted, analyzed and debated. Once the design is complete, the construction project is put out to bid. The time for debate and changing priorities is past. Having a clear and detailed plan with a current estimate of cost by professional

BEST COPY AVAILABLE

estimators in place before the dirt is moved mitigates cost and time overruns. The number of costly change orders and miscommunications will be significantly reduced. As the construction of the facility progresses, the ability to modify the design, components and interior fixtures is increasingly limited. Thorough planning and design ensure lower construction costs due to fewer changes and lower maintenance and operation costs once the facility is occupied.

Educational Specifications

The first key issue that affects the quality, cost and time of a construction project in the design phase are Educational Specifications (ed spec). The ed spec is a document that describes all of the educational programs, unique curriculum needs, along with personnel to be housed in the structure. The specifications also include minimum spatial size requirements, spatial function relationships, and use of technology. The document also specifies the interrelationship between interior spaces and exterior spaces. The specifications should ensure that the facility meets state standards, guidelines, specialized curriculum needs, and needs of the stakeholders.

The ed spec is the way the stakeholders communicate their needs and desires to the architect. The document is best developed collaboratively. The school board, administration, teachers, parents, maintenance staff, architects, and construction experts should all be part of the process. The design professionals on the team can facilitate this step of the process. The sooner the project team is established, the greater the opportunity for good communication and the lower the probability of misunderstandings that will increase costs and total project time.[1]

Teacher office space and planning space for instruction should be, but often is not, specifically addressed in the educational specifications. In a nationwide study about the environmental factors that influence teacher attrition, several large factors included "inadequate work and/or office space, inadequate equipment or materials, and isolation from colleagues." [2] Given the teacher retention problems and the projected need for new teachers it is important that facilities be designed to meet the needs of teachers (and students). However, additional space for teachers does not come without added cost and planning.

Though developing ed specs with input from the stakeholders may increase the time of the design phase, the trade-off is that the quality of the project improves because all the uses and needs for the space are considered. Future costs due to change orders are

[1] Vanegas, Jorge A., M. Hastak, A. Pearce, and F. Maldonado. A Framework and Practices for Cost-Effective Engineering in Capital Projects in the A/E/C Industry. Construction Industry Institute, Austin, TX, 1998.
[2] Gonzalez, P. Factors that Influence Teacher Attrition. Washington, DC. US Department of Education. Office of Educational Research and Improvement. 1995.

reduced because the decisions have been made before plans are draw and the project is being constructed. With fewer changes, the project can stay on schedule.

Pre-design

As the education specifications are finalized the stakeholders are ready to develop some preliminary plans. The district should secure the services of a design professional for the pre-design phase, if it does not have in-house staff.

> The programming or pre-design phase is the most critical time during the construction process. In many instances, this phase is hurried, simplified, and in some cases ignored. What is done during this phase dictates the remainder of the program and affects both schedule and budget for [the forthcoming design and construction]. Every decision needs to be addressed during this phase, so the process becomes a series of conscious decisions that are well thought out early in the process . . . instead of reactionary decisions in the field. It is a lot easier to change items on paper than in concrete and steel.[3]

During the pre-design step, the stakeholders and the architect put the concepts found in the educational specification into a variety of schemes and then these schemes are discussed. As one academic note, "The design of school facilities should be learning centered, developmentally and age appropriate, safe, comfortable, accessible, flexible, equitable and cost effective." [4]

An assessment of all local and even state educational needs should be made to determine what programs (including post secondary) may be delivered in the proposed facility. This assessment should be completed no later than the pre-design phase. Up front joint planning produces facilities that better serve multiple programs and purposes.

Some of the advantages of pre-design are that it:

∑ Considers curriculum and program needs for facility considered early.
∑ Takes into account other utilizations for the facility.
∑ Reduces the probability of changes during or after construction, and can save on first cost (and time) of construction as well as life cycle costs.
∑ Makes school system define mission and purpose for facility before the physical space is even drafted.
∑ Captures input from various stakeholders.

Pre-design requires some time and funds be expended up front rather than after the final budget is approved. Some see pre-design as an added cost, however, the activities

[3] "Avoiding Pitfalls in School Construction," Georgia Department of Education Facilities Services Section Conference, February 24, 1998.
[4] Lackney, Jeffery A. "Thirty-three Educational Design Principles for Schools and Community Learning Centers," Educational Design Institute Mississippi State University, January 31, 2000. www.edi.msstate.edu/learningcenter.html)

done during pre-design have to be done at some point in the construction process. Pre-design and programming is best done very early. The quality of a project is related to the amount of time spent resolving disputes and defining the plans in the pre-design step.

Design Standards

The second key issue related to quality, cost and time during the design phase is the development and use of design standards. Design standards are a critical component of the design phase and often are standards set by state or local leadership that document the minimum standards for quality of materials, performance of building systems, and/or equipment used in construction of a project. These standards could include major building systems such as exterior and interior wall systems, structure, roofing, plumbing fixtures, heating, ventilation and air control (HVAC), electrical, communications, and technology systems.

> "It is a lot easier to change items on paper than in concrete and steel."

Two types of design standards are common. The first type is a specific list of materials, equipment and systems that are approved for use in the construction of the facility. An example of a specific type of design standard would state, "All classroom floors are to be covered in vinyl composition tile (VCT). " The second type of design standard is a performance based standard. An example of a performance standard would be, " All floor coverings in classrooms must last 10 years and require minimal maintenance."

Whether a specific list or performance based, design standards allow for immediate and long-term costs to be considered as well as environmental factors and maintenance considerations. If the school system does not develop or follow a specific set of design standards, building design professionals will use their own standard specifications and office design standards in the construction documents. During the pre-design phase and design phase, school administration and the design professional should evaluate what materials and design are best based on a first cost vs. life cycle cost analysis. Life cycle analysis is where the architect and/or school system defines a pay back period and evaluates a purchase based on the usable life of the product, maintenance cost, initial cost and any energy savings captured during the useful life of the product. If the cost savings and useful life out weigh the initial purchase price, then the item should be considered. Planners should evaluate equipment, major systems and materials based on their payback period and ultimate potential cost savings over time.

According to an energy audit of Georgia schools and hospitals conducted by researchers at the Georgia Tech Research Institute, considerable cost savings could be realized by more environmental and conservation minded designs and renovations. Researchers found that energy savings of 33 percent were possible by efficient operation and capital improvements in schools. If schools were designed efficiently to begin with, the institutions could have realized the savings from the beginning.[5]

[5] Brown, Michael L. et al., "Energy Conservation Recommendations, Implementation Costs, and Projected Paybacks for Georgia's Targeted Schools and Hospitals Conservation Program"

ERIC

Similarly, in a pilot project in Texas, a high school was designed using an energy efficient design. This facility showed 16 percent to 40 percent utility cost savings over other high schools in Texas.[6] Taking into account long-term benefits of energy efficient and environmentally conscious design and materials during the design phase may help school systems capture unrealized cost savings.

Both immediate and long-term cost savings may also be realized by taking into account environmental factors from a performance standpoint. Providing performance-based standards, in which the desired performance of the building is specified instead of specific materials or systems, can help to ensure that the desired quality of the school is obtained while allowing designers the flexibility to take into account the interaction between and among the features. For example, a common environmental goal is to reduce energy consumption of the building. If this goal is articulated as a performance standard (e.g. "the facility should exceed Model Energy Code requirements by 30 percent as demonstrated by whole building simulation"), designers can choose from whole palette of options that could meet the goal, some of which may be less expensive than a generic design applied to many situations. If the designer is encouraged to optimize the design from a whole building perspective, the first cost of the building can actually be reduced while also reducing life cycle operational costs.[7]

Design integration across building systems saves money by acknowledging the interdependencies among these systems. For example, if designers decide to improve the environmental performance of a building by using high performance, energy-saving windows, the size of the HVAC system can be reduced due to the reduced cooling load that must be supported. In addition, the size of the ductwork and/or plenum can be reduced proportionately, meaning that the floor-to-floor height of the building can be reduced, leading to a smaller overall wall area. If design is integrated in such a way that these improvements are made concurrently, then the savings from smaller HVAC plant, ductwork, and reduced wall area can more than offset the additional cost of the high performance windows.[8] The key to achieving these synergies in design is to provide design standards that emphasize the desired level of performance for the building, then suggest a variety of high-performing building system types and technologies that can be used to achieve them.

Balancing the initial cost against serviceability and continuing operational costs for maintenance and energy is necessary. However, the significance of improvements in energy conservation should not be underestimated. The City of Philadelphia school district found in 1983 that the use of performance-based standards for energy-efficient operation of its 260 facilities resulted in an impressive savings of $3.3 million in the first

---

[6] Maxwell, Charles L., "Energy Efficient Design Concept For Mesquite Independent School District," Mesquite Independent School District, Mesquite, Texas.
[7] Weizsacker, E., et al. *Factor Four: Doubling Wealth, Halving Resource Use*. Earthscan Publications, London, UK.; Pearce, A.R., Fischer, C.L.F., and Jones, S.J. (2000). *A Primer on Sustainable Facilities & Infrastructure*. Georgia Tech Research Corporation, Atlanta, GA.
[8] Hawken, Paul, Lovins, Amory, and Lovins, L.Hunter. (1999). *Natural Capitalism*. Little, Brown & Company, New York, NY.

year in energy costs.[9] The cost of energy upgrades can also be supported by programs such as EPA's Green Lights program, which provides its partners with connections to financing opportunities and extensive technical assistance to identify "profitable" lighting upgrade opportunities, i.e. those with a rate of return of 20 percent or more.[10] A school designed to maximize the conservation of energy, minimize environmental impacts, be resource efficient, and be aesthetically compatible with the site is desirable if first costs can be managed, and programs like Green Lights can provide a variety of options for ensuring that they are.

Consideration of other environmental quality factors can provide additional positive benefits as well. By using environmentally-sensitive building materials that improve indoor air quality and improving the performance of heating and lighting systems, some schools have reported lower rates of absenteeism and vandalism by "creating an atmosphere in which students can take pride in their school."[11] Researchers at Georgetown University found that achievement scores in school buildings with "poor" environmental conditions were over five percentage points below scores of students in buildings with "fair" ratings, and 11 percentage points below those in schools with "excellent" conditions.[12] Another study in North Carolina found that children in daylit (rather than artificially lit) schools score higher on standard performance exams (up to 14 percent increase over three years) and have better attitudes and attendance rates than their peers in nondaylit facilities.[13] Similarly, a Canadian study of the effects of natural light in elementary schools found that students in classrooms with full spectrum light were absent less, grew taller, and had increased concentration levels and more positive moods.[14] Energy savings from daylit schools can also be significant: estimates are that $500,000 on average can be saved over a 10 year period in the average middle school that incorporates daylighting features.[15]

Establishing performance-based design standards to achieve environmental quality goals for schools can have significant impacts not only on the first and life cycle costs of the building, but also on the basic health, achievement, and learning of the students. By providing designers with the flexibility to seek innovative and synergistic design solutions for their projects, a variety of high-performance features can be built into the school that will benefit not only the pocketbook of the school district and the state, but also the environment and the students themselves. Schools in Wisconsin, Maine, California, and elsewhere have successfully integrated advanced building technologies such as photovoltaic arrays, computerized energy management systems, or multi-fuel

---

[9] Sender, Malcolm, Energy Conservation Program Coordinator, School District of Philadelphia, Philadelphia, PA.

[10] Green Lights Program, U.S. Environmental Protection Agency, http://www.epa.gov/docs/GCDOAR/EnergyStar.html.

[11] "Energy Smart Schools," *Energy Ideas,* Vol. 4, No. 3, Winter 1996/Spring 1997.

[12] Edwards, M. (1991). *Building Conditions, Parental Involvement, and Student Achievement in DC Public Schools,* Georgetown University, Washington, DC.

[13] Nicklas, M.H. and Bailey, G.B. (1996). "The Difference is Daylight," *Washington Post,* Sept. 5.

[14] Alberta Dept. of Education. (1992). *Study into the Effects of Light on Children of Elementary School Age: A Case of Daylight Robbery.*

[15] English, H. "Students Shine in Daylit Classrooms," *Energy Ideas,* Vol. 4, No. 3, Winter 1996/Spring 1997.

boiler systems. These computer-controlled technologies not only help the school's maintenance staff do a better job of operating the building, they also double as a teaching tool, where students can monitor fuel, energy generation and use, and other variables. The final product then becomes a learning laboratory to demonstrate the physical and scientific principles of both sustainability and building science for the students and community.[16] The Center for Renewable Energy and Sustainable Technology (CREST) is the most well known of a variety of organizations that have developed online educational tools including classroom activities, lab experiments, and other exercises that use building-related problems and projects to teach math, science, and economics.[17]

Another factor in determining what materials to use and equipment to buy for the facility is the cost and skill level of local maintenance. If a HVAC system is installed that no one in the area or school system can maintain, then the on going cost will be greater. Similarly, planners should consider the cost of maintenance when choosing floor covering, fixtures, and interior and exterior surfaces. The design professionals must match the local expertise of system's staff or local private industry to maintain the equipment and building systems. It is not cost-effective to import maintenance staff from larger metro areas hours away.

The pros and cons of using design standards include:

Pros:	Cons:
∑ Evaluates materials, systems, and design. ∑ Captures input from various stakeholders. ∑ Facilitates cost-benefit analysis and life-cycle analysis prior to construction. ∑ Reduces the number of change orders. ∑ Provides flexibility for designers to seek innovative, systems-based solutions that meet performance goals. ∑ Increases the probability that performance and quality goals for the building are met. ∑ Reduces long-term costs over the life cycle of the building.	∑ Possibly requires outside consultant fee. ∑ Increases the design time. ∑ May need to be individualized to the maintenance staff's skill set. ∑ May preclude the needs and preferences of the local system.

[16] Greven, E. "Investments that Last a Lifetime," *Energy Ideas,* Vol. 4, No. 3, Winter 1996/Spring 1997. Augenbroe, G.L.M. and Pearce, A.R. (1998). "Sustainable Construction in the USA: A perspective to the year 2010," in Bourdeau, L., Huovila, P., Lanting, R., and Gilham, A., eds. *Sustainable Development and the Future of Construction: A comparison of visions from various countries.* CIB Publications, Rotterdam, The Netherlands.
[17] See http://solstice.crest.org for online resources and links

The pros and cons of design standards are directly tied to quality, cost and time. If the design standards are a specific list of items, then they can establish a minimum level of quality, control costs, and reduce time because the decisions related to the type of materials, equipment and systems is already specified. The type of materials, equipment and systems allowed is known and procurement, installation, and maintenance can be planned. Alternatively, if the standards are performance based they may require more time. Costs can vary depending on the type of materials selected. Performance based standards do allow the designer and local school system more flexibility and quality is held at a minimum standard.

Ed specs and design standards are preliminary steps to drawing plans for the school. Often if an owner likes a school constructed in another county or state, he or she will replicate that design. The reuse of plans or using prototype plans is one way to reduce the pre-design and design time for a facility. The next section discusses prototypes further.

Prototype Designs

The third issue related to quality, cost and time of construction is the use of prototype designs. The definition of prototype (base) plans varies. Prototypes can range from a general layout to a base model that can be upgraded to a final design or stock plan that is ready to build once it is adapted for the site. Another source of prototypes is a library of plans, which is a collection of school designs previously constructed with associated documentation.

The use of prototype designs and plans is common in residential and commercial construction. The actual cost savings from using a prototype must be weighted against other considerations unique to that community and the cost of adaptation. The final design and blueprint drawings of a facility are affected by a multitude of variables including site, soil, elevation, sewer and water, utilities, and climate.

Usually prototype plans do reduce time in the design phase and cost of construction. First, time is reduced because the ed specs and design standards are done. Second, prototypes may cut costs because they are designed for minimum volume, minimum square footage, and may use lowest cost materials. Traditionally in Georgia the cost of the architect is four to six percent of the cost of construction. According to local architects, in the best-case scenario, if the proposed construction site were similar to the site for which the prototype facility was developed and no changes are made to the plan, the school system would save about one to two percent from the architectural fee. These potential cost savings are more probable when the same architect firm (A/E), contractor and subcontractors are used to build the facility from the same plan. This is usually possible in a local area where construction sites are in close proximity and contractors do not have to travel significant distances.

By law school systems that use prototype designs are still required to hire their own A/E firms to develop the site-specific package, provide bidding assistance, and to provide construction administration services. If the cost of adaptation nears the cost of a custom design, the school system may opt for the latter to have a facility that best meets their needs, environment, and local identity.

Key Design Conditions and Issues Related to Stock Prototype Plans

When constructing a facility using a final or stock prototype plan, certain factors must be considered when adapting the prototype. The following is a list of these factors that contribute to the cost or feasibility of adapting prototype plans:

Site Issues

- A minimum usable site with required dimensions to accommodate the building, parking, service drives, and access drives is required for a school building.
- Standard plans generally lend themselves to level sites. Georgia's topography ranges from flat land to mountainous terrain. Present site-grading costs range from $100,000 to $1,000,000.
- Availability and location of utilities.
- Not all sites in the state have public sewer, water or natural gas. This condition will limit construction of schools using 100 percent finalized prototype plans. Modifications erode cost savings in A/E fees.
- The location of actual water lines, storm sewers, sanitary sewers, gas and power locations and characteristics may not conform to the design and equipment of standard building. Waste must flow from every point in the building in the direction of the available sanitary sewer. This sewer, if available, may be in any direction with respect to the building. Some sites do not have available sanitary sewers and an on-site disposal system must be designed.

Climate Factors

- Varying climate from North to South Georgia can affect the design of the heating, air-conditioning and ventilation systems. For example, a packed electric heat pump that works well in many areas will be less effective in some of the northern latitudes of the state. Schools in warmer areas may require a larger cooling system and smaller heating system with the case reversed for schools in cooler climates.
- A worst-case design for standard plans forces over-design of the HVAC systems.

Subsoil Conditions

- The range of soil bearing capacity in Georgia runs from 1,500 pounds per square foot (PSF) to 4,500 PSF across the state. The use of standard plans may force the use of worst-case conditions thereby increasing the cost unnecessarily.

Other Environmental Issues

- Wind Loads: Georgia's wind loading zone requirements run from 70 MPH to 100 MPH.

∑ Seismic Considerations: Some areas in Georgia contain faults that must be accounted for in the design.

Local Code Requirements / Code Revisions

∑ Many municipalities have local requirements that must be addressed that are in addition to the state building code.
∑ All codes are regularly revised or updated on a two to five year cycle, which will require regular updating of any standard plan.

Community Issues

∑ Communities may want a design that reflects the local architecture and provides a sense of identity.
∑ Prototype plans could significantly reduce the level of local involvement in the design and construction planning process.
∑ The prototype may not be easily adapted for a local system's instructional strategies or programs.

Architectural Issues

∑ Contractually, the state or school district must own the plans. Unless negotiated otherwise in the contract, the architecture firm has copyright of the plans and anyone that wants to use the same design usually has to work with that architecture firm. Under the current contract used by Georgia local systems, the plans for schools constructed with state capital outlay funds become the property of the local system.
∑ New liability issues will arise from the use of standard plans, drawn by one A/E firm, modified and administrated by another A/E firm. State law would need to be changed to permit one firm to reseal another firm's plan.
∑ The use of performance-based specifications provides a potential solution to these issues while increasing the quality and consistency of school construction.

With standard plans some savings can be expected on A/E services and construction cost if the plans are widely used and the local systems do not modify the plans. Stock prototype plans become economical if the sites are similar and if the state owns the plans for all facilities built using that plan. However, stock plans do not eliminate the necessity for employing architects and engineers. A/E must be retained to adapt the stock plan to a new site with different soil conditions, topography, location and utilities. A/E services will still be required for the construction and administration phase of each project.

The following summarizes some of the main pros and cons of prototypes.

Pros	Cons
∑ Reduces architectural fees ∑ Reduces time for development and approval of construction documents ∑ Saves on construction costs by optimizing choice of materials and maintaining minimum space sizes and building volume (and capacity) ∑ Comparable facilities across the state ∑ Emphasize the state minimum classroom size ∑ If regularly updated, would facilitate learning from mistakes.	∑ Requires updating plans regularly to keep plans compliant with building code changes ∑ Requires compliance with minimum requirements for size ∑ Without redesign for specific site locations, over-design in HVAC structure and other systems may occur due to variations in climate ∑ Requires more state oversight and resources to manage a prototype program ∑ Programmatic constraints. o Reduces local system input to the design and construction planning process. o May discourage a local system from adapting the facility to fit instructional strategies or programs. o Could cause a loss of identity for local systems if used for architectural features of the building.

<u>Library of Plans</u>

A library of plans is a collection of plans of past schools or schools currently under construction that is housed in the state department of education or on a web-based database. Schools from around the state can then access and use these plans. Plan libraries, if properly indexed, can reduce the design time in situations where performance-based specifications are provided to the designer. If performance metrics are used to index the plans, designers can search the libraries for plans and details that could be adapted to meet the performance requirements specified in the design standards. Thus, the designer is not restricted to any particular combination of design features but instead can choose the best-performing elements of existing schools to create a design solution. The start-up cost and site adaptation issues are similar for using plans from a library of plans and prototype plans.

Some of the pros and cons of library of plans include:

Pros	Cons
∑ The design is done - o Reduces architectural fees o Reduces time for development and approval of construction documents ∑ Anyone else with the same conditions can use the design ∑ The costs are known because the plan has been constructed ∑ The problems with the design are known and fixed during previous construction ∑ Plans are updated regularly at no additional cost to the state ∑ Allows local school system some choice in design	∑ Without redesign for specific site locations, over-design in HVAC structure and other systems may occur due to variations in climate ∑ May require additional state staff to administer the library

Like prototypes, a library of plans, if properly indexed, can reduce the design time. The school system could view the database of plans and choose a plan that best fits their needs. The plan is then adapted for the site and ready to bid. Besides the reduced design time, another advantage of a library of plans is that the costs and quality of the design is already tested and known. The mistakes have been corrected when it was first constructed.

Value Engineering

The fourth issue related to the quality, cost and time of a construction project is the use of value engineering. Throughout the four stages of the design phase, it is wise to be constantly checking the plans for optimal value and total cost. Value engineering is a systematic process for reviewing the elements of a design both individually and in connection to one another to identify opportunities for cost savings while maintaining the project's quality. It is aimed at satisfying user needs by means of a specific procedure through:

- ∑ Modifying the activity (process);
- ∑ Evaluating the economic factors (what materials and labor costs); and
- ∑ Assessing the multidisciplinary interactions of the processes (how one does it).

In many cases, value engineering can be achieved through good design review practices. While value engineering can be a valuable opportunity to reduce costs by identifying things designers may have overlooked, it should never be used without understanding the rationale for design selection. Careless value engineering can result in poorly performing buildings that meet no one's needs. Value engineering often analyzes specific components of a building to determine if less expensive alternatives can be substituted. However, if a careless substitution is made without understanding all the reasons for the initial choice, the whole performance of the building can be compromised. The classic example of poor value engineering is the case of high-performance windows: value engineering may recommend the substitution of less expensive, less energy-efficient windows, the result of which would be a building that is always overheated because its HVAC system is not resized to address the new cooling loads created by the revision in building envelope.

The improvement of a process must never put into jeopardy the quality of a project, especially in terms of the safety and usability of the project. Value engineering is based on the fundamental principle that the customer is always looking for the best product at the least cost. Value engineering is the connection between customer needs, satisfaction, and price.

The A/E professional, program manager, or in-house program management staff should perform value engineering throughout the design process. Value engineering can be a useful tool, not only for identifying cost savings opportunities, but also for catching design conflicts, errors, or omissions before construction begins. To be effective, however, it must be conducted in close coordination with the design team so that substitutions are not made that compromise the performance of the building.

Value engineering can help assist in assuring a well-developed and coordinated set of specifications and clear project definition, which in turn can reduce the cost of construction significantly. One study has shown that projects that are poorly defined cost 17 percent more than the average and projects that are well defined cost 20 percent less.[18] In addition to cost savings, a well-planned school will meet the immediate and future needs of the students, teachers, administration, and community.

Pros	Cons
If done properly, value engineering may assist in: ∑ Eliminating over-design ∑ Reducing use of expensive materials when a lesser costly material will satisfy the need ∑ Eliminating costly building systems ∑ Reducing spaces in excess of the program ∑ Providing alternates for owners' consideration ∑ Reducing errors and omissions in construction documents ∑ Reducing construction delays due to conflicts in documents	If done improperly, value engineering may: Lead to cost-based substitutions resulting in a poorly performing building

[18] R.W. Merrow, Independent Project Analysis Corporation, Reston, VA. Quoted in "Optimizing Value and Avoiding Problems in Building Schools," http://www.3di.com/Essays/essays.htm.

∑ Reducing change orders	

If done correctly, value engineering can insure a quality project, that can be kept on schedule and adjust the plans to eliminate any unneeded costs.

Qualified and Experienced Architect

The fifth issue related to quality, cost and time of construction is the selection of design professionals. These individuals will play an influential role in the building design process, because they are responsible for controlling construction costs, choosing materials based on lifecycle cost and quality, and setting the time schedule for construction. It is in the best interest of the local school system to ensure that the most qualified firms are selected for school projects.

The selection process should be based on:

- ∑ Competition
- ∑ Lowest fee of qualified A/Es
- ∑ Experience with like project with proof of experience
- ∑ Available staff for the project
- ∑ Current work level
- ∑ Distance from construction site
- ∑ Record of meeting and controlling project construction cost
- ∑ Record of number and length of addendums issued during bid process
- ∑ Past record of clarity and completeness of documents
- ∑ Record of number and types of change orders during construction phase
- ∑ Proof of insurance
- ∑ Etc.

In addition to the benefits of choosing a qualified and experienced architect, alternative methods for procuring design services can also help to reduce the overall cost of construction. Typically, architectural services are contracted on a percent of the total project cost basis, which may be an incentive to install larger systems (e.g., HVAC systems) than are needed and to over-design many other aspects of the project. As pointed out by an expert on environmental design of schools, the problem is compounded because "architectural firms are often held accountable if building systems are improperly sized or fail to work as promised - another incentive to overbuild or to stick with old, reliable technology."[19]

Design services should be procured in a way that *encourages,* not penalizes, the designer for seeking ways to improve the performance of the building by right-sizing equipment and incorporating new technologies where appropriate. Alternative procurement strategies include fees on a per student or other unit basis, fixed-fee contracts, and long-term partnerships where designers receive additional payments

[19] Creighton, S.H. (1998). *Greening the Ivory Tower.* MIT Press, Cambridge, MA.

ERIC

over time from operational savings brought about by their good designs. With these and other properly formulated incentives, designers will be rewarded for creating buildings that meet performance goals, rather than needing to be policed through processes like third-party value engineering. Partnering strategies with long-term payoffs as described earlier also provide the means and incentive to invest in education and updating of designers' repertoires to include best available technologies and practices.

The pros and cons of increasing attention to selection of architects and changing the way design services are procured are:

Pros:	Cons:
∑ Increases the likelihood of obtaining a higher quality building, particularly if selection criteria reflect cost, schedule, and performance goals ∑ Provides selected architect with incentives to design better buildings at lower cost, not only in the short term but also over the life cycle ∑ Reduces incentives for over-design ∑ Shares the responsibility for bad performing building (as well as the credit for good buildings) between the school district and the designer	∑ Requires additional time for solicitation of architectural services and review of qualifications ∑ May affect existing relationships between school districts and architects from past projects

Level of Input – State vs. Local

The issues of education specifications, design standards, and the use of prototypes, specifically, as well as encouraging value engineering and selecting an architect, return to the question of local input versus state standards and regulation. This section is an overview of the various options available in defining what level of input the state will have compared to local school systems.

Each step in the design phase offers a continuum of options and levels of input. Future state policy and procedure will be determined by when and how state leadership decides to guide school design decisions.

<u>Education Specifications</u>
Ed specs vary in size and detail. The level of state input on education specifications can vary depending on the goals and objectives of the leadership. The box below presents the continuum of control related to educational specifications.

Less → Level of Input	More
Local process	State determined
General guidelines	Specific
Optional use	Required use
No state determined square footage	Specific state square foot on all

The state could either develop *recommended* education specifications for facilities based on state curriculum standards, instructional guidelines, and best practices, or *require* local systems to follow the state's specifications. In the latter case, the state would have the *option* to exempt local school systems from the state specifications provided the local specifications received state approval. Alternatively the state could *require* local school systems to develop their own specifications for state approval. Another option would be for the state specifications to serve as the minimum for every school funded with state funds *or* simply as suggested guidelines. These education specifications could range from specific requirements (either performance-based or more directive) to general statements or questions that could facilitate the writing of local specifications.

<u>Design Standards</u>
The level of state input on design standards can vary depending on the goals and objectives of the leadership.

Less → Level of Input ←	More
Local decision	State determined
Optional use	Required use
General state guidelines	Specific state criteria
Local system decides what materials to use	State defined list of Materials
State funds at specific sq ft	Defined list of materials and level of funding based upon program
State funds all projects by square footage only	State fund only state designs

First the state needs to decide if it wants to establish minimum design standards for schools. It could require the local system to define the standards for their own construction or the state could develop a state standard for all schools. If the state developed statewide standards, the standards could range from minimum materials and systems, to more extensive standards and choices of materials, equipment, HVAC systems, space utilization, design features by type of room, and design features not funded by the state (e.g. atriums, curved walls, and extra external walls).

<u>Prototype Designs</u>

As mentioned earlier, education specifications and design standards are preliminary steps to drawing plans for the school. Often if an owner likes a school constructed in another county or state, he or she will replicate that design. In other states, prototype designs are developed by the state to help schools cut the cost and time of design. The level of state input can vary with prototypes as well.

Level of Input		
Less	Moderate	More
Custom – local decision	Base Model – with possible upgrades Or Library of plans	100% prototype plan and construction document (Same facilities for everyone) – State program

For example, in Georgia, the state could continue with the status quo and allow large school districts to use state funding to build a custom designed school or one using their own prototypes. On the other hand, the state could certify prototype designs for use statewide. The state could decide that prototypes should be encouraged and adjust the state funding policy to encourage reuse of plans or use of state prototypes. In any case, policy makers should review the effectiveness of prototype plans in other states prior to making a recommendation for their adoption in Georgia.

A prototype design could range from a basic plan to a final design with construction documents. This is similar to shopping for a car. When choosing a car, you can buy a base model, or for some extra money, purchase upgrades and packages. Similarly, a prototype school could be just a basic plan that meets the minimum educational specifications and design standards of the state. This layout could be modified and upgraded as needed to meet the specific needs of the school system. The trade-off of modifying a prototype is usually less cost savings. On the other extreme, the state could develop final complete prototypes with few modifications permitted and require their use.

A state library of plans is an option that would have moderate input from the state. The state would house the plans and collect the cost, performance and change order data regarding the plans. The local systems would be able to choose a plan from the library, thus reducing their design cost.

<u>Value Engineering</u>

A state can make similar choices about its level of control over value. For instance, will the state require or simply recommend value engineering? How specific would any guidelines be? What kind of oversight would the state exercise?

<u>Selection of Architects</u>

In terms of the selection of architects, a state could pre-qualify a list of architects and require local systems to make a selection from that list. Or the state could publish recommended guidelines and assist smaller systems in the selection process. As for all parts of the process, state leadership has many options depending on what outcomes it seeks and what it believes to be important.

III. CURRENT CONDITIONS

The State of Georgia has a backlog of school construction needs and cannot keep pace with the annual growth of students in K-12. The 10 largest school districts account for almost two-thirds of the new school construction in the state. Because these large districts are constructing so many schools, they are becoming proficient in school design and construction. However, smaller school districts with limited resources that need new facilities lack the in-house expertise or construction control of the fast-growing larger districts. In Georgia, school design and construction has long been a local activity, with minimal input from the state. However, the state is responsible for a certain percentage of funding for new school construction so the state does have a vested interest in improving school design and construction processes. Additionally, the Georgia law 20-2-260 (a) specifically indicates that the policy of the State of Georgia is to appropriately house all students.

> "It is declared to be the policy of the State of Georgia to assure that every public school student shall be housed in a facility which is structurally sound and well maintained and which has adequate space and equipment to meet each student's instructional needs [as defined by law]."

The following addresses the current conditions of the five topic areas that contribute to an effective design phase.

Education Specifications

The state consults with the local system to document the current facilities inventory of existing instructional spaces in the system. This inventory, along with the number of students currently assigned to the existing schools, documents the need for either additional instructional units or the number of surplus instructional units in the system.

If additional instructional units are needed, these additional instructional units are listed on the "Curriculum and Space Needs" page in the Local System Facilities Plan. For a new school, the "Instructional Unit Allocation Chart" is used to determine the number of instructional units based on grade level and school organization. The larger districts are usually able to do this inventory with in-house staff; other school systems receive help from a design professional, usually at no cost.

The state provides minimum square footage requirements for school facilities including: classrooms, corridors, art and music rooms, auditoriums, labs, vocational training space, physical education space, food service area, and lavatories in the "State Square Footage Requirements Guideline."

The "Curriculum and Space Needs" page along with the "State Square Footage Requirements Guideline"[20] form the minimal education specification in Georgia. These two documents, along with any additional documentation developed between the local system and their A/E, are often times the only ed spec needed to design new schools and additions. Most times the ed spec is developed with little input from stakeholders. A limitation of only using the Curriculum and Space Needs page as an ed spec is that the local system may not adequately plan the total facility. This page only requires the local system to plan for the items for which state funds are available. If this page with the square footage is the only ed spec, the local system may fail to plan and budget for the total project including parking, extracurricular facilities, and design features such roof and HVAC systems. These pages and the facilities plan may be updated as needed by the school system.

Additionally, not only educational needs, but also state funding can determine classroom size. For example HB 1187 may have an impact on school facility plans and design as the size of classes is proscribed. In addition, the Governor's Education Reform Commission is also looking at issues that may impact design.

The value of programming or pre-design has recently been addressed by the state in its management of capital projects. In July 2000 the Office of Planning and Budget (OPB) and the Georgia State Financing and Investment Commission (GSFIC) jointly issued recommended guidelines for pre-design of capital facility projects.[21] The guidelines were developed to educate state agencies about the importance of pre-design and assist them through the process. Requiring pre-design fro state agencies before appropriations are approved by the General Assembly, is a reversal of the old process of capital facilities planning.

On the national level, the control of education specifications varies by state. For example, in Ohio, the state provides a detailed level of guidance to school systems. These specifications were recently developed at a cost of $550,000.[22] In Florida, the level of guidance is more moderate.[23] Compared to these other states, Georgia has minimal education specifications to allow for maximum local choice.

Design Standards

Unless the school system has already developed design standards, the architect will use his or her firm's stock standards for office space or standards from a previous school project. Each local school system has preference for building materials, building

[20] Square footage requirements and Instruction Unit Chart can be found on the internet at http://www.doe.k12.ga.us/facilities/squareft.pdf
[21] http://www.opb.state.ga.us/Predesign-Final-July%202000.pdf
[22] Georgia Department of Education staff telephone interview of Ohio staff.
[23] Florida Department of Education Design Standards.

systems, and equipment. Though the choice of materials tends to be fairly uniform across the state, the trend in selection of equipment and systems is that the larger metro systems prefer more complicated building equipment and systems and the smaller systems choose equipment and systems that is less complex.

As with the education specifications, the local school system is currently responsible for providing the design standard document for their architect and engineers. The development and level of detail of these standards varies by school system and location:

- Some districts rely on in-house staff;
- Some districts use outside architectural programming firms to develop their design standards; and
- Most small school systems rely on their design architects.

The design standards are communicated to the design professional in both written and verbal form, and range from a one-inch thick document to a verbal command to copy previous standards. For example, the Gwinnett County School system builds more schools per year than most other local systems in Georgia. As a result, Gwinnett has developed both comprehensive education and design specifications for its facilities.

The state Capital Outlay program has no life cycle costing incentives. Local systems have little motivation to go with higher initial cost if totally local funds are limited and the system is more dependent on state funds. Local systems that primarily rely on state funds for construction must keep the initial cost of the school low. The trade off is spending more up front on better quality or getting one more classroom for the same cost.

While Georgia's guidelines focus on minimum requirements, some states set maximum standards for design and materials that the state will fund. For example, Ohio's standards state that:

> Materials other than those mentioned in this chapter, which meet or exceed the characteristics or performance of the stated materials, will be considered, provided adequate information is submitted for approval by the Design Professional and the Ohio School Facilities Commission. Alternate materials, which exceed the cost indicated in the Design Manual, will be at the school district's cost.[24]

Florida also has statewide design standards. The level of specificity is much less in Florida compared to Ohio.

More study is needed to determine the relative effectiveness of the different approaches to design standards in meeting performance goals for schools in Georgia.

[24] State of Ohio School Design Standards, 1999.

Prototype Designs

The use of prototypes or prior designs by individual systems is common in Georgia. More study is needed to verify how extensive the re-use of plans is in school systems. An initial survey of architects and several large school systems in the state shows that prototypes (meaning re-use plans) are most commonly used for elementary school design and construction. The percentages of schools constructed by reusing plans of a previously constructed school are:

- Elementary 80% to 90%
- Middle School 75%
- High School 15% to 25%[25]

High schools tend to be customized more because they are community centers and are designed to meet a variety of specific school and community needs. The larger systems that build several schools a year have found greater economy and control of their design process by reusing plans.

School systems experiencing significant growth have recognized the benefits of using prototype plans. Some of Georgia's school systems that are currently using their own prototype plans include:

- Chatham County
- Clayton County
- Coweta County
- DeKalb County
- Fayette County
- Forsyth County
- Fulton County
- Gwinnett County
- Henry County
- Paulding County

The prototypes used by these school systems vary in configuration depending on educational philosophy, community funding, and/or preference for a specific building system and finishes. For example, some school systems prefer a box while others prefer a finger design. Some prefer wall-mounted heat pumps while others want a closed-loop water system with boiler and chiller. Some want vinyl tile in the halls, others want Terrazzo flooring. Some want metal roofs, while others want built-up roofing. In general, most of the prototypes used in the large school districts are finished prototypes and require minimal adaptation. Resulting savings on a typical $5 million elementary school could be between $50,000 to $100,000.[26] However, these savings evaporate

[25] Data based on an Office of Planning and Budget survey of two local architecture firms and seven large local school systems.
[26] Georgia Department of Education Facilities Section estimate.

very quickly if the design requires an extensive site adaptation, any additions, or other changes to the plan.

In Cobb County, the vendor that manages construction for the school system uses a "kit of part" prototype concept where the various components of a school are prototypical parts and the kit is the school. For example, every kindergarten classroom is identical. It is considered a kindergarten part. Similarly, other classrooms, the kitchen, bathrooms, and other components or parts of a school is prototypical based on defined ed specs. The costs for each part or component are known. To design a school the various components are configured or assembled to fit the site and maximize space and stakeholder needs.

Many A/E firms offer the school systems reduced fees for reuse of the firm's current existing plans. If negotiated properly, a school system may realize a cost saving of one to two percent of the construction document development fee.

Retail outlets purchase or develop flat sites and build a cookie cutter building to maintain a brand or provide a single function such as selling a product. In most circumstances, stock plans that are developed and constructed with little or no adaptation would likely be difficult because schools provide a multitude of services and are designed to meet specific educational needs. Additionally, stock school plans are difficult in Georgia because of the many different types of topography, climate, soil, and other variables. The American Institute of Architects, the Associated General Contractors, and American Consulting Engineers Council, noted in a joint statement that in the last 50 years, 37 states have considered or tried "stock school plans"; all have quickly rejected there use. [27] A design that is a general layout or a base model that can be easily adapted is a better definition of a prototype.

Nationwide the adoption of prototype models varies. For example, Florida has recently legislated the development of prototype learning centers. The state legislature budgeted $500,000 in 1996 for the development of designs for four elementary schools. The construction documents for Learning Centers "A" and "B" plans were just recently completed. Completion of the prototypes was delayed until funding was made available. Design schematics for Learning Centers "C" and "D" are complete and awaiting additional funding to complete the construction documents. To date, one school system has elected to use the prototypes, but with modifications. The incentive for schools systems to use the prototype is the lower cost of design and construction document development and economy of construction costs. This economy of construction cost was accomplished by minimum size and choice of less costly materials. All the district has to do is adapt the prototype to the site and bid the contract.[28]

[27] Joint letter from AIA, AGC and ACEC, September 25, 2000.

[28] State of Florida, Learning Center Prototypes. And Interview with Florida facilities staff, September 2000.

Library of Plans

As mentioned earlier, in some states, instead of having a formal prototype, the state has a library of plans that school systems can use in selecting the design of a new school. The Department of Education currently has a collection of plans for all facilities under construction. These plans are all full sets of drawings and construction documents but are not in electronic form. DOE keeps change orders that are submitted, but does not collect contractor performance data, true cost of construction, or other evaluation data. These plans are kept for the duration of construction. Once the school is constructed the plans are discarded to make room for new plans. Often these new plans are in reality just updated plans for a new facility elsewhere in the district or state. Similar plans often circulate through the library because the large districts use prototypes and because individual architects often offer local school systems that use a previous plan a discounted fee.

In North Carolina, the Department of Public Instruction maintains a clearinghouse of school designs. Any architect can submit a design for a school that has been built in North Carolina, and which substantially meets the state "Facility Guidelines." The designer is required to submit school data, drawings, and pictures in a standard format, developed through a joint government/industry task force, so that all plans are presented in a similar manner with the same types of information. Each school has an e-mail or contact link back to the designer so that a school system has an easy manner in which to contact the designer for a potential re-use. In North Carolina, the designer maintains ownership of the plans as required by law for liability issues. School systems can access the clearinghouse over the Internet and select plans.[29]

California also has a web-based library of plans. Architects submit their designs electronically and then school systems view layouts over the Internet. This library helps users see the many designs available, an estimated cost and contact information of the architect. The California library of plans can be accessed through the vendor's website at www.designshare.com.

Value Engineering

Some larger school systems are currently doing limited value engineering of construction documents with in-house staff. Others are assigning this process to architectural firms, project managers, or construction managers – or not doing it at all. The smaller local systems have to rely on their architect and engineers to audit themselves and get feedback from construction contractors during the bid process to clean up errors and omissions in the construction documents.

Currently, value engineering is only done if the owner requires it as an additional task or the project is over budget. Value-engineering services add approximately one-half to one percent to the cost of the project. More study is needed to determine how much is actually saved over the building's life cycle as a result of value engineering.

[29] Interview with Steve Taynton, Consulting Architect, School Planning North Caroline Department of Public Instruction, September 14, 2000.

It is unclear how successful school systems are at implementing value engineering. Value engineering, if properly done, can assist local school systems in coordinating the many components of the design process and reduce the number of change orders in the construction phase by catching errors.

Qualified and Experienced Architects

There is currently no statewide standard practice in place for the selection of design professionals in Georgia. The local school system is responsible for selecting its architect and engineers. Currently the Georgia State Finance and Investment Commission (GSFIC) is contemplating using an evaluation instrument for A/E selection, but none has been considered for use by the Department of Education. The American Institute of Architects also has a qualification based evaluation instrument for A/E selection.[30] Larger systems like Gwinnett County and others presently develop their own criteria for design professional selection or use in-house staff for some functions. One large school district, Cobb County, outsources all aspects of the construction process and the program manager selects the architect and engineers.

The smaller local system may or may not have a formal selection process. The process of selecting design professionals is difficult for the small local school system not familiar with managing a major construction project for a few reasons. First, these systems are not in the construction market on a continuing basis. Second, the administration of the local school usually consists of educators and generally does not include construction professionals; moreover, no statewide program is available to assist them with this task. Third, local staff is not familiar with the industry, its contracts and how to negotiate them, and its procedures. As a result, many small local systems ask the state or a larger system for suggested guidelines for the selection of their design professionals, or simply employ the architect based upon previous relationships of a board member or superintendent.

Design professionals and engineers are chosen by the local board of education with no input from the state Department of Education. In addition, there is no formalized evaluation process used.

The Georgia State Finance and Investment Commission (GSFIC) suggests that the criteria for evaluating professional services of architects and engineers include:[31]

- Prior experience, including the successful completion of similar projects
- Prior experience with successful completion of state projects
- Prior experience of the applicant's subconsultants with successful completion of similar projects

[30] AIA, "Qualifications – Based Selection: A Process for the Selection of Architects by Public Owners," January 1992.
[31] Georgia State Financing and Investment Commission, "Selections Procedures for Design Professions: Recommended Guidelines," July 28, 2000, p. 3.

- ∑ Prior knowledge of local conditions or special conditions possessed by the applicant and subconsultants
- ∑ Relevant individual experience of the applicant's proposed project principal and discipline leaders
- ∑ Projected extent of minority business enterprise participation
- ∑ Location of proposed project office
- ∑ Demonstrated capacity to accomplish the study within the desired schedule
- ∑ Four references from the most closely related projects
- ∑ Other pertinent information

ERIC

IV. FINDINGS

Based on the background and current conditions discussed earlier in the paper, the following are some of the major findings by topic.

Education Specifications

- Ed specs are necessary to define the square footage and how the facility will be used.
- The degree of detail in ed specs varies by school system.
- Detailed qualitative ed specs are presently not required for state funding. Many times the only ed spec used is the state's "Curriculum and Space Needs" page from the local system's five-year facility plan and the square footage requirement.
- Ed specs may vary; some districts rely on in-house staff; some districts use outside architectural programming firms to develop their educational specifications; and most small school systems rely on their design architects.
- Ed spec development is a local process that is usually done once at no or low cost by an architect and updated as needed.
- Involvement of stakeholders in the design of a school may result in minimizing the need for redesign, remodeling or ultimately unusable space or inadequate space.
- Equality and standardization statewide are possible with state design standards.
- Quality working environment issues may need to be added in the future.
- The state funding formula for school facilities may need to be adjusted to provide incentives for schools to follow any new state policy regarding ed specs.
- HB 1187 may have an impact on the ed specs and design related to smaller class sizes and the need for more classrooms.

Design Standards

- Design standards are necessary as a prelude to design.
- Design standards vary; some districts rely on in-house staff; some districts use outside architectural programming firms to develop their design standards; and most small school systems rely on their design architects to provide design standards.
- Technical assistance from the state related to developing design standards is very limited. Most systems without in-house construction staff rely on their own knowledge and their architect.
- Failure of local school systems to document their design needs and wishes in writing opens avenues for miscommunication and costs overruns as the project progresses.
- Design standards help accelerate the decision, planning, and design process.
- A menu of pre-qualified materials that meet state standards could facilitate bulk purchasing of certain materials.
- State-determined maximum funding for a specified list of materials, systems, and design features is used in other states. The trade-off is more state input and

potentially increased cost.

- The state funding formula for school facilities may need to be adjusted to provide incentives for schools to follow any new state policy regarding design standards.
- If additional funds are provided as an incentive to use materials and equipment with a known lower maintenance cost or better energy efficiency, schools may be more apt to use such materials and equipment.
- Materials and equipment regardless of know efficiency, must be compatible with the local maintenance skill level.
- Items such as roofs, HVAC, windows, floors, and lighting are areas where life cycle costing makes a big difference.

Prototype Designs

- Prototype designs make sense within a local system when building multiple buildings of the same type in a short time frame.
- Use of prototype designs incorporates the education specifications process, thus eliminating most of that process in the design phase.
- The use of prototypes and existing plans reduces the design phase significantly for large school systems.
- Cost savings using prototypes are more probable when the same A/E firm, contractor, subcontractors, and suppliers are used to build the facility, in the same local area.
- The potential cost savings of using prototypes could be eroded by variables including site, soil, elevation, sewer and water, utilities, climate, and local program, and community needs.
- The state currently maintains a collection of plans for state review that is updated regularly.

Value Engineering

- Value engineering is a tool to eliminate over-design during the design phase of the construction process.
- Value engineering has many benefits throughout the construction process, but especially during the design phase.
- Value engineering encourages the review of construction documents by architects prior to the bid. This reduces the confusion and stress in the bidding phase and future change orders for the owners if the errors are overlooked.
- Most local school systems do not have the resources to review construction documents, designs, and bids. No state incentive is in place to encourage the use of a value engineer.

Architects

- Liability and copyright issues exist regarding use of a prototype plan developed or owned by another firm.
- The state does not have a standard practice in place for the selection of the design professionals.
- The state does not have a way of verifying the qualifications or performance of architects by project.

V. ALTERNATIVES

The alternatives presented are not mutually exclusive, and are intended to drive further discussion on school design.

Education Specifications

Because well thought-out ed specs can improve communication and insure that the school systems get what they are paying for, the Commission should consider at least six different alternatives.

1. **Define more detailed standard educational specifications and require their use by the local school systems.**

   The state may consider defining in more detail than is currently done what the minimum programmatic standards for school facilities should be. This includes minimum standards for instructional space, curriculum, and program needs to help local school systems design schools that function as safe, functional, economical, and aesthetic learning environments and community centers. These specifications may be general requirements or statements that would help the local administration and architect discuss and design the school.

2. **Develop state incentives to encourage school systems to develop education specifications and make other pre-design decisions with input from all stakeholders.**

   Provide incentives to encourage local system to solicit input from all stakeholders in the development of ed specs. When all the potential needs for a facility are addressed, the design and use of the facility can improve.

3. **Require local systems to develop education specifications as a pre-requisite for state funds.**

   There are three options in this alternative that are not mutually exclusive:

A. Encourage smaller school systems to partner with larger school systems to develop standard minimal education specifications for local school system use. An incentive may help since it might put an extra burden on larger systems.

B. Have the local school system's architect / engineering firm assists the local school system in education specification development and bring them into the process at the earliest possible opportunity.

C. Require that local specifications be state approved to ensure equitable quality and costs across the state.

4. **Put together a study group comprised of stakeholders and architects to identify and assess the costs of meeting the workspace requirements for teachers as recommended in the "Attracting and Retaining Quality Teachers" issue paper.**

This group may study the cost and requirements for including the needed workspace in new schools, in schools with major renovations planned, and by adding on to existing schools.

5. **Enlist a group comprised of stakeholders, such as teachers, administrators, architects, and policy makers to re-evaluate the space requirements and funding formula for classrooms given the new mandated class size limits in House Bill 1187.**

6. **Maintain the status quo.**

Design Standards

The design phase is where most of the cost savings are realized during both the construction and life cycle of the facility.

1. **Set state mandated uniform minimum design standards for local school systems.**

Like other states, Georgia could provide more detailed specifications related to materials, equipments, and systems that could be used in school construction.

2. **Develop and set minimum performance-based standards for school facilities, leaving the decision of how to meet the standards to each system.**

Georgia has the expertise within our university system to develop performance-based standards that result in schools that are safe, functional (both as learning environments and community centers), economical, environmentally-friendly, and aesthetically pleasing. A group could be retained to develop and pilot such standards that could then be implemented statewide.

3. **Require local systems to develop design standards as a prerequisite for state funding.**

   A. A larger school system could assist or partner with a smaller school system. Smaller school systems could purchase or request the design standards of a larger system and use or modify them to fit a school's geographical and building code requirements. For this alternative to work, the state may facilitate a clearinghouse of design standards by geographical region.
   B. Have the local school system's architect / engineering firm assists the local school system in design standards development. Local systems would then contract with a firm to develop these standards. Without proper controls and oversight, this alternative could result in a firm imposing their self-interest and developing a high cost, low quality facility.
   C. Create a state library of Department of Education certified model design standards available for smaller school systems. This library could include plans, details, and strategies that represent best practices both in Georgia and elsewhere in the country. Ideally, the library would use a consistent, electronic format to facilitate the exchange of information among the state, school districts, and design and construction professionals that build Georgia's schools.
   D. Require that local specifications be state approved to ensure equitable quality and costs across the state.

4. **Conduct a benchmark study of state design standards from an environmental standpoint.**

   This alternative could lead to recommendations that may enhance the indoor environmental quality, reduce the impact of schools on the environment, and save costs in the construction of the school and life of the facility. Additional lifecycle cost and environmental impact analysis should also be conducted on potential materials and systems used in school construction. This study could also be used to identify environmental best practices that could be applied to school design and construction in Georgia.

5. **Mirror Ohio in setting maximum design standards and funding.**

   The cost for any materials, systems or designs that exceed the state-approved items would be the responsibility of the local school system.

6. **Require local systems to complete the design phase prior to applying for state funding.**

This would force local systems to think through the various stages of the design process and have the costs defined before submitting requests for state entitlement earnings.

7. **Provide local systems technical assistance during the pre-design phase.**

   Local systems without in-house construction staff could use the expertise of DOE staff to assist them in developing ed specs and design standards. DOE staff may assist the local system in getting stakeholder input and providing guidance in selecting an architect and negotiating contracts.

8. **Provide incentives for life cycle costing.**

   The State may provide additional funding for school systems that select materials, equipment and systems that have significant long-term benefits such as energy savings, longer life, or lower maintenance costs (such items may have a higher initial cost).

6. **Implement a prototype program.**

   With a prototype program, the education specifications and design standards would already be completed and included. Prototype alternatives are explained further in the next section.

7. **Maintain the status quo.**

Prototype Designs

1. **Develop and use prototype school plans for new school construction.**

   A set prototype plan that could be used or adapted statewide may reduce architectural fees and the time to design and approve the construction documents. Prototype plans may help standardize school facilities across the state and facilitate buying materials in bulk. Learning curve savings could reduce contractor cost if the same contractor builds the same design repeatedly (more common in large school systems). Finally prototypes may help reinforce state policy regarding maximum class size and school size.

2. **Adopt base model prototypes with upgrade options (car model) or a "kit of parts" prototype for school design.**

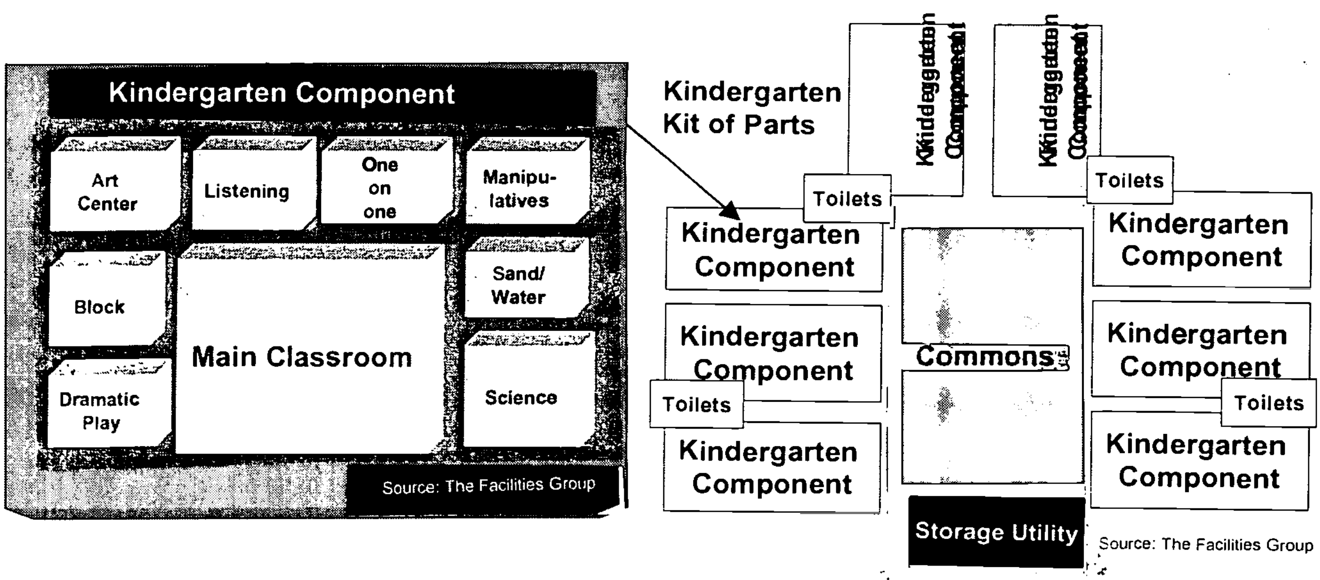
This alternative requires a base model school design and a pre-qualified list of approved options with the same relative cost, potential life, and quality.

A. "Car Purchase Model"

Basic Prototypes	**State approved Menu of Options** (Choose from 3-4 options in each category with similar cost)	**Local Upgrades** Paid for by the local school system
Basic school design that can be adapted for the site.	- Paint colors - Floor coverings - Parking - Utilities - Technology - Etc.	- Furniture - Floor coverings - Wall coverings - Facings - Curved walls - Atriums - Additional external walls - Commons areas - Etc.

B. Kit of Parts Model

This prototype is based on the principle that certain components of a school are typically the same. In the illustration below, the kindergarten component is designed according to an ed spec that specifies the necessary ingredients in a kindergarten room. The designer then develops the kindergarten area of the school by organizing various prototypical components. The materials, equipment, and fixtures are identical within a component or part and costs standardized.



3. **Encourage the reuse existing constructed school plans to reduce design cost and time.**

This alternative would have the same benefits and concerns as the use of statewide prototype plans with the added benefit of school systems having a greater choice of architectural plans. Rather than choosing from three or four prototype plans, the school system could reuse any plan that had been used elsewhere in the state.

For this alternative to be viable the state may need to modify the law to allow a second architect to re-seal the original architect's design. If not, the same architect firm that originally designed the facility would most likely be used, though the construction contractors could still be selected based on competitive bid.

The state may want to reserve the right to approve plans for reuse based on state design standards and an evaluation of projects that are based on the particular design to ensure that local systems do not replicate less successful designs.

4. **Develop a web-based library of plans of those plans currently available for review at the Georgia Department of Education.**

. This library would have all plans and specifications for new schools developed by local school systems containing state capital outlay funds in Georgia. The final plans would be stored in a standardized computer CAD format. The proposed budget, the final budget, and notes of interest would be cataloged in the library. A record of all change orders, including costs of each would also be included. These plans and specifications would be housed at the State DOE and available for school system employees or board of education members to review. An example of a web-based library can be viewed at www.designshare.com. State laws related to liability and copyright would have to be addressed for this option to be viable.

As is the case with all construction projects, the school system will still need to hire their own A/E firms to develop the site-specific package, provide bidding assistance, and provide construction administration services.

5. **Conduct a contest for best school design constructed in the state in various categories.**

Winning school designs would then become the prototypes for the state. Judges comprised of school administrators, teachers, students, parents, architects, et al would evaluate submitted designs against state criteria or ideals the Governor wants to encourage. This could be a Governor's Award Program and would carry recognition, and perhaps even a monetary award, for the winning school districts. The contest may select an overall winner and individual winners by predetermined category.

6. **Consolidate bids for construction of several schools.**

   Allow school systems that want to use the same plan to bid their contracts together. This way the same architect, and contractors could work on the projects. This could help realize some of the efficiencies of bulk purchasing and learning from mistakes.

Value Engineering – Program Management

Value engineering alternatives may require additional staff or money for consultants. Any entity overseeing the design process could potentially provide the value engineering service if they employed trained staff. These entities could include: GSFIC, OPB, DOE, program manager, architect firm, or local school system staff.

1. **Recommend or require value-engineering standards for local school systems.**

   This alternative works in concert with the state developing design standards. When a local school system starts developing a project, the state standards would help guide the school administration and architects in making sure the project is managed in an economical and effective way resulting in a quality product.

2. **Have the local school system's architect / engineer assist the local school system in value engineering and the development of standards.**

   Under this alternative the state would require some form of value engineering as part of the local system's contract with the architect/engineering firm.

3. **Provide value-engineering review for all state funded projects.**

   This alternative proposes centralizing the value engineering review of all school construction projects in the state. The state would review all specifications, designs, construction documents, and bid documents prior to the project being open for bid. This alternative would require additional staff or an outside consultant.

4. **Have an independent engineer, construction manager, or program manager review design.**

   This would add cost to the project, but the cost may be compensated by reduced errors.

5. **Conduct a benchmark study to identify cost and schedule drivers for school construction programs in Georgia.**

This study would provide a basis for identifying the most critical opportunities to reduce costs and save time. The driving factors identified in the study could be used as the basis for a standard process for value engineering. The study would also reduce any added costs of value engineering by focusing the process on areas most likely to present the opportunity to save time or money.

Design is without a doubt the best opportunity for cost savings in a facility construction project. However, the most significant changes can be realized by expanding the rigor of the design process to save costs *downstream*, i.e., in construction, close out, occupancy, renovation, and end of life cycle. The least effective way to achieve a building of the desired quality/performance on time and at a low total installed cost (or life cycle cost) is to minimize money (and thus effort) spent on design. Consider just construction costs as an example:

Suppose you develop a standardized or prototype design for a type of school, e.g., a "generic" elementary school design that can be varied to apply to any site in the state of Georgia. To adequately adapt this design to the site on which it will be put, there is a spectrum of extremes:

∑ Use the prototype design "as is," and let changes be made during construction as necessary (very expensive, lack of certified quality)
∑ hire a designer to adapt the prototype design somewhat, and use a value engineering process to optimize it prior to construction
∑ spend a good deal of design time adapting the prototype, reducing the probability of construction changes and keeping these costs down.

In the case of Georgia school construction, it would behoove us to mathematically analyze which of these variables is currently driving the process. Due to demographic changes, a greater number of schools need to be built quickly with a pool of funds that is not growing as fast as school construction requirements. Since reducing the quality of school construction is not an option, it would seem that we are trying to hold the quality variable constant while improving on the other two.

Changes in design and construction processes can help to optimize project cost or shorten overall project delivery time. In order to accomplish this, it would be necessary to have a firm grasp (based on analysis and experience) of the following:

∑ What are the components of the cost of a typical Georgia school?
∑ How much time does each step in the process take for a typical Georgia school?

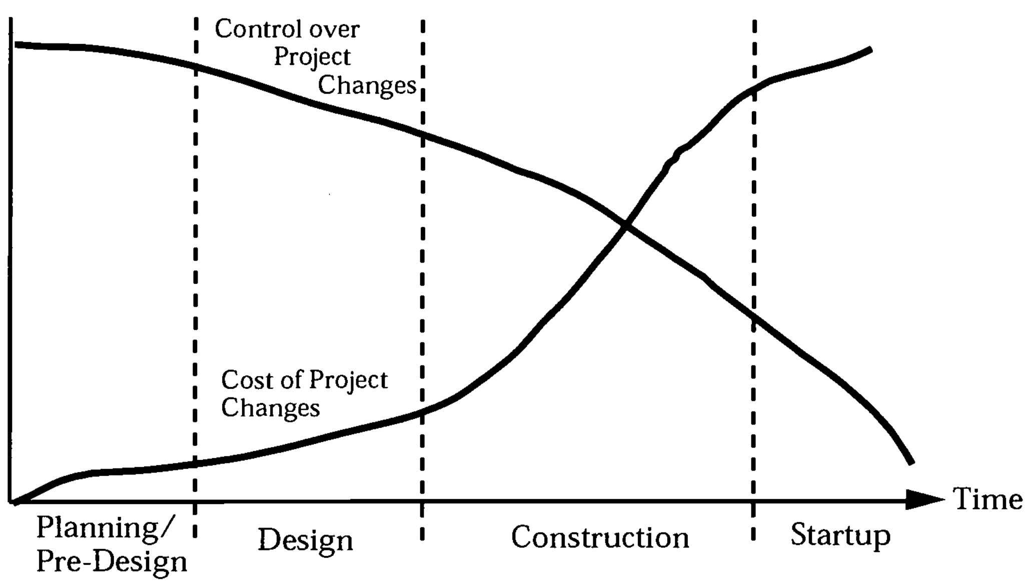
ERIC

Given that Georgia's construction costs for schools are low, further reducing the cost of new construction may not be first priority in meeting the goal of providing consistent quality schools at the lowest cost and in the shortest amount of time. Instead, perhaps other costs associated with school construction (e.g., site acquisition, etc.) provide a better target for cost reduction.

If we could obtain cost breakdowns for a representative sample of school construction projects, we could begin to identify what factors drive the cost of construction and determine how they should be managed to control costs in these projects. In many cases, you find that fairly obvious factors such as complexity of building geometry (i.e., building a finger design instead of a multi-story box), contractor experience with that project type, and choice of building systems control costs. These are the kinds of factors discussed in this paper.

However, in other cases it is not so straightforward. What if by reducing the designer's level of participation in the process you increase the numbers of construction change orders for the project? The only cases in which it is cost effective to make changes during construction rather than design is when a longer time to completion means significant loss of revenues to the owner (e.g., in steel mills and other kinds of production-intensive industrial construction).[32]

According to the Construction Industry Institute, this means that you usually end up with lower total installed costs (and also life cycle costs) if you front-end load the design process (i.e., spend more time, effort, and money) in the early planning and design stages. The following figure illustrates this relationship.[33]



[32] Vanegas, Jorge A., Hastak, Makarand, Pearce, Annie R., and Maldonado, Francisco. (1998). *A Framework and Practices for Cost-Effective Engineering in Capital Projects in the A/E/C Industry.* Construction Industry Institute, Austin, TX.
[33] Ibid.

As is evident in this report, we currently do not have enough information about what drives the cost of construction in Georgia schools, and therefore it is extremely difficult to say what can be done to help reduce costs further. The same is true for time – if you have the data, you can determine what parts of the process take the longest and focus your attention on managing those tasks to reduce overall project time. Thus a study such as the one proposed in this alternative would be extremely valuable and could inform guidelines, policies, and practices for the entire construction process.

6. **Facilitate value engineering by using the Construction Manager at Risk method of construction delivery.**

   This alternative suggests that value engineering is included in a contract with a CM at Risk. Because the contractor is involved during the design phase, the contractor can have input on ways to design and construct the facility more efficiently.

Qualified and Experienced Architects

1. **Develop criteria and evaluation procedures of design professionals for school systems' use, and evaluate the effectiveness of using those criteria to increase project quality and reduce project cost and time.**

   The Department of Education could adapt the GSFIC selection guidelines in evaluating and selecting professionals the school systems could use. This alternative could also be modified so that certain firms would be on statewide contract for professional services as needed by local districts.

2. **Provide technical assistance in the selection process for an architect.**

   This alternative provides the option of having state staff provide assistance to local school systems in the selection of an architect. Guidance may be based on best practices related to evaluating and selecting an architect.

3. **Participate with the local system in the selection of their design professionals.**

   State representatives could serve on the local school system selection committee and assist them in evaluating and selecting a design professional. Technical assistance could also be provided by one or more of the outreach programs offered by schools in the University System of Georgia.

4. **Have the state pre-qualify design professionals and program managers for local systems.**

When a school system anticipates constructing a school, that system could immediately contact only pre-qualified architect or design professionals to be their consultant. Pre-qualified architects may be tied contractually to their prototype design. Thus the architect firm of the plan chosen would automatically become the architect for the project.

5. **Develop and recommend or require the use of state selection criteria in selecting an architect.**

A. Require the use of the Georgia State Finance and Investment Commission's professional selection guidelines.

The Department of Education could enact a policy requiring all school systems to use GSFIC professional selection guidelines. Considerations are similar to those for alternative 1 above.

B. Require the use of the "Qualifications Based Selection Process" of the America Institute of Architects.

The Department of Education could enact a policy requiring all school systems to use the AIA Qualifications Based Selection Process and criteria in selecting a design professional. This is the selection process currently recommended by DOE staff to school systems looking for an objective process and criteria. Considerations are similar to those for alternative 1 above.

6. **Have larger school systems assist or partner with smaller school systems.**

The Department of Education could enact a policy or recommend that small school systems use the criteria and selection procedure used in one of the larger school systems. DOE would probably need to define, review, and certify the process used by the larger school systems before endorsing the guidelines or process.

7. **Have the architect certify if the design being used is a prototype plan, a plan from the state library of plans, or a custom design.**

If it is a prototype the school system should negotiate for a reduced architect fee. If it is from a library of plans, the costs and potential problems should be made public to all parties.

8. **Develop a database containing an objective evaluation of the design professional's performance on each capital project.**

This database should include data about the performance of the building post-occupancy, as well as any other pertinent indicators such as number of change orders, total installed cost, and adherence to schedule. The database could include quantitative indicators as well as qualitative ratings of the architect by the local system and the construction team. It should also take into consideration the performance of other members of the project team (e.g. contractors, school systems, etc.) that might have influenced the designer's performance.

9. **Investigate alternative strategies for procuring design services.**

Alternatives to the percent of total project cost basis for architect's fee include:

A. Fixed fee based on some unit such as number of students to occupy the school – this type of fee would also level the playing field in terms of demographics while still compensating the architect for the additional work presented by larger schools. A certain fixed fee would have to be included to offset the common costs of all projects (e.g. the size and complexity of certain features such as gymnasiums and auditoriums are relatively constant no matter how many students attend the school).

B. Post-design pay-for-performance – this could be an incentive on top of some other kind of fee system in which the designer and school system split any savings due to superior performance of the building. This option would encourage architects to design schools that can be built and operated cost-effectively.

The basic idea behind alternative strategies for design procurement is to eliminate any incentives for over-design and encourage innovation to improve the overall performance of the constructed facility.

ERIC

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

ERIC
Educational Resources Information Center

NOTICE

Reproduction Basis

X This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

☐ This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").