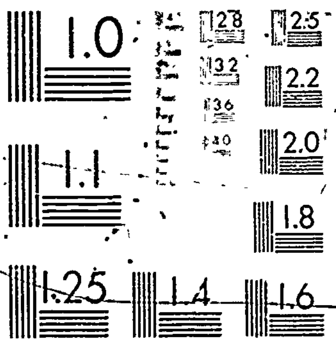
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ABSTRACT

This study is focused on organizational and procedural aspects of the Construction Systems Program (CSP), a developmental/demonstration project. The report is derived principally from practical observations by 42 active participants (architects, engineers, contractors, construction managers, owner's staff) in a four-school pilot program. Also included are diagrams that analyze (1) overall program organization, (2) document preparation, and (3) construction scheduling experience. Other graphs and tables plot construction cost experience. This report directs its research to the concerns of various categories of participants through four major phases of building: (1) design and organization, (2) documentation and bidding, (3) control of time and money, and (4) management of construction operations. Particular emphasis is given to problems of contractual relationships and professional responsibilities as influenced by the techniques of systems building. The report concludes with recommendations, particularly for owners utilizing the new methods. (Author/MLF)

NEW TACTICS for BUILDING:

Experience/Analysis/Recommendations from the Detroit Public Schools Construction Systems Program

Edited by: Wallace B. Cleland

Detroit Public Schools, Office of School Housing
5057 Woodward Avenue, Detroit, Michigan 48202

Printed: January 1975

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NEW TACTICS for BUILDING: Experience/Analysis/ Recommendations from the Detroit Public Schools Construction Systems Program

Published by Detroit Public Schools, Office of School Housing, January 1975, 162 pp.

Abstract:

This study is focused on organizational and procedural aspects of the Construction Systems Program (CSP), a developmental/demonstration project co-sponsored by the Detroit Public Schools and Educational Facilities Laboratories, Inc., New York City.

The report is derived principally from practical observations by 42 active participants (architects, engineers, contractors, construction managers, owner's staff) in a four school pilot program called "CSP-1." Also included are diagrams which analyze: 1) overall program organization, 2) document preparation, 3) construction scheduling experience. Other graphs and tables plot construction cost experience.

An earlier publication (Assessment of CSP, Richard L. Featherstone, Michigan State University, 1972) used statistical comparisons to show that the diverse approaches employed had significantly reduced costs and time from conventional construction, while improving quality of school buildings. Techniques have included: 1) industrialized subsystems, 2) performance specifications, 3) bulk bidding, 4) phased bidding, 5) management contracting, 6) expanded scheduling.

The current report directs its research to the concerns of various categories of participants through four major phases of building: 1) design & organization, 2) documentation & bidding, 3) control of time & money, 4) management of construction operations. Particular emphasis is given to problems of contractual relationships and professional responsibilities as influenced by the techniques of systems building. The report concludes with recommendations, particularly for owners utilizing the new methods.

Available from:

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Price: $4.00 (Checks payable to Detroit Public Schools)

The CONSTRUCTION SYSTEMS PROGRAM has been co-sponsored by the Board of Education of the City of Detroit and Educational Facilities Laboratories, Inc., New York City.

FOREWORD:

The work of the Construction Systems Program has given us encouragement as we strive to solve our many problems in creating renewed and improved facilities for thousands of students. Many hurdles remain, particularly in this period of unprecedented inflation; however, we believe we have developed methods and information useful in controlling costs and accelerating construction time. Our CSP-1 pilot program experience will permit us to apply the successful features of systems and management technologies to subsequent programs, thereby aiding amortization of investment while upgrading educational environment.

We hope this procedural analysis, which is based primarily on practical participant views, will be useful not only in Detroit but may be of benefit for cities and school districts confronting similar problems elsewhere.

Dr. Alvin G. Skelly, Deputy Superintendent
Office of School Housing, Detroit Public Schools

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FOCUS of this REPORT:

Lowered enrollments have eased the crisis, but planners know the problems have not diminished. In cities like Detroit, where certain older secondary schools provide only half the space per pupil of newer suburban schools, the pattern of deprivation is sustained and serious. Just keeping up with replacement of obsolete and unsafe facilities — not to mention needed expansion for new and improved curriculum — seems impossible within present or anticipated economic resources. Yet, responsible school boards, administrators, and planners must keep trying to upgrade the educational environment for every student now inadequately housed.

In 1969, Detroit organized the Construction Systems Program (CSP) in an effort to cope with certain of its school building cost/time/quality problems. The program included a successful four-school demonstration project called "CSP-1" which was evaluated in a 1972 publication, "An Assessment of the Detroit Public Schools Construction Systems Program," by Richard L. Featherstone, Ph.D., Michigan State University. That document primarily used statistical comparisons to show that the diverse new approaches employed by CSP-1 had: 1) reduced conventional construction time by 44 percent, 2) reduced conventional construction costs by 14 percent, 3) improved quality by providing air conditioned, highly flexible space.

The "Assessment" was a welcome and useful summary of accomplishments and ideas; however, it was not intended to be a "how to" book. It did not attempt to probe the complex concerns of building professionals regarding specific techniques and contractual relationships. Thus, this follow-up study was conceived as an organizational and procedural analysis of architectural, engineering, and business aspects intrinsic to multi-million dollar school construction projects.

Because people are needed to make things happen, this report focuses on — and, in fact, derives from — the concerns of individuals who were actively engaged in organizing, designing, bidding, constructing, and supervising the CSP-1 schools. Although directed toward "building professionals," that term is emphatically interpreted to include the "owners" who assemble the building team and who are at the heart of the contractual relationships. Only by concerted improvements in the performance of many participants will urban schools be able to cope with their vast backlog of crowded and deficient facilities.

ACKNOWLEDGMENTS:

Among the many who have cooperated generously and helpfully with the Construction Systems Program and with the preparation of this study are:

- The Board of Education of the City of Detroit and the Board of Directors of Educational Facilities Laboratories, Inc., who were the two co-sponsors.
- The five co-sponsor administrators and officers (named inside the front cover) who provided continuous essential leadership.
- The twenty-seven Advisory Committee members (named on page viii) who provided ideas and aid during the developmental phases.
- The forty-two pilot program participants (named on page ix) whose experience and interest, revealed through intensive interviews, have provided the basic content of this report.

Special words of appreciation should go to:

- Robert J. Jason, architect-consultant, who conducted the personal interviews with participants, summarized the basic data, and prepared the graphic materials.
- Betty L. Bradley, secretary to the CSP office, whose skills and experience contributed much to the preparation of this report and to the entire program.

Gratitude should also be expressed to Bernard L. Coker, Edward W. Gabert, Robert J. Jason, John Lansing, and Alvin G. Skelly for their suggestions while reviewing the manuscript in preparation.

W.B.C.

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	WILLIAM PAXTON	McClurg Associates
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	ROMEO CORRIVEAU	A. J. Anderson Construction Co.
	THEODORE CORRIVEAU	A. J. Anderson Construction Co.
	RICHARDS CRAWFORD	Armstrong Cork Company
	ROBERT FOX	Romac Steel Corp.
	WILLIAM HOYT	Armstrong Cork Company
	JOSEPH INATOME	W. J. Rewoldt Company
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I. A. CSP EXPERIENCE:

1. Defining Detroit's Facility Needs:

The Construction Systems Program (CSP) was organized to deal with the particular need of Detroit for specialized-use additions to secondary schools. All Detroit secondary schools are seriously overcrowded on the basis of statewide standards. Some buildings are obsolete, but there are many substantial older structures which within their rigid architecture can accommodate academic classrooms, offices, et cetera. There is, however, a great need for expanded curricula in vocational-technical subjects. Architecturally, this requirement translates into 1-, 2-, and 3-story wide-span variable-space additions with flexible services, adaptable to changing needs for shops, laboratories, art, homemaking, and music rooms. Often there is a need for additional or improved supplemental services, such as kitchens and dining facilities. These requirements constitute a more complex, highly-serviced, and more expensive building type than standard academic classrooms or open space instructional area.

The original proposal for CSP described the twin dilemmas of rising costs and slower construction time. Costs for conventionally-designed permanent buildings had risen 100 percent in the preceding 10 years. Construction time had increased 70 percent in the same period. These dual aspects were inter-related, and they combined to create serious problems for a school district which sought to be responsive to community needs.

2. Outlining a Systems Program:

Based on advice received from several consultant sources and from investigations of experiences in other cities, Detroit outlined a program that was largely derivative in objectives and methods from predecessor programs in the United States and Canada initiated by Educational Facilities Laboratories, Inc. (EFL), New York City. EFL was established by the Ford Foundation to encourage research in all areas relative to improving learning environments. Like the prior programs, CSP was aided by EFL and, like the others it called itself a "systems" program. The term "systems," most commonly defined as "an interdependent group of items forming a unified whole," has been interpreted to pertain not only to the parts of construction but to its process.

One of the first CSP activities was the formation of an advisory committee. (Refer to roster on page viii.) This group of professionals from government, education, and the construction industry provided direction and assistance throughout the organizational phases. Because CSP has been a multi-project cooperative effort, there have been many additional contacts between representatives of contractors, suppliers, manufacturers, regulatory agency officials, and others. One of the major benefits of CSP has been its function as a forum for diverse groups to interact and exchange ideas.

3. Initiating a Demonstration Project:

After early discussion about the size of an initial project and the market potential required to interest industry in an innovative technological response, the CSP Advisory Committee recommended a "two-track" program, of which the first track pilot project would be of relatively modest size. Four projects were designated for the pilot program -- all specialized-use additions to secondary schools. They were to range in size from 44,000 to 105,000 square feet, and aggregated to 280,000 square feet in area. Four architects had already been separately commissioned, but they agreed to work cooperatively, and they participated in subsequent decisions on how the program was to be accomplished. After some analysis, they decided to base the systemization of components on five subsystems: 1) Structure, 2) Atmosphere (HVAC), 3) Lighting-Ceiling, 4) Interior Space Division, 5) Vertical Skin. The architects also agreed to work within a common modular design discipline. Although performance specifications for the five subsystems were derivative from the Toronto Systems program called "Study of Educational Facilities" (SEF), they were extensively revised for Detroit needs and Detroit area codes. Bidding techniques used in Detroit were different from Toronto's, and more closely resembled those of the State of Florida's "Schoolhouse Systems Program" (SSP).

4. Bidding the Work:

Five subsystem contract awards, totaling $4.1 million, were made in March of 1971. Two subsequent bidding phases resulted in contracts for an additional $7.4 million of "nonsystems," which included separate substructure, and conventionally-organized work categories (Building, Mechanical, Electrical), plus three equipment contracts. The "nonsystems" also included alterations to existing buildings and some site work. By August of 1971, $11.5 million in contracts had been awarded to twelve prime contractors, all of whom worked on all four sites more or less simultaneously. Contracts for the four schools totaled about three percent below what was considered a very tight budget. Subsystem bidding came in more than 10 percent below estimates. Nonsystems bids came in about 10 percent over estimates, and some cuts were made in alterations work at two existing buildings. Detailed costs are in data form and diagrams on pages 99 through 113 of this report. Other comparative cost information appears in the next section, "B. Assessment of Pilot Program."

5. Managing the Work:

Although CSP began with the expectation of having a general contractor assigned contracts and an "overall coordinative managerial responsibility," it was decided to experiment by commissioning a "Management Contractor" to assume this responsibility. Requests for proposals were sought from several types of organizations, but the firm selected was an independent affiliate of an established general contracting firm. They manned four sites, handling full-time supervisory and expediting responsibilities, but doing no actual building, serving as an "owner's agent" in a professional capacity for a lump sum fee. The service was limited in duration to the actual construction period, and limited in scope because basic scheduling, estimating, and cost control duties were handled by a separately-commissioned consultant. Partly because of the somewhat restricted nature of the responsibilities, the designation "Management Contractor" was used, rather than the more common term "Construction Manager." Additional background and discussion of these services are included as major sections of this report.

B. ASSESSMENT of PILOT PROGRAM:

1. Measuring Objectives:

Some months before the completion of the CSP-1 schools, a study was initiated which led to the presentation to the Detroit Board of Education in September, 1972, just as the additions were being occupied, of a report by Dr. Richard L. Featherstone of Michigan State University. Called an Assessment, the document was, essentially, a measure of how successfully the program had met its three originally-stated basic objectives:

a) reduce construction time,

b) reduce construction costs,

c) maintain or improve quality of buildings.

The report analyzed the objectives by tabulating comparative statistics with recent equivalent conventionally designed and built Detroit schools (i.e., similar-sized specialized-use additions to secondary schools) where the factors could be quantified. The 41-page document included, in addition to background information, a number of observations and recommendations too lengthy to report here. However, primary conclusions appear in the next paragraph. A synopsis of the "Assessment" appeared in the Council of Educational Facilities Planners Journal for December, 1972, (pp. 8-11).

2. Stating the Conclusions:

The "Assessment," stated that the objectives had been met. Briefly, the conclusions were reported as follows:

a) Savings of about 44 percent in time over selected similar recent Detroit school projects;

b) Savings of about 14 percent in costs over selected similar recent Detroit school projects.

In regard to the third objective ("to maintain or improve quality"), the report pointed out that the conventionally designed and built schools used as a comparison were not air-conditioned, while the CSP-1 schools were. Also, the "Assessment" emphasized the much greater flexibility of CSP-1 buildings because of their relocatability of partitioning, lighting, air supply and air return. Enhanced by flexibility, the report stated, "CSP-1 projects are likely to be more functional as educational programs and teaching methods change in the future."

C. APPROACH to this STUDY:

1. Viewing Total Process:

When the original CSP proposal document was prepared in 1969, it included a commitment to conclude the demonstration project with a "technical evaluation." Many types of evaluative research could be beneficial in helping organize subsequent building programs, for example: a) measures of how successfully CSP-1 schools met environmental criteria (thermal, auditory, photometric, etc.), or b) measures of attitudinal response from CSP-1 school users (students, teachers, community, etc.) This study, however, has concentrated on analyzing the total process of getting schools built, rather than evaluating the final product.

Much of the impetus for this particular type of investigation came from "Building Systems Information Clearinghouse" (BSIC/EFL), Menlo Park, California. Working closely with its parent organization, Educational Facilities Laboratories, Inc. (EFL) in New York City, BSIC/EFL convened directors of six EFL-sponsored systems programs in 1972. At the initial meeting, Alan C. Green, Secretary-Treasurer of EFL, spoke of the "need to identify the organizational aspects of systems programs" as an aid in replicating similar programs in other locations or situations. The directors concluded that the most effective method to accomplish the objective was to focus in a highly analytical way on the process of getting schools constructed. Although originally visualized as a cooperative investigation of several programs in the United States and Canada, the work came to be concentrated on Detroit's CSP-1 schools. However, it has retained the concept that the overall process is relevant elsewhere; and not just for systems buildings, but for building programs everywhere.

2. Explaining the Research Method:

The study has been based primarily on interviews with 42 participants in the CSP-1 program: a) owner administrators, staff and consultants, b) commissioned architects, c) consulting engineers, d) management contractor personnel, e) contractor representatives, including manufacturers, suppliers, and contractor's engineers. (Refer to roster on page ix.) Each of the interviewees was selected as having an active and interested role. Obviously, some were much more involved than others; for only a few participants was CSP 1 their sole responsibility during their active period. Two representatives were selected from each of the four architectural firms. Generally, one was involved with design and one with construction phases. Under Detroit's professional contracts arrangement, engineers are consultant to the architects. However, they were interviewed as an autonomous category in order to identify their particular concerns.

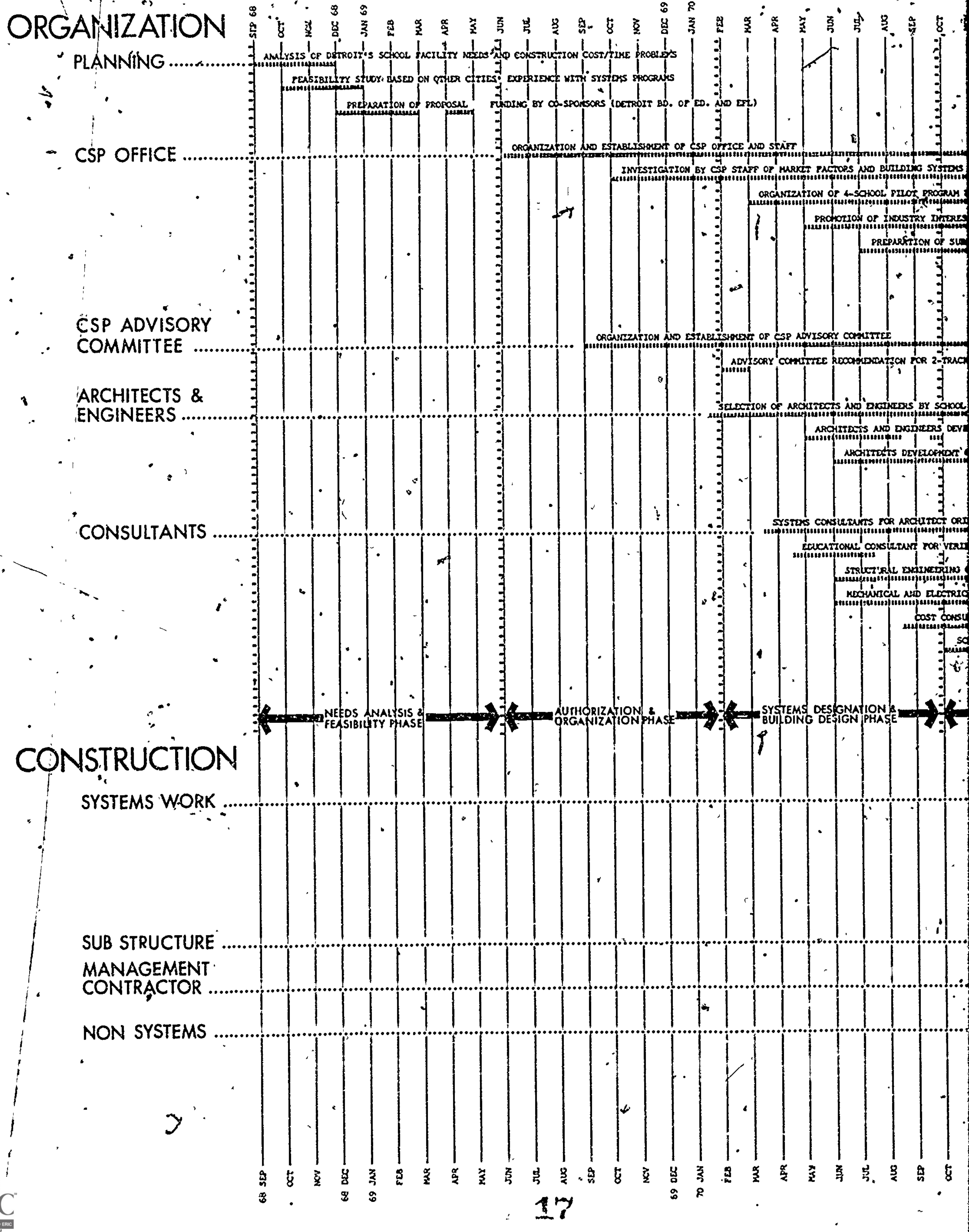
In order to encourage forthright answers, interviewees were assured that their replies would be reported anonymously, although identified by broad category of primary concern. With the exception of three participants who were not personally accessible and who replied to written questionnaires, interviews were tape-recorded with permission. Later, their commentary was summarized in written form, and the tapes were erased. Although all interviewees were asked certain of the same representative questions, the foremat was informal and open-ended. Interviewees were encouraged to volunteer comments and suggestions, and most had much to say. A typical interview lasted three hours and comprised perhaps 15,000 words. Sections II through V summarize the ideas and opinions in abbreviated form, sometimes paraphrased for brevity or clarity. A conscientious effort has been made to present the responses as accurately as possible.

3. Summarizing the Data:

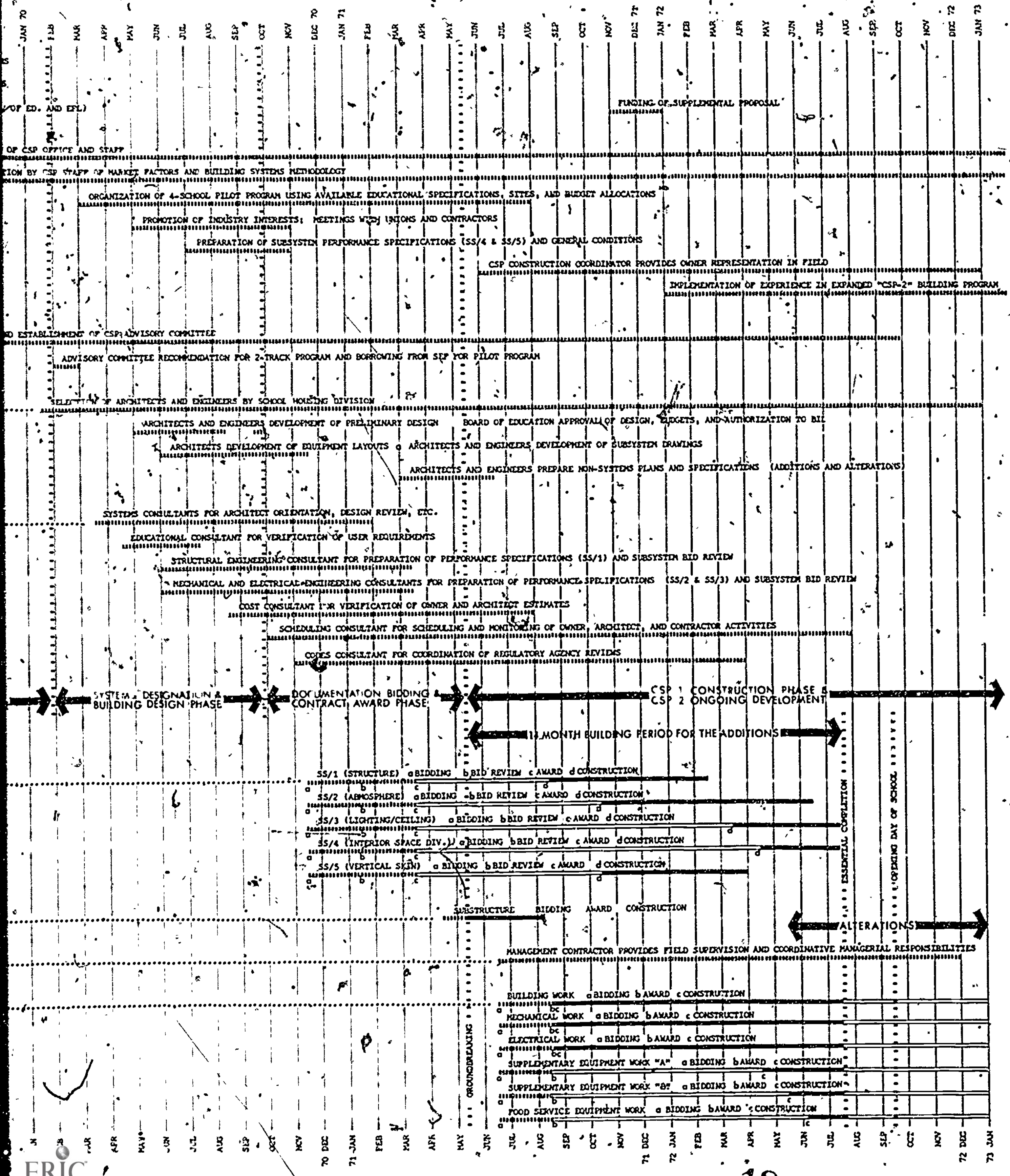
In order to help the interviewees reconstruct and expand their own thoughts, summaries of scheduling and cost experience data had been prepared and were available for review by interviewees involved with those aspects. This same scheduling and cost information is included in graph form in the body of this report. In the interview process, special emphasis was given to probing aspects new to the owner's experience in CSP-1, such as: a) industrialization, b) performance specifications, c) bulk bidding, d) phased bidding, e) management contracting, f) expanded network scheduling. Other topics were simultaneously explored, such as: a) supervision of construction, b) professional responsibilities, c) payment procedures, d) cost control, 3) regulatory agency relationships, et cetera. Using a research methodology loosely termed "content analysis," the interviewees' responses were categorized into 19 topics and further categorized by respondent classification. With each topic there are, typically, two representative questions: a) How did it work?; b) How can it be done better another time? In other words, analysis and recommendation. The predominant view is that of non-owner participants but, finally, in Section VI, an attempt is made to summarize the total process from the owner's perspective.

A summary view of the overall time span appears immediately following this section. (Refer to "Schedule of Program Organization in Relation to CSP-1 Construction Phases," page 9.) Because CSP has been a developmental effort with long range goals, its organizational aspects were extended. Subsequent demonstration projects will eliminate or abbreviate as unnecessary many organizational phases. However, this comprehensive schedule will help the reader to identify the sequence of major events and the several levels of simultaneous activity necessary to keep participants and process in cadence.

SCHEDULE OF PROGRAM ORGANIZATION IN RELATION TO CSP I CONSTRUCTION PHAS



ANIZATION IN
RUCTION PHASES



II. A. ADAPTING to DIVERSE ATTITUDES:

1. Background:

In CSP-1 the roles of all participants changed considerably. For the owner's staff, CSP became a new appendage. For architects and engineers, CSP meant less autonomy. For the management personnel, it involved pioneering in a professional category almost completely new to them, although all had prior construction contracting experience. For the contractors, most of whom had been subcontractors or suppliers, it was new to be a "prime contractor" in a direct relationship with the owner.

2. Representative Questions:

a. What was the general attitude or feeling toward the CSP-1 schools within your office?

b. How did the work on CSP projects compare in difficulty with a more typical school?

3. Responses of Owner Administrators, Staff & Consultants:

All attributed to themselves a generally positive view of the CSP endeavor. Most, however, attributed negative attitudes to particular others within their own organization. In speaking of others, they described a varied response, and used such adjectives as "bitter," "accepting," "resentful." One said:

- Attitudes within the School Housing Division varied among departments from acceptance to skepticism to opposition. Broader staff participation should be encouraged another time.

In regard to the difficulty of CSP projects, nearly all mentioned favorable aspects:

- More early problems, but fewer crises finally.
- Fewer problems because of more consultant help.
- No more problems on CSP-1, but owner gets more involved because he is midwife to four different architects.
- In final analysis, CSP-1 probably took less owner administration time than normally.

- CSP-1 a sound investment because most aspects can be picked up and used quickly again on future projects.

4. Responses of Project Architects:

None of the architect interviewees admitted personal or outright opposition to the approach; however, a majority expressed some disapproval:

- Early enthusiasm faded to discouragement because of limitations on aesthetics of design.

- Interest and beneficial learning process died because of laborious administrative process.

- Educating but frustrating.

- Ego deflating.

Two viewed their experience more cheerfully:

- Eager to start. Learned pitfalls. It is a new and exciting way to build, and we are still enthusiastic.

- Apprehensive, but positive. No objection to overall method. Design approach required more creativity and ingenuity.

The architects were about evenly divided on the problem aspects:

- No more difficult, but more complex and frustrating because of standards imposed by system.

- Requires greater expenditure by architect. Less detailing, but more administration.

- Basic job easier because of fewer details. Took a little longer, but it went smoother.

- More time and effort required. Regular approach preferred.

- Uneasiness and unsureness on everyone's part caused delays, but I'd like to do another.

- We are using this approach on our subsequent work for other clients.

5. Response of Project Engineers:

They expressed attitudes as follows:

- Initially positive; then deteriorated. Could not move ahead as quickly as hoped because of number of participants and uncertainty of responsibilities.
- Very enthused in beginning by challenge of new methods.
- Initially doubtful. As we got into it, we saw it could be done. Attitude remained positive until scheduling pressures built up at end of job.
- We were a bit negative during design phase, but have no gripes financially. We anticipate improvement next time.

Two of these engineers described their difficulties thus:

- CSP-1 more complicated and time consuming than conventional projects.
- Systems work was less difficult; non-systems work was more difficult primarily because of alterations.

6. Response of Management Contractor Personnel:

All of the management contractor personnel expressed support for the CSP approach:

- Attitude very favorable to concept.
- Step in right direction.
- As a Detroit taxpayer, I feel it's a very worthwhile program. Good organization and personnel.

Most recounted some problems:

- Difficult because of arrogance of a number of contractors.
- Building time was faster, but having four different architects created unusual difficulties.
- Too much paper work.
- Some architects earnest and sincere; one disinterested.
- Lots of problems and misunderstandings that could be reduced another time.
- Faster, but more difficult because of newness.

- Not as difficult as a normal job.

7. Responses of Contractor Representatives:

Virtually all the respondents in this category described their attitudes affirmatively:

- Enthusiastic. Like it a lot better than old way. Pressures better distributed.

- Positive attitude. CSP has helped to make industry more aware of available technology.

- I thought it was fantastic idea, but my company was skeptical. Now their concept has changed.

- A viable solution to cost and time reduction of construction.

- We were interested and intrigued. Good program despite some disappointments.

- I liked the projects, but architects and engineers bad-mouthed them; however, this is just resistance to change.

- We were skeptical at first about parts of program, but we became believers as we got further involved. We realized CSP had done a fine job overall.

- Our company was much interested that these schools go well and that there be others.

There were a couple of adverse criticisms:

- It seemed disorganized because of failure to assign tasks. Most bidders did not know what they were doing.

- We were elated to have a contract and we were interested. However, I don't like the buildings. Prison-like in character. Aesthetically horrible.

Regarding difficulties, the responses were contradictory. Two were negative:

- Time on CSP-1 was faster and the projects more profitable. Work was more difficult, however, because of uncertain responsibilities.

- More difficult because the interface responsibilities were so inadequately handled prior to bid.

In contrast, two were positive:

- Less difficult. Smoother. Minimum of problems because of simplicity.

- Less difficult, mostly because of four jobs simultaneously. A solution arrived at on one job benefited another. Excellent spirit of competition between work crews.

8. SUMMARY of RESPONSES on ADAPTING to DIVERSE ATTITUDES:

Regarding the question, "What was the general attitude or feeling ....," virtually all interviewees claimed a positive view. No one was willing to condemn experimentation. However, among the groups the architects seemed to feel the most reluctance about the CSP-1 approach. Their consulting engineers expressed certain related concerns. These responses will not surprise anyone who has followed construction industry trends nationally. Most often, it has been the professionals who have viewed the systems approach as impinging heavily on what they as architects and engineers view as prerogatives.

Nearly all of the difficulties alluded to in this section (delays in scheduling, conflicts in authority, etc.) are probed extensively in the following pages of this report. Therefore, no attempt is made to analyze specific problems at this point. The questions on attitude were intended to give information helpful in weighing subsequent responses.

II. B. ACHIEVING INDUSTRIALIZATION:

1. Background:

"Industrialization" had been defined for the interviewees as "use of repetitive building components which lend themselves to off-site fabrication and rapid on-site construction." This aspect was described as a basic goal of CSP-1, as it has been for all predecessor systems programs in the United States and elsewhere. The reason is, of course, that on-site construction costs have for many years been accelerating at a steeper rate than have the costs of off-site, in-plant manufacture of building components. Combining economic goals with acceleration and stricter quality control, systems planners have sought to combine historic trade categories based on hand-craft skills (carpentry, masonry, etc.) into more developed manufactured assemblies.

2. Representative Questions:

a. Would industrialization benefit scheduling and/or costs of subsequent schools?

b. Are there any portions of buildings of this general type which you believe could be more industrialized by use of off-site manufacture of parts or by pre-assembled components?

3. Response of Owner Administrators, Staff, & Consultants:

All but one of the respondents in this category foresaw advantages to increased industrialization:

- Industrialization tends to reduce costs and makes quality control easier.
- There was great interest in bidding CSP-1 from national manufacturers, particularly those without local contractor-suppliers who might be alienated by having a parent organization bid directly.
- The kind of off-site manufacture now done with furniture could be done much more extensively with building components.

The one opposing view:

- Pre-assembly of building components has always been a dismal failure. I don't know why, but there is no apparent advantage to off-site manufacture.

Those who held the predominant favorable view had several suggestions for increased industrialization:

- Roofing assemblies to permit more rapid enclosure.
- Large prefabricated brick panels as an alternate cladding choice.
- A coordinated electric-electronic subsystem combining all services plus signals, alarms, and communications.

4. <u>Responses of Project Architects</u>:

Some architects saw advantages to industrialization:

- Almost every component of construction could and should be industrialized to save time and money.
- Further steps could be taken toward off-site fabrication and would have great advantages in scheduling.

However, there were negative views:

- I am dead set against it. A bad experience because -- although industrialization saves time -- it deteriorates quality.
- If you are going to have industrialization, the architect will need to supervise manufacture of products.
- The problem with industrialization is uniformity of components. The only variety is in manipulation.

From those who viewed industrialization as advantageous came these suggestions:

- Pre-assemble doors, frames, and hardware.
- Pre-assemble coffered ceilings, stairways.
- Pre-manufacture roof curbs.
- Expand scope of interior partitioning to include off-site installation of plumbing and wiring inside, plus tack and chalk boards outside.

5. <u>Response of Project Engineers</u>:

(No questions asked on this topic.)

6. Responses of Management Contractor Personnel:

(No questions asked on this topic.)

7. Responses of Contractor Representatives:

Most respondents in this category saw advantages to off-site fabrication of components:

- Industrialization concept worked fine, but you have a lot of unhappy architects.
- Yes, pre-engineered and pre-assembled parts are now available, but I don't think it is necessary or desirable to use performance specifications to secure them.
- Yes, there are real benefits. For example, plug-in light fixtures used by CSP were a great saving in time and money.

From this group there were recommendations to expand industrialization by seeking:

- Pre-wired electrical panels.
- Pre-assembled plumbing units.
- Pre-assembled doors, frames, and hardware.

There were warnings, however, about problems caused by accidental on-site damage to pre-finished components and general warnings about union jurisdictional disputes.

8. SUMMARY of RESPONSES on ACHIEVING INDUSTRIALIZATION:

Of the three categories of participants interviewed on the topic of industrialization, nearly all regard as a worthy goal a greater reliance on off-site manufacture of building parts. A number of specific suggestions were made regarding potential expansion of industrialization for subsequent buildings of the CSP-1 type; however, respondents recognized that the existing pattern of craft guild trade categories, under the management of relatively small contractor-entrepreneurs, discourages the type of corporate organization required for manufacturing. European experience is that true industrialization evolves only from a government-guaranteed market. Nonetheless, there are slow trends in this direction in the USA. The responses recorded here suggest that even the architects, who as a group have been most committed to the concept of custom-designed, custom-constructed buildings, can adapt to a limited industrialization.

II. C. DESIGNATING NEW COMPONENT GROUPINGS:

1. Background:

Early in the organization of CSP-1, a recommendation was made to borrow certain aspects of the successful Metropolitan Toronto School Board systems program called Study of Educational Facilities (SEF). That ambitious, sophisticated and well-organized program was admired in nearly every respect. However, the decision to utilize particular SEF component groupings was not made until after the CSP-1 architects had been commissioned. During the early exploratory phase, these architects, assisted by CSP staff and consultants, visited and studied Toronto's ongoing program. The consensus was that not all of Toronto's developments were suitable for Detroit's program and particular building type (i.e., specialized-use additions to secondary schools). The recommendation was that Detroit should try to adapt only five of SEF's ten subsystems (Structure, Atmosphere, Lighting-Ceiling, Interior Space Division, and Vertical Skin) comprising an estimated 40-45 percent of building costs. Before the five subsystems could be borrowed, their specifications had to be extensively rewritten to consider Detroit codes and standards.

2. Representative Questions:

a. In addition to the five subsystems used in CSP-1 schools, are there other portions of the work which should be handled as early-bid subsystems?

b. What problems (or opportunities) do you see ahead for building systems?

3. Responses of Owner Administrators, Staff, and Consultants:

Respondents in this group had a number of ideas for adding subsystems. Categories mentioned were: 1) underground mechanical combined with substructure, 2) all equipment and furniture currently purchased separately by owner, 3) plumbing, 4) electric-electronic, 5) hardware, 6) roofing, 7) flooring, 8) sprinklers.

Interviewees discussed opportunities for systemization, with comments such as:

- Undoubtedly better quality buildings both educationally and maintenance-wise.

- Lower costs. The way we're headed our buildings will be $100/square foot; but systems buildings will be $75/square foot.

- Discipline of systemization can benefit all participants in building team.

- Simplification of process means owner does not have to maintain so much in-house technical expertise, which means more time for owner in educational considerations that really count.

- Systemization techniques will tend to create managerial skills that have been absent from individual segments of building team.

Regarding problems of systemization, the respondents had these views:

- There may be trade union and regulatory agency problems in increased systemization, but CSP could use its Advisory Committee to facilitate solving these difficulties.

- There may be some problems for owners in keeping up with technological innovation. As we do now with automobiles, we may buy only what the manufacturers make.

- Building industry will be dominated by big manufacturers (or conglomerates) who set their own standards rather than our standards.

4. <u>Responses of Project Architects:</u>

When considering expanding the roster of subsystems, this group suggested: 1) plumbing, 2) electric-electronic, 3) doors, 4) hardware, 5) roofing, 6) interior masonry, 7) stairs, 8) elevators, 9) sprinklers, 10) alarms and signals.

There were positive endorsements for adding subsystems:

- Great savings in time and cost, along with better quality.

- We have used early bid subsystems for electric-electronic and for plumbing on another job, and it worked out better than CSP-1.

Also, there were negative comments and concerns:

- Major problems are jurisdictional and regulatory.

- Serious legal responsibilities with manufactured products.

- If you give too much freedom to construction industry, you are taking architect out of his proper role.

- I am not enraptured with term "systems." Why can't we just talk of rational buildings?

- Proliferation of systems may deteriorate human qualities of design.

Much the greatest concern was with two of the original subsystems:

- Major problem is aesthetics. Drop "Vertical Skin" as a subsystem.

- Eliminate visual pollution of rooftop multi-zone HVAC units.

5. Responses of Project Engineers:

Suggestions for additional subsystems included: 1) sprinklers, 2) underground mechanical, 3) electric-electronic, 4) plumbing.

They discussed opportunities provided by systemization:

- Greatest benefit in fast erection; real economy will only be achieved with multi-project bulk bidding.

- Cost and time savings, but only if highly standardized.

Also, they foresaw problems:

- Buildings will be stereotyped and dull.

- Biggest problems in quality control and workmanship.

- You may get innovative design from national manufacturers for a large multi-project program, but you will never get it from local contractors.

A middle view was taken by one engineer:

- No real problems with systemization. It is just a matter of educating designers and contractors to become familiar with new processes. Great opportunity for architects to enhance the appeal of systems buildings by improving appearance of buildings.

6. Responses of Management Contractor Personnel:

There were specific recommendations to expand systemization by including: 1) doors, frames, and hardware, 2) plumbing, 3) electric-electronic, 4) underground mechanical combined with substructure, 5) shop equipment. However, there were contradictory feelings from management personnel that such categories as plumbing and electrical that require very intensive architect-engineer coordination are not good candidates for early-bid subsystems.

On problems of systemization, they commented:

- Building industry is so spasmodic and cyclical it is difficult to maintain production of any component or subsystem.
- There are unique labor problems. One subsystem contractor could shut down a job. On a conventional job, the general contractor would find another supplier to keep going.
- Systemization can go too far in diffusing responsibility among a lot of different contractors.

On opportunities, they commented:

- Systemization can be beneficial if it evolves logically from master schedule.
- Potential for more diversified contractors to get involved.
- Big advantage is speed.
- Even greater cost savings when present systems refined.
- Great opportunities if bulk bidding is used. Very promising for the Detroit market.
- Unlimited opportunities for quality and speed, as demonstrated by European progress.

7. Responses of Contractor Representatives:

Because the contractors represent quite specialized trade or subsystem categories, they were not asked to make suggestions on overall expansion of systemization. However, they had a variety of observations on the concept, with almost unanimous endorsement of the opportunities, including:

- Potential for better quality, cost, and time. I see this as moving force in the school building industry in the years ahead.

- Faster and lower in cost; quality will depend on design professionals.

- Greatest advantage now is speed. Variety of component selection will increase.

- Systems building will increase in scope. As new manufacturers enter the bidding arena, pre-qualification may be mandatory.

- Opportunities for systemization are expanding, particularly in school and commercial building.

- Present construction industry is sick. Systems will give a shot-in-the-arm. Old way is just too expensive and time consuming.

Despite their generally supportive view, contractors foresaw some difficulties, including:

- Potential union problems, but they can be worked out.

- Poor appearance a principal flaw.

- Systems concept can be overworked. Real solution is for architects to do more research.

- Real problem is in using performance specifications. They invite bidders to use cheapest, flimsiest products. This arrangement permits components to be cheapened after bids are taken. Performance specifications must be rigidly enforced.

8. SUMMARY of RESPONSES on DESIGNATING NEW COMPONENT GROUPINGS:

CSP-1 participants of every type can see cost- and time-saving opportunities which could result from restructuring the old trade categories into new component categories called ubsystems. Architects are the most reluctant group because they resist what they see as limited design choices. However, architects are quick to suggest additional systemization they believe might free them from technical worries and permit them to focus on the aesthetic/environmental qualities which most concern them. On a somewhat similar note, certain owner staff people are eager to be relieved of technical concerns in order that they can return to their fundamental role of educating children. Contractors appeared particularly willing to reshuffle the traditional trade categories. From every participant category, however, there were warnings that changed procedures result in unclear lines of responsibility, particularly for the design professionals whom the owner expects to maintain standards of quality.

II. D. BENEFITING from REPETITIVE ELEMENTS:

1. <u>Background</u>:

Specifications for the five subsystems used for the CSP-1 program (Structure, Atmosphere, Lighting-Ceiling, Interior Space Division, Vertical Skin) were prepared in the CSP Office by owner's staff or consultants. Therefore, these subsystem components are standardized and repetitious among the four pilot program schools. By contrast, the nonsystems work was specified by the individual architects and, in the case of Building Work, was subject to all the normal vagaries. Because all four architectural firms shared the same mechanical and electrical engineering consultants, the Mechanical Work and Electrical Work were essentially standardized. For example, toilet fixtures and electrical panels are of the same manufacture in all four schools. However, roof insulation is an example of an item specified differently for each of the schools. The variations called for in this relatively standard commodity were among a number of discrepancies questioned by the Building Work contractor who had simultaneous responsibility for multiple projects.

2. <u>Representative Questions</u>:

   a. Would standardized nonsystems specifications aid in cost reduction and/or shortened construction time?

   b. What recommendations would you make regarding possible increased use of repetitive construction components in a subsequent program?

3. <u>Responses of Owner Administrators, Staff, and Consultants</u>:

Representatives from this group were unanimous in perceiving advantages to use of standardized components. Specific categories mentioned included: 1) glazing, 2) roofing, 3) sealants, 4) flooring, 5) concrete hardeners, 6) waterproofing, 7) plumbing fixtures, 8) chalk and tack board, 9) shop and laboratory equipment, 10) lockers, 11) paving, 12) doors and frames, 13) hardware.

The consensus was that it would be advantageous to the owner to prepare and distribute standard specifications for many building elements. Related comments:

- Owner should be responsible to update specifications regularly.

- A good idea, but architects will strongly oppose.

- Biggest problem with standardization is settling on manufacturers who are acceptable. You must deal objectively with architects' prejudices.

- The goal should be to upgrade quality; therefore, the owner should simultaneously standardize testing procedures that are part of specifications.

- There are potential time and cost advantages, but only for a bulk-bid multiple-project program.

4. <u>Responses of Project Architects:</u>

The architects were not generally adverse to the idea of using standardized specifications, at least for many elements of buildings. In addition to some of those categories mentioned earlier, architects nominated: 1) paint, 2) carpeting, 3) classroom cabinetry, 4) toilet partitions, 5) roof decks and insulation, 6) mechanical piping, 7) lintels, 8) roof hatches, 9) copings.

Supplemental comments from four different architects reveal, quite unconsciously, that all of them rely heavily on direction from the owner in establishing specified qualities and characteristics:

- Owner should adopt industry-recognized standards like "Masterspec" or "Specdata." Present Board of Education standard specification for hardware is unique and hard to understand.

- There are advantages to standardization in lowering bid costs; however, there are potentially far greater savings in long term maintenance costs for the owner.

- Owner should have a manual or handbook. You can't rely on architects to standardize voluntarily.

- Strong direction from owner is required. A special consultant to owner might help.

That standardized specifications may be difficult to achieve is revealed by this pair of comments:

- Standardization of specifications for doors would have eliminated many problems on CSP-1.

- Doors should probably not be standardized because of aesthetic reasons.

Despite the general affirmative attitude, they were apprehensive about aesthetics:

- Architects must have freedom to prevent a stereotyped environment.

- Standards must not thwart initiative and creativity.

- Standardization is fine if architect agrees, but what if owner wants to use a new material? The architect cannot be responsible to see if it works.

- There are problems because architect is supposed to be responsible for content of specifications documents.

5. Responses of Project Engineers:

Standardization seems not to worry or excite engineers. Their only comments:

- There are particular potential savings for multiple projects of the same size and character. The more duplication, the bigger the advantage.

- Some of inconsistencies in specifications were because we did not have enough time to find them.

Engineers, too, revealed an apparent need for owner direction:

- The reason there are four different thicknesses of insulation on the roofs of the four CSP-1 schools is because somebody failed to coordinate the architects. The contractors should have considered this, but no doubt they did not.

6. Responses of Management Contractor Personnel:

Endorsement of standardization was unanimous in this category. The reactions:

- Standardization would help. As soon as you standardize specifications on a multi-project program you have, in effect, created a "subsystem." The only deterrent is architects' egos.

- It is particularly important to have consistent "General Conditions."

One respondent in this group went further, by suggesting:

- Owner should purchase some components (like doors and hardware) directly, and just deliver them to a contractor for installation at the jobsite.

7. Responses of Contractor Representatives:

These interviewees were not asked about repetitive building elements, but there were several complaints from contractors about inconsistent specifications and detailing on the four CSP-1 schools. One comment:

- Anything that adds to repetition is economically advantageous to the owner, as well as to a contractor. I would like to do twenty such schools!

8. SUMMARY of RESPONSES on BENEFITING from REPETITIVE ELEMENTS:

Nearly all respondents spoke of significant economies derived from using repetitive building elements. Although the focus was on first cost, there was recognition of long term maintenance cost advantages. They recognized that potential economies are greater for multi-project programs, but they seemed ready to endorse standardization generally. In so doing, they did not make a careful distinction between early-bid subsystems and the conventionally-bid nonsystems.

They recommended a wide variety of products or trade categories for greater standardization. Despite predictions that they would be an obstacle, the architects joined in a number of suggestions. Architects, however, were apprehensive not only about restrictions on creative design, but about divided responsibilities for technical proficiency. All interviewees assumed that repetitive building elements are best generated by writing standardized specifications. The owner, it was assumed, must provide the primary role in establishment of standards and even in the actual preparation of specifications.

III. A. USING PERFORMANCE SPECIFICATIONS:

1. Background:

Specifications describing what certain building components should do, rather than what they should be, were utilized for CSP-1. Experience with such performance-type specifications was new to the owner. As with predecessor systems programs, the objective of their use was to tap the resources of knowledge held by manufacturers, suppliers, and contractors. With traditional prescriptive-type specifications, such knowledge is generally inaccessible to the owner and his design consultants. Ideally, the use of performance specifications should open a wider range of choices for the owner or, by stimulating industry innovation, encourage totally new solutions to problems.

From the program's inception, it was recognized that CSP-1 would not be large enough to constitute a market that would attract major significant innovation. However, by adapting performance specifications from Toronto's SEF for Detroit codes and special requirements, it was hoped to attract a range of options and, thus, to retain owner prerogatives as to just which complement of components would best fulfill needs. Performance specifications were used for the five basic subsystems; the balance of the work (referred to herein as nonsystems) was specified by the architects and engineers using conventional content and format.

2. Representative Questions:

a. Would you describe the most troublesome areas of the performance specifications for subsystems, and recommend revisions?

b. What other portions of the CSP-1 specifications (nonsystem prescriptive specifications or general conditions) would you suggest revising for a subsequent program?

3. Responses of Owner Administrators, Staff & Consultants:

Problem areas identified included:

Subsystem #1 - STRUCTURE (fireproofing inclusion)

Subsystem #2 - ATMOSPHERE (ventilation duct size limitations)

Subsystem #3 - LIGHTING/CEILING (sprinkler coordination)

Subsystem #4 - INTERIOR SPACE DIVISION (piping & utility panel accommodation)

Most interviewees in this group expressed reservations about the use of performance specifications:

- To convert completely to performance specifications would limit owner's ability to choose quality.
- Performance specifications are gaining popularity because of speed of preparation and the lack of knowledge required to write them.
- Many of our staff do not believe in performance specifications; they are completely oriented to prescriptive specifications.
- Not architect's responsibility to verify quality and installation because certain products were imposed on them by owner's prewritten performance specifications.
- With sophisticated subsystems like elevators, owner is completely at mercy of supplier.

There was only one strong endorsement from this group for performance specifications:

- For a rapidly changing field such as electronics, the owner certainly should insist on performance specifications. Their use permits industry an opportunity to offer up-to-date technological improvements.

Also, several other respondents in the owner category indicated a supportive view by suggesting possible additional component groupings (e.g., hardware, roofing) which they believed would be well to bid via performance specifications. One said:

- I am in favor of performance specifications. Only problem is in who makes value judgment about acceptance.

4. <u>Responses of Project Architects:</u>

They mentioned particular problems with:

Subsystem #1 - STRUCTURE (fireproofing inclusion).

Subsystem #2 - ATMOSPHERE (gas piping code compliance; supplementary heat requirement; exhaust ventilation requirement).

Subsystem #5 - VERTICAL SKIN (fenestration characteristics).

One said:

- No more problems than usual with either subsystems or nonsystems specifications.

Most, however, expressed dissatisfaction through comments such as:

- Our only problems were with performance specifications prepared by owner. Architect's role in administration not clear.
- Subsystem specifications too open.
- Performance specifications are a cop-out. Industry is not ready for it. When we set minimums, we start downgrading.
- Performance specifications are too sophisticated; bidders are frightened.

There was general agreement that the biggest problem with the subsystem performance specifications was with the mandatory interface between subsystems rather than performance factors. Despite the lack of enthusiasm for performance-type specifications, the architects seemed more concerned with problems engendered by particular requirements of the general conditions of both subsystem and nonsystem specifications (i.e., cleanup, protection of openings, temporary heat, vandalism protection, etc.).

5. Responses of Project Engineers:

Because the engineers interviewed were few in number, the limited sampling may seem to magnify their response for this and other topical categories. However, these engineers reflected the attitudes of their national professional groups in their ardent disapproval of performance-type specifications:

- I recommend completely eliminating subsystem categories and the use of performance specifications.
- Performance specifications are too open. We should decide what we want (say, between steel and concrete) and go ahead and insist on whatever it is.
- Use of performance specifications was biggest problem on CSP-1; prescriptive specifications for nonsystems portions were fine.

The owner's concept of using performance specifications as a tool to gain industry know-how and/or encourage innovative proposals had not impressed the engineers, one of whom responded:

- We knew what was available; then we just wrote specifications to conform.

6. Responses of Management Contractor Personnel:

The only specific suggestion regarding elimination of a trouble spot pertained to:

Subsystem #1 - STRUCTURE (fireproofing and slabs inclusion).

There was general agreement that interface of subsystems was the biggest problem. There were certain criticisms of performance specifications:

- Responsibility for mee^^ng codes should be taken out of performance specifications and given to the architect.

- Performance specifications gave too much emphasis to design responsibilities of contractor.

Other comments were more favorable:

- No problems with specifications for systems or nonsystems.

- Not many problems except with some General Conditions items like cleanup, temporary closing of openings, and security.

Only one respondent considered the basic objective of performance specifications:

- Writing a specification is not enough. Someone must do advance work with industry if owner is to get what he needs or wants. For example, architects or owners could have worked with masonry contractors on Subsystem #5 - VERTICAL SKIN in order to get a better looking product. 'Contractors are willing to learn, but they completely lack engineering expertise.

7. Responses of Contractor Representatives:

As expected, concerns with subsystems performance specifications came only from those contractors directly involved. Problems mentioned were:

Subsystem #1 - STRUCTURE (floor slabs inclusion).

Subsystem #2 - ATMOSPHERE (noise level requirements; gas line codes).

Subsystem #3 - LIGHTING/CEILING (fire codes).

Subsystem #4 - INTERIOR SPACE DIVISION (doors & hardware inclusion).

Subsystem #5 - VERTICAL SKIN (thermal break; hardware inclusion)

Reaction to the use of performance specifications was mixed:

- Performance specifications were clear, but could be simplified.

- It is very difficult to write a performance specification for a building as complicated as a school. I don't believe in performance specifications. Conventional approach of naming 3 or 4 manufacturers is better.

- Basic specifications OK. No union problems or interface problems. Owner cannot afford to keep changing specifications.

- We need clarification of exactly what is required for shop drawings.

- Major problem is with defining responsibility for meeting codes.

One contractor amplified his opinions:

- In public work, there are greater dangers in bidding on a performance basis. You do not have a good pre-qualification method, and you have a good chance of getting a miserable contractor on the job who will give you problems throughout.

When asked to comment on technical sections of the specifications, most contractor representatives replied, "no problems." However, a number of respondents commented on cleanup responsibilities, adding rather contradictory recommendations:

- Building Work contractor should be held entirely responsible for cleanup, with proportional percentage charge being made to each separate contractor.

- Use AGC rules for cleanup charges.

- AGC rules are no good.

- Cleanup allowance should be a pre-determined allowance as part of each bid, and should be handled entirely by Management Contractor.

8. <u>SUMMARY of RESPONSES on USING PERFORMANCE SPECIFICATIONS</u>:

Most respondents are not attuned to the broad goal of attracting the creative skills and knowledge of the construction industry on a national scale. Understandably, they are primarily concerned with the practical problems imposed day-to-day in accomplishing their work on local projects. Although a few of the contractors or suppliers (particularly those whose firms have acquired sophistication in dealing with performance specifications in predecessor systems programs) seem at ease with this method of bidding, many participants are irritated by what they feel to be vagueness of the documents. The discomfiture varies from negativism on the part of most architects to outright opposition on the part of the engineers. It is the latter group who feel that judging someone else's engineering is less desirable -- perhaps less ethical -- than doing it themselves in the first place. Repeatedly the responses indicate it is uncertain shifts in responsibilities which most distress the building team participants.

Although the CSP-1 components bid on a performance basis were completed successfully and although the itemized technical problems identified herein are relatively few and solvable, the dissatisfaction with performance-type specifications is evident in all respondent categories. Nationally, in the building industry and in government, the "performance concept" appears to have gained wide acceptance; however, the skepticism or opposition revealed by the foregoing responses augurs poorly for expanding the practice of bidding on a performance basis locally, at least in the near future.

III. B. REQUIRING INDUSTRY COOPERATION:

1. Background:

While the use of performance specifications is designed to capitalize on construction expertise that might not otherwise be available to the owner and his design consultants, it was recognized that input from multiple industry sources is valuable only if meshed in a precise and practical way. The CSP-1 mechanism to encourage the necessary joint planning between subsystem bidders is called "mandatory interface." Again, the method was derived in large measure from Toronto's SEF program.

The CSP-1 "Notice to Bidders" explained it as follows: "Effective use of a building system requires a high degree of component compatability between subsystems based not only on modular coordination but on management and scheduling coordination." A subsequent paragraph continued, "In order to assure that bidders whose subsystems adjoin have prepared their bids in cooperation with others, a minimum of two prices will be required from each bidder based on variations (if any) in price related to the balancing of responsibilities under terms of the mandatory interface." The General Conditions (Art. 2.3) further stated, "Satisfactory interface of subsystems without additional work by the Owner is necessary and implicit."

By contrast, the specifications for nonsystems portions of the work were conventional in nature, with full responsibility for coordination falling to architects and engineers in the traditional manner.

2. Representative Questions:

a. Were there special problems between subsystem contractors in complying with the "mandatory interface" requirement of the specifications, and can such problems be simplified?

b. Were there other coordinational problems between subsystem and nonsystem contractors, and what are your suggestions for improvement?

3. Responses of Owner Administrators, Staff & Consultants:

Because the topic pertains primarily to construction, rather than planning, only those in this category with regular job-site responsibilities were asked these questions. Several interface problems were identified:

Subsystem #1 - STRUCTURE vs. Subsystem #5 - VERTICAL SKIN
(Joint between second floor slab and exterior wall panels)

Subsystem #1 - STRUCTURE vs. Subsystem #2 - ATMOSPHERE
(Vertical joist members at horizontal ventilation ducts)

Subsystem #2 - ATMOSPHERE vs. Subsystem #3 - LIGHTING/CEILING
(Ventilation ducts at coffered lights)

Subsystem #4 - INTERIOR SPACE DIVISION vs. Subsystem #5 - VERTICAL SKIN (Door hardware coordination).

Additional subsystem/nonsystem conflicts mentioned:

Subsystem #2 - ATMOSPHERE vs. MECHANICAL WORK
(Ventilation ducts at plumbing lines)

Subsystem #3 - LIGHTING/CEILING vs. MECHANICAL WORK
(Ceiling grid at sprinkler drops)

When asked suggestions for correcting coordinational problems of the type itemized above, two respondents commented:

- The interface process finally worked out, but it was too slow. During the design stage, we should organize a team of technical/coordinators, including scheduling and cost consultants. We should "sit down" with industry before we even go out for bids.

- Perhaps interface responsibilities could be handled better another time if, as in Toronto's SEF, each contractor is required to identify his engineer at bid time. We could then turn to a particular engineer in working out problems that arise.

4. Responses of Project Architects:

Nearly all these interviewees recalled the particular interface conflict at the narrow gap between the second floor slab and the exterior walls at the periphery of the buildings. Perhaps the reason for remembering it so clearly was the Fire Marshal's insistence that the problem be solved, and the owner's insistence that the architects participate in the solution. Except for this single incident, architects could recall few problems, perhaps indicating that the contractors (and/or the management contractor) successfully worked out most conflicts. However, they also mentioned:

Subsystem #1 - STRUCTURE vs. Subsystem #3 - LIGHTING/CEILING
(Depth of special joists at coffered lights)

Subsystem #3 - LIGHTING/CEILING vs. MECHANICAL WORK
(Ceiling grid at sprinkler drops)

Subsystem #4 - INTERIOR SPACE DIVISION vs. MECHANICAL WORK
(Relocatable partitions at equipment plumbing).

Some architects viewed the mandatory interface unenthusiastically:

- Contractors did not comply with interface requirements or communicate with one another.

- There was a problem in cooperation because all were prime contractors and there was no general contractor.

- Conflicts could be solved by better shop drawings.

Generally, however, this group was not disapproving of industry cooperation:

- Cannot recall any problems.

- Only problems with nonsystems contractors were the familiar ones of determining who is responsible for cutting and patching.

- Major problems involved usual general conditions items of cleanup, temporary closures, and scheduling.

5. <u>Responses of Project Engineers</u>:

Engineers believed that interface between subsystem groupings was a serious concern. Structural engineers found no major problems, but mechanical and electrical consultants found a number:

- The bidders said they'd interfaced, but they had not.

- Part of problem was in failure of subsystem contractors to provide adequate and timely shop drawings. I recommend you let the engineer coordinate as he does on a normal project.

- These conflicts could be coordinated by engineers before bidding.

- In such problems as plumbing and electrical conflicts, whoever gets there first is lucky!

- If you had a General Contractor, he would just say, "do it!"

6. Responses of Management Contractor Personnel:

Although the respondents in this category were supervising twelve separate prime contractors on each site and were deeply involved in coordination, half of them seemed relatively untroubled:

- Interface problems between subsystems were very similar to coordination problems on an ordinary project.
- Fewer problems than most projects.
- Problems were typical. Some coordination problems are really personnel problems.
- Some systems/nonsystems problems, but minor.

The other half considered the difficulties more significant:

- To some extent requiring contractors to interface tends to diffuse responsibility. Architects did not live up to their own interface responsibility.
- Subsystem contractors resisted meeting together. They wanted to abdicate their responsibility to interface.

One of the management contractor personnel who had experienced problems asked:

- How about the owner paying contractor-bidders a separate fee to design earlier and carefully interface?

7. Responses of Contractor Representatives:

Every interviewee in this category recognized that there were problems. Subsystem contractors, on whom responsibility for dimensional and functional interface had been thrust for the first time, stated:

- Our employees didn't know what "interface" meant.
- At first post-bid meeting of five subsystem contractors, I don't think we actually knew if we could or could not interface.
- We thought we had all interface problems worked out, but we didn't.

Certain contractors objected to interface responsibilities even though they were clearly a contract requirement:

- Interfacing is an imposition; it compels me to divulge information to another contractor.

Two contractors did not care who assumed such responsibilities, as long as it was someone else:

- The management contractor failed to provide interface coordination -- which really should have been provided by the owner or the architect.

- Way to avoid interface problems is to revert to traditional way of having a general contractor.

A few are willing to adapt to this type of bidding:

- Apparently the only way to get satisfactory interface is to have more pre-bid meetings and to get joint-bidding contractors to have firm written agreements between them.

- Pay contractors from a special fund for attending "interference meetings."

- Interface technical drawings and shop drawings need to be complete enough to recognize all the problems before they happen.

Several contractors thought that coordination problems were more troublesome with nonsystems than with subsystems portions of the work. One of them added:

- Coordination would be improved if management contractor exerted more authority. Their processing of payment requests gave them plenty of authority -- and money talks.

8. SUMMARY of RESPONSES on REQUIRING INDUSTRY COOPERATION:

Few respondents felt completely comfortable with what for all of them was a first experience with subsystem interface responsibilities or with the other special coordinational responsibilities which come with phased bidding and multiple prime contracts. Although the owners group had no objections to the concept of seeking industry participation in interface, they recognized that difficulties could be alleviated by an earlier start and by clearer identification of contractors' engineers. The architects and the management contractor personnel seem able to adapt to the new requirements.

Engineers realize that adequate technical interface is accomplished only by pre-engineering (i.e., by engineers in the employ of contractor bidders) and that such splintering of engineering responsibility is perhaps troublesome and certainly threatening. Some contractors also prefer the conventional detachment of engineering tasks; however, others recognize changes in the construction industry. Representatives of subsystem contractors, to whom most of the responsibility was actually assigned, share the belief that an earlier start and a better understanding will solve most problems another time.

III. C. INVOLVING BIDDERS in DESIGN:

1. Background:

In the conventional process, a building design usually is completed by architects and engineers before bidders are notified that a potential project exists. Others in the industry have long recognized that this traditional method creates dichotomy and delay. A whole range of early warning systems (reporting services) and information sources (sales engineers, catalogs, etc.) have been organized to alleviate the problem; however, the techniques are indirect. CSP-1, like its predecessor systems programs, sought a direct early input of industry know-how by designating subsystems and seeking early bids from contractors who either were themselves manufacturers of building products or who were closely allied to such manufacturers.

The "Notice to Bidders" (Item 4.9) of the CSP subsystem specifications stated proposals must provide "full descriptive and graphical information . . . either preliminary shop drawings or catalog data . . . full assembly details and evidence of successful interfacing with other bid submissions." With such a process, it is inevitable that product design is done by others than the owner's architect-of-record. It is inevitable, also, that engineering of the products is done by someone other than the architect-of-record's consulting engineers. Although the responsibility problems have been evolving for decades with increasingly complex pre-engineered building parts manufactured off-site, the dilemma has been emphasized by the separated and phased bidding of systems programs. Certain systems programs, particularly Toronto's SEF, have required that engineers employed by bidders be formally identified, and that the engineers use their professional seal to certify their endorsement of component design, including interface with adjacent subsystems. Such engineering endorsement was not a part of CSP-1's specifications; instead, the conventionally-commissioned architects and engineers were expected to include engineering review within their usual scope of work.

2. Representative Questions:

a. Who should prepare subsystem shop drawings or engineering drawings, and how complete do these drawings need to be prior to bidding?

b. There was disagreement as to who approves or seals subsystems shop drawings or engineering drawings. How do you recommend this be handled in a future program?

3. Responses of Owner Administrators, Staff & Consultants:

Only individuals in this group who were involved in the considerations about preparation and approval of subsystem shop drawings or engineering drawings were asked these questions. Virtually all seemed satisfied with the idea of involving bidders in design:

- Bidders should identify engineers at bid time. Lack of adequate pre-engineering should be a basis for rejecting a bid.

- Contractor should accept responsibility for sealing subsystem drawings; that is, his engineer should seal drawings. This would eliminate need for architect to have an engineering consultant.

- Best way may be to meet with bidders prior to bidding and explain they must hire an engineer, as in Toronto's SEF program. However, owner will need to push a lot harder on CSP-2 and give more guidance to local contractors.

- Bidders should be compensated a specific sum for their bids. We do not need more bidders, but better bidders with more accurate and complete bids.

One respondent soft-pedaled the controversy with this view:

- An engineering seal is inconsequential. The city building department does not have authority to require that any <u>part</u> of a set of drawings be sealed by an engineer. The architect's approval should be accepted. The architect hires an engineer. The architect should have his engineer check all drawings, and pay the engineer a full fee for his service.

4. Responses of Project Architects:

One architect, even after his project was finished, was still misinformed as to what the documents had actually included:

- The advice of our legal counsel was that we had no legal responsibility to approve pre-engineered drawings. CSP specifications said contractors had responsibility for sealing the drawings.

The other respondents in this category had a more accurate view of the contractual obligations and recognized the problem of involving bidders in design; however, they were vague about recommending improved procedures:

- Contractors should identify their engineers at bid time, and the shop drawings or engineering drawings should be signed by a registered engineer.

- Owner must clarify responsibilities of architect and his engineering consultants.

- There is no way for architect or engineers to be responsible for pre-engineered work.

5. <u>Responses of Project Engineers</u>:

All of this group favored identification of contractors' engineering consultants. A typical response:

- Systems contractors should identify their engineers at bid time; then this information should be used as a basis for selection of bids.

However, there was disagreement on procedure and assignment of responsibility:

- We went through all calculations, but we would not seal contractors' drawings because it is against registration act to seal drawings not prepared under our supervision. To do so would be prostituting our seal.

- We would not be opposed to sealing drawings prepared by another engineer provided we could effect changes we believed necessary.

- Engineer-of-record (i.e., in city building department building permit records) should seal shop drawings once he has checked them. Sealing is pretty much an arbitrary exercise. An engineer can be held responsible even if he didn't seal. In fact, if contractor or manufacturer sealed drawings, the engineer-of-record might have trouble getting desired results in field.

Whatever the legalities and technicalities may be, it is obvious engineers would rather proceed in their traditional manner:

- It is a whole lot harder to check a design than to design it first and take responsibility.

- On CSP-1, we acted more as checkers than designers.

6. <u>Responses of Management Contractor Personnel</u>:

(No questions asked on this topic.)

7. **Responses of Contractor Representatives:**

Queries as to who should prepare subsystem shop drawings or engineering drawings and how complete such drawings should be at bid time, elicited a varied response:

- Many local contractors are qualifed to prepare these drawings with technical backup from national manufacturer of their particular subsystem.
- Requiring more complete drawings at time of bids might have helped.
- It is impossible for a subsystem bidder to come up with a complete design at bid time.
- Whole problem with delays was in lack of engineering prior to bidding.
- It wouldn't help to have more complete drawings. Contractors don't know enough about codes to solve the engineering problems.
- As a contractor, we were not aware we were to go to an engineer at our expense and say; "Please design this."
- Everybody waited to do much of engineering until after bids were awarded, which might work for simple buildings but not for complex schools.

Regarding taking responsibility for engineering design, views were contradictory:

- Although CSP-1 specifications said architect would approve shop drawings, the architect's consulting engineers were reluctant to act.
- If contractor engineers the job, he should be responsible. To have the contractor's engineer seal the drawings would solve a lot of problems.
- Engineer who approves drawings should seal them; that means the architect's consulting engineer.
- If the contractor's engineers are going to be asked to take full responsibility they will have to be paid more, if only to cover their liability insurance.

8. SUMMARY of RESPONSES on INVOLVING BIDDERS in DESIGN:

There was almost unanimous agreement from the respondents that backup material was inadequate at time of subsystem bidding. Also, there was general agreement that it would be desirable for the contractor-bidder's engineer to be identified on the bid submissions. However, there was great lack of agreement on exactly what such an engineering responsibility should be. Engineers themselves feel particularly uneasy about "pre-engineering," but even among them there were considerably varied views. Some of the disparity can be attributed to participants who never really read the CSP contract documents. CSP-1 was predicated not only on involving bidders in design but on retaining an active and primary responsibility for individual architects in regard to individual buildings. The architects were paid a full professional fee, and the owner expected a full professional service even if that meant reviewing and approving drawings prepared by another design professional. Obviously, not everyone grasped the concept. These and other aspects of professional responsibilities are discussed in the next section.

III. D. MODIFYING PROFESSIONAL RESPONSIBILITIES:

1. Background:

Many aspects of CSP-1 coincided to create altered responsibilities for most participants. Although each architectural firm was assigned but one school, each was asked to cooperate with the others -- an unfamiliar pattern. For the balance of the participants, having four buildings in progress concurrently was a different experience. The fact there were twelve prime contractors (and no general contractor) functioning simultaneously on four sites created new roles for all those firms, as well as first-time responsibilities for the management organization. As recorded in the sections just preceding, the broadened involvement of the construction industry in CSP-1 -- in particular, the pre-engineering of subsystems -- proved controversial. Also, the further fragmentation of supervisory responsibilities engendered by the addition of the management contractor to the previous roster of supervisors (architects, engineers, owner representatives, regulatory agency officials) introduced intramural confrontations somewhat changed from traditional ones.

2. Representative Questions:

a. In what ways were your usual responsibilities altered with the CSP-1 schools?

b. Can you suggest an arrangement to be used on a future program which would more clearly define the role of all participants and improve their cooperation?

3. Responses of Owner Administrators, Staff & Consultants:

Nearly all of this group believed their responsibilities had changed with CSP-1. The general observation was "the owner was more involved." Despite the quite broad involvement, most of the comments were about responsibilities of the architects. The criticisms tended to be adverse:

- Owner needs to be more selective about architects, and to find those who know industry components and can direct their assembly.

- Architects should have been selected on basis their project would be part of a systems program; then it could have gone much smoother.

- Owner should choose architects who not only know codes and how to deal with a multiplicity of regulatory agency problems, but who become skilled in urban community problems as well as urban construction problems.

- Architects have demonstrated a lack of strength in field supervision; so we should reduce that aspect in our contractual relationship with them.

- Granted architects had some conditions dictated by owner; but, having accepted this situation, why couldn't they judge what we were supposed to be getting? Only the architect can say, "This work is not according to plans and specifications."

There was, however, a lack of clarity about assigning these responsibilities, as evidenced by:

- In last analysis it is owner's staff who must verify quality and installation of all items. It should have been management contractor's responsibility if they'd been introduced to project soon enough. It was not the architect's responsibility because several products were imposed by owner.

- Architect should have a larger role in pulling together all consultants.

- Architect's consulting engineer should shoulder his responsibilities and reject what is unacceptable.

4. Responses of Project Architects:

The architect interviewees had responded, at least partially, to these questions when asked about attitudes and difficulties (Refer to Section II. A). They reiterated comments about shifting work loads (more administration; less detailing; less field supervision). Some felt the total burden was about the same; others felt they had greater expenditures of money and time with the GSP-1 procedures. When asked a subsidiary question as to whether closer cooperation between the architects would have helped to eliminate problems, most participants answered affirmatively. Auxiliary comments were:

- Cooperation did not work and it won't work because each architect has his own way of doing things. If I do something once, I don't want to do it again.

- The change will be difficult for architects, but they must learn to adapt to systems methodology.

- It will be hard to get architects to agree on anything. Owner must take a stronger hand.

In recommending arrangements to improve cooperation in a future program, two architects repeated earlier recommendations about encouraging greater uniformity of specifications and details.

5. Responses of Project Engineers:

As indicated in a prior section, the consulting engineers were upset with the changed responsibilities brought about by the use of performance specifications and pre-engineering undertaken by contractors for selected subsystems:

- The problem with this system is that there could have been no consulting engineer at all. Our fees were cut tremendously because architects thought our work was easier.-- yet it was just as complicated as when we get into a total package.

- Next time, have owner hire engineering disciplines directly; engineers are probably more cognizant of systems approach than architects.

- We really didn't know what was expected; need a more complete written definition from owner.

- Next time, don't use a performance specification; let the professional take charge.

- We didn't have time enough to do a good job. Contractors didn't submit complete drawings, and it was impossible to reject drawings without setting back the construction schedule.

- To avoid discrepancies in design, owner must pressure architects to coordinate.

6. Responses of Management Contractor Personnel:

Because the management contractor role was a first experience for that newly-formed organization, the first question about "usual responsibilities" was not asked. Instead, there was informal discussion about the MC duties as defined in the owner-manager agreement. That contract had spelled out certain items as exclusively in the manager's province (administration; expediting; sustained supervision; coordination; verification of payment requests, etc.) and other items as exclusively in the architect's province (authorization of changes in contract documents; approval of shop drawings and materials; approval of payment requests, etc.). Related comments:

- Although I am a strict constructionist, we got drawn into making determinations in areas of architect's responsibility. In a future program, architect should be made to take more responsibility.

- MC is "The Enforcer," but he cannot replace professional judgment of architect and engineer. A greater sense of responsibility from the architects and a greater degree of sharing between them would have helped.

- Owner should define a stronger and earlier role for MC; include scheduling and costing.

- Next time, I would recommend the owner consider accepting management proposals from joint ventures (such as, architect-contractor-scheduler).

7. <u>Responses of Contractor Representatives:</u>

All of the twelve prime contractors felt their responsibilities had altered. Certain of the subsystem bidders, accustomed to being subcontractors on conventional projects, welcomed the more direct relationship:

- I like the systems method because our responsibility was not to a general contractor but to the owner. This is better and more economical for owner because general's mark-ups are eliminated.

- A way should be found to prevent general contractors from bid shopping. The construction industry is sick.

All contractor representatives indicated satisfaction with CSP-1 methods to the extent of willingness to bid a similar program again. However, they split on the role of local contractors (labor sources) and national manufacturers (product suppliers):

- I don't believe a manufacturer should bid a local contract. some of the manufacturers who used to do this have gotten smart and gotten out.

The CSP experience was that a number of national firms wanted to bid directly, but dropped out after exploring the local situation:

- Manufacturers don't want to alienate local contractors.

- Most manufacturers don't want to take risk in local labor market.

One middle-of-the-road view:

- Owner is best served when local contractor and the national manufacturer combine their strengths.

The contractor representatives were very aware of the controversy over pre-engineering:

- Although the contractor's engineer is definitely a subcontractor, it is difficult to get owner to pay engineering fees for work not yet in place. We had to "front end load" the money because the owner wouldn't recognize engineering as a billable item.

- Because no contractors will do pre-engineering (on account of risk of not getting job), perhaps owner should offer a lump-sum amount to each pre-qualified contractor who submits a bid of a certain quality and completeness.

- It is unethical for manufacturers to go into engineering. I visited a manufacturer's plant and not one person on their staff was qualified to be an engineer.

Two others, however, who did not comment specifically, indicated their companies would continue their engineering practices, as they have for many years.

Finally, two totally discordant views of how roles should be altered in a subsequent program:

- Owner should hire architect only as an interim consultant for the design phase; then all the work should be turned over to a management contractor.

- If the engineers go to work for contractors, the owners soon will have no one to turn to. Why not pay the architect more for complete services, and have him working for the owner?

8. <u>SUMMARY of RESPONSES on MODIFYING PROFESSIONAL RESPONSIBILITIES</u>:

It is surprising that, although CSP-1 encouraged a more extensive "building team" effort, the focus of owner criticism was at the architects. Perhaps this was the surfacing of ancient dissatisfactions which interviewees heretofore have not had opportunity to express. Or perhaps it reveals that the owner really does turn to the architect as leader of the building team, and still expects the architect to "carry the ball." The Management Contractor group also tended to be critical of architects, but some were willing to take on architect's former tasks. Among both architects and engineers, there were recalcitrant individuals dedicated to maintaining the status quo; however, a few are ready for major change in their traditional duties and lines of responsibility.

From almost every respondent category, there were opinions which variously expressed, "The owner needs to take a stronger role." However, the answers from owner administrators, staff, and consultants did not reveal an eagerness to assume a dominant position. Rather, they kept suggesting that the architects be selected more carefully. The pattern of professional relationships nationally suggests that owners cannot lean on their architects as heavily as they once did. Many owners are reinforcing professional services with an applique of consultant-managerial advice; others are turning to construction organizations that obscure the functions of architects and engineers in conventional private practice.

The most persistent controversy revealed by these responses is the one about pre-engineering. Although accentuated here by the use of performance specifications, similar disputes are occurring on all projects employing technologically-sophisticated components. The apparent consensus is: 1) the owner, willing or not, is to be drawn into the building process; 2) contractual agreements an owner signs had better state <u>exactly</u> what design and engineering judgments are to be provided by each participant.

III. E. PHASING the BIDS:

1. Background:

In the initial scheduling of the CSP-1 pilot program, a two-stage bidding process was outlined. It was believed that bidding of five designated subsystems prior to the balance would, if they were within budget, give the owner an early firm hold on overall costs and would accelerate construction by giving the successful manufacturer-contractors a head start on component production. Because of delays, particularly in the preparation of nonsystems documents, a later decision was made to extract also the "Substructure" work from the nonsystems portion, and bid it separately. Therefore, CSP-1 had three bidding phases.

Similar, sometimes more fragmented, bidding has become popular nationally -- not only for construction organized with subsystems, but for more conventionally-organized building work. Such sequencing of bids has greatly altered the role of the general contractor, who often has been supplanted by a "construction manager." Phased bidding also alters the procedures and practices of all other participants.

2. Representative Questions:

a. In your judgment, will phased bidding (or "fast track") improve cost or time factors in the building of schools; if so, would you recommend additional (or fewer) bidding periods than the three used for CSP-1 projects?

b. Are there particular portions of the construction work which you recommend be handled as an early bid subsystem?

3. Responses of Owner Administrators, Staff, & Consultants:

These interviewees generally endorsed phased bidding:

- Desirable for reasons of time, as well as cost.
- Possible savings in time; no apparent savings in cost.
- No economy per se; but, if owner stays flexible, phased bidding can permit changes that can lower costs.

Recommendations on number of bidding periods varied from 2 to 5, generally. Only one person recommended a highly fragmented phasing of bids.

Several expressed cautions:

- Management will cost more, and you must carefully balance this expense.

- Phased bidding requires very close attention to market conditions and the guidance of a competent manager.

- An interrupted phasing may make it more difficult for owner to supervise construction.

- Good for economy, but it does create paperwork and coordination problems for owner and for architect.

In regard to particular categories, most recommended a limited early bidding (i.e., substructure, structure, underground mechanical and site work). There were miscellaneous recommendations to early bid: 1) plumbing fixtures, 2) electric/electronic, 3) roofing, insulation, 4) sprinklers, 5) doors, frames and hardware, 6) cladding, 7) HVAC equipment.

One interviewee expressed a different view:

- Rather than phasing by trade categories, I would recommend asking contractors to early-bid unit prices only, based on schematics prior to final design; then owner would use these prices for pre-qualifying the three lowest bidders. Later, the three could compete based on final drawings. A management contractor would handle first phase; architects for individual projects could handle second phase.

4. <u>Responses of Project Architects</u>:

All these architects foresee situations when phased bidding is advantageous for reasons of cost or time. A majority expressed satisfaction with CSP-1's three phases. One architect recommended "1 or 2"; another suggested "no more than 6." Because they had discussed early bidding of subsystems along with "Designating New Component Groupings" (Refer to Section II. C.), they added few suggestions for particular additional categories. Two respondents expressed concern about added cost and work involved in preparing contract documents. One stated:

- Architect must have extra compensation in his professional fees from owner if he is to adapt to multiple bidding packages.

5. Responses of Project Engineers:

All agreed that a three-phase bidding, similar to that used for CSP-1, was reasonable. One suggested:

- Two periods would be adequate.

Like the architects, they had reviewed their preferences for early bid subsystems under "Designating New Component Groupings," and they reiterated their recommendations for achieving an advanced start on: 1) foundations, 2) structure, 3) site preparation, including underground mechanical. Related comments:

- I favor early bid on all long lead items.

- I recommend bidding renovation work on existing buildings separately (either earlier or later) from new additions. Complexity of renovation work particularly delayed production of CSP-1 drawings.

6. Responses of Management Contractor Personnel:

Most respondents replied affirmatively about phased bidding. There were two negative comments:

- There's twice as much paperwork!

- My experience was not good. Architects don't understand the process, and the drawings are not prepared properly.

The majority were satisfied with the 3 phases of CSP-1, although there were qualifications:

- Few periods as possible; 2 better than 3.

- Any expansion in phased bidding may require greatly changed procedures in getting building permits from city departments, as well as approval from state department of education.

- Generally there are advantages, but only if you can save design time.

One enthused response:

- Buildings are cheaper sooner rather than later. I recommend 15 or 16 biddings if you have a competent management contractor.

Typically, particular recommendations from this group on staging of bids fell into these categories:

Phase I: Site work, foundations, underground mechanical and electrical, manufactured mechanical items, structure.

Phase II: Masonry and/or vertical skin, roofing, sash, doors.

Phase III: Flooring and ceilings, balance of mechanical-electrical.

Phase IV: Finish carpentry, painting, furniture & equipment.

7. <u>Responses of Contractor Representatives</u>:

With only one exception, all these interviewees expressed approval of the principle of phased bidding. Virtually all indicated satisfaction with the 3-phased timing of CSP-1, although two contractors recommended restricting phasing to two periods. Other endorsements:

- Phased bidding is an economy. Increasing numbers of contractors will realize they can make more money if they get in and out faster.
- Bidding early is a great economy for us by permitting us to schedule our work evenly.
- Substantially lower building costs using phased bidding.
- Not less costly, but faster.
- Early information can help to control costs.

However, there were a few qualifications:

- Phased bidding requires flexibility -- and the ability to adapt to some "extras" -- on part of owner.
- You can phase bids, but you cannot deviate from traditional trade categories without getting into trouble.

8. <u>SUMMARY of RESPONSES on PHASING the BIDS</u>:

Phased bidding appears to have become an acceptable mechanism to diverse participants in the building industry such as these interviewees. The practice, popular only in commercial and industrial work until recently, has become quickly commonplace in public works and institutional architecture. From a prior section on "Designating New Component Groupings," it was apparent that most participants are ready to accept the rationale for expanding early-bid categories. Therefore, the question seems to be one of degree and, most important, who assumes the coordinative responsibility. It is not surprising that the greatest number of cautions or warnings came from the owner group. It is they who are most likely to find aggravations in diffuse assignments. Everything was simpler and easier in the days of one general contractor and a single contract. However, many contractors, particularly those in the manufacturer, supplier, or former subcontractor categories, like a briefer, more direct involvement than they have experienced previously. And the owner, who has too often suffered the "do or die" perils of lump sum bids, appreciates the greater control afforded by awarding contracts in stages.

III. F. EXPANDING the BID PACKAGES:

1. Background:

When CSP was conceived, a feasibility study and market analysis suggested a potential bid package of 500,000 square feet of space for Detroit for the particular building type (specialized-use additions to secondary schools) over a two-year period. A tentative projection was for 10 additions averaging 50,000 square feet each in size. Even at that early stage, it was recognized that the program should be derivative, at least in part, from predecessor programs because Detroit's immediate market potential did not compare in size with the 1.0 to 2.0 million square feet of area organized for California's SCSD or Toronto's SEF and, therefore, it could not be expected to generate the capitalization requisite to stimulate major technical innovation within industry. As it developed, Detroit elected to proceed with an even more modest four-school pilot program of 280,000 square feet, ranging in size from 44,000 to 105,000 square feet in area. However, this was the first time in Detroit or in Michigan that similar components had been bulk bid for simultaneous construction on several separated sites.

2. Representative Questions:

a. In your opinion are there economic advantages to bulk bidding a group of schools, as was done in CSP-1?

b. What are your recommendations about the size or number of projects that would make a desirable bulk bid package?

3. Responses of Owner Administrators, Staff & Consultants:

Nearly all saw advantages to bulk bidding:

- Without a doubt our bidding packages should be larger. We can learn from Toronto's SEF and Florida's SSP to determine optimum size of bidding package.
- We should expand both size and number of projects. We do not need a "systems program" to take advantage of economies and to expand bulk bidding.

Two respondents added:

- We should explore direct purchases of certain components from manufacturers without going through contractors.
- Smartest thing owner could do would be to buy early and in bulk, storing new materials at today's prices for tomorrow's market.

Others were supportive, but cautious:

- I wouldn't bid much larger quantities than we did. I think we were pretty much at our limit on four different jobs. Larger projects wouldn't hurt. The size is not so important as the number.

- Complexity is more important than size. It is important to keep all the buildings in a bulk bid package quite similar in character.

Only one was skeptical:

- It seems logical that bulk bidding would lower prices, but it apparently has no effect.

4. Responses of Project Architects:

Most responded affirmatively about potential benefits:

- Real financial advantage to bulk bidding.

- The owner's goal should be to expand size of bidding package.

- Projects should be greater in number and larger if possible; but they need not be built simultaneously. Owner should explore an "annual contract" to build school space on demand as needed.

Two were unconvinced:

- Detroit does not have adequate contractors to handle larger projects.

- I have no opinion. Establishing best size of bidding package is an art, not a science.

5. Responses of Project Engineers:

All generally praised economic benefits of bulk bidding. On size of total bid package, their comments included:

- CSP-1 was comfortable. If any smaller, you would only have attracted less competent contractors.

- Expand size and number, as long as one supplier can handle the group.

- Bulk bidding lowers costs on new work, but has no effect on alteration work.

One engineer questioned this last view:

- Projects could aggregate to a size much larger than CSP-1's 280,000 square feet. Even lumping in renovation work was probably beneficial to overall economy.

6. Responses of Management Contractor Personnel:

Recommendations from this group were almost unanimous for more and/or larger bidding packages:

- Because work in Detroit is not attractive to many contractors, there is need for owner to use this method in recruiting bidders.

- Best competition for major trades when bulk bids are in $3 to $5 million range.

- Bulk bidding is advantageous; real problem is with having four different architects as with CSP-1.

- I would recommend bulk bidding if projects are similar and even more so if you could have one architect for all projects.

There was one added note of caution:

- Bulk bidding is "iffy" because of possibility of delays. Although CSP-1's four schools made a generally comfortable package, in the case of one subsystem the overall schedule could have been accelerated by fragmenting award of bids rather than merging them.

7. Responses of Contractor Representatives:

Nearly every response was affirmative to the question about economic advantages of bulk bids:

- There are savings in material costs and also in efficiency because of increased skill of workers.

- The larger the aggregate bid, the better the price; you can begin to get quotes more directly from manufacturers, and prices become more competitive.

- I recommend more and larger projects to reduce contractor's overhead.

The single disagreement:

- There are economic disadvantages to bulk bidding. Many times schedules and material availability are such that we could furnish one school within the desired time, but not several. Also, limitations on bonding may limit competition for large programs.

Contractors, of course, tended to view size of bid package in terms of their own competitive situation:

- CSP-1 optimum; possibly larger.
- I don't recommend bidding less than 300,000 square feet.
- CSP-1's four schools a good size; eight at half their size would have been impossible.
- It would be reasonable next time to add a few to size of CSP-1 package.
- CSP-1 fine! Even a mixture of small and large projects would be good.

8. <u>SUMMARY of RESPONSES on EXPANDING the BID PACKAGES</u>:

Participants in the CSP-1 program are overwhelmingly supportive of multi-project bulk bidding. With only a few exceptions or qualifications, the respondents endorsed the idea of a subsequent program somewhat larger than the initial one. Nearly all seemed to think bulk bidding was an appropriate technique not only for additions like CSP-1, but for new buildings and even renovations. The major criteria for bulk bidding are similarity and simultaneity.

The questions did not probe directly the possible close relationship between bulk bidding and industrialization (off-site fabrication of components, probably by manufacturers with national markets); however, as expected it was evident that bulk bidding appeals to representatives of national organizations. Perhaps more significant is the fact that relatively small local contractors see economic advantages to even very limited market aggregations, if it is within their bonding capacity to bid. Manufacturers, suppliers, and contractors of all types appear ready to change from one-at-a-time structures. Even architects and engineers, who as a group are most committed to custom-designed buildings, admit the economies and efficiencies of bulk bidding.

[redacted]

IV. A. DEVELOPING the SCHEDULES:

1. Background:

The earliest overall scheduling of CSP-1 was performed by CSP staff, assisted by systems consultants. Considerably later, shortly before subsystems were bid, an independent scheduling consultant was commissioned. He first prepared a subsystem schedule which was, in effect, a master schedule for construction. Incorporated in the subsystem specifications and including penalty and reward requirements, it was binding on awarded contractors. Subsequently, he added a "Precontract and Document Schedule" aimed at expediting preparation of nonsystems work by the architects and engineers. (See diagram, page 77). Then, just before nonsystems work was to be bid, he issued "General Construction Schedule Diagrams" on an individual project basis. Soon after, following contract award and contractor consultation, those schedules were expanded on an activity-by-activity basis and issued as computer printouts, using a "milestone-oriented" critical path method technique. The monitoring of schedules and issuance of updates and revisions continued intensively throughout the entire construction period.

The Detroit Public Schools had used computer-generated network scheduling techniques on a number of projects over recent years. However, the scheduling focus had been almost exclusively on the construction phase. For CSP-1, the recommendation was made to broaden the scope of scheduling to include owner and architect-engineer activities. The decision came from observation, both locally and of predecessor programs, that many delays stem from architect and owner inaction -- not just from poor performance by contractors or suppliers. A number of observers expressed surprise that Detroit had separated the preparation of schedules from the management contractor's responsibilities. Although construction management is quite a new endeavor, it usually has embraced scheduling as part of the service to owners. Some controversies over the merits of the CSP-1 arrangement occurred during construction.

2. Representative Questions:

a. For a subsequent program would you recommend retaining an independent scheduling consultant, or would you favor earlier and more intensive involvement by a management contractor in scheduling?

b. How would you recommend changing the development or timing of the various schedules?

3. Responses of Owner Administrators, Staff & Consultants:

Several favored a more active participation by the management contractor (MC) in scheduling. One said:

- Earlier involvement by MC a must. He should provide schedule and be responsible for it.

However, opposing views were in the majority:

- I do not think MC should get involved in actually preparing the schedule, although certainly he must use it.
- There are advantages to having scheduler independent and reporting simultaneously and consistently to architect, owner and MC.
- Architects could do it.

There were some criticisms of the CSP-1 scheduling as:

- Owner has been wasting a lot of money on schedules no one knows how to use.

However, another respondent defended the methods:

- Developing schedules is a lot more complex than just making them easy to read. When schedules are included in documentation, as they were with CSP-1, they must cover legal aspects. They have got to be completely detailed in order to protect the owner.

Most believed that CSP-1 schedules should have been developed and released earlier than they were. About the "Document Preparation Schedule," they suggested:

- Make it part of design manual; that is, as soon as preliminary drawings are approved.
- Incorporate it with owner-architect agreement.

In regard to the "activity-by-activity" construction schedule, one owner's staff person recommended:

- To accelerate construction, identify "milestones" for major phases, but establish earlier completion dates than would result from an accumulation of critical activity durations. Also, identify alternate scheduling patterns in order to let management choose best approach.

4. Responses of Project Architects:

Architects were evenly divided on who is best qualified to conduct scheduling operations. Three interviewees favored having the MC do it; three others recommended use of an independent scheduling consultant. Two rejected both approaches:

- Either the architect or a general contractor could handle scheduling just as well.

- Schedules never work. It's just the nature of the construction industry. You have to be realistic. Contractors lie about schedules. They'll say whatever they think an owner wants to hear.

Additional comments presented contradictory views:

- Contractor, owner, and architect must join together in developing schedules.

- Owner should not get involved in detailed scheduling on an activity-by-activity basis, but only should review projected end dates.

Nearly all architects recognized the need for detailed construction schedules. Some favored the development of such schedules early (i.e., during design); others believed that detailed schedules are not useful prior to contract awards. Most of their comments, however, were directed at the "Document Preparation Schedule" which had been developed (ostensibly with the architects' cooperation) by the owner's consultant:

- Owner has no business getting involved in architect's schedules. Give architect a due date; then let him do his job.

- I laughed when I got it, and then ignored it.

- Not much value. A waste of money. Real problem is with expediting owner's reviews and approvals.

- Document preparation schedule not well thought out.

Two of the architects did perceive a need for scheduling of this type. One said:

- I liked it. Kept us on the ball.

5. Responses of Project Engineers:

These interviewees were not asked about the merits of shifting scheduling responsibilities to a management contractor. Instead they were asked their general view of schedule development. Regarding the detailed construction schedule, they said:

- Fine, except one time we disagreed with scheduler on planning logic.
- We had little input; scheduler completely disregarded us.
- No input, but no problems.

Related comments or suggestions:

- Major problem was with owner changes.
- All our scheduling problems were with the alteration work.
- Involve the engineers!

About the "Document Preparation Schedule":

- No effect whatsoever on our working drawings.
- We did not use it, but we noted end dates.
- It was not useful for non-systems work because of lack of information from owner and because of delays in information on subsystems.
- Develop it earlier, right after completion of preliminary design.

6. Responses of Management Contractor Personnel:

The majority favored having their own group assume major scheduling responsibility:

- MC should do it all.
- Overall costs would be less if MC provided his in-house scheduler.
- Having MC do scheduling would eliminate personality conflicts.
- Squabbling over schedule on one school set that job back six weeks.

However, two interviewees favored retaining an independent scheduler.

Recommendations for improvement were general:

- Schedules were inflexible.
- Real problem was contractor resistance.
- Owner too involved.
- Scheduling methods not the best, monitoring was excessive and costly.

One respondent recommended a simplified type of schedule diagramming.

The MC personnel were not involved with the Document Preparation Schedule. Regarding the detailed construction schedule, they unanimously agreed that it should occur earlier than it did on CSP-1. However, most recommended it be developed only after bidding and w. h the cooperation of the designated contractors. One different view:

- Develop activity-by-activity schedule along with preliminary drawings. Keep it flexible, but include <u>all</u> responsibilities, particularly regulatory agencies' and owner's.

7. <u>Responses of ̣ ntractor Representatives</u>:

All in this category were strongly supportive of precise scheduling procedures. They were not asked the question related to who should prepare the schedule, but they were asked to appraise the effectiveness of CSP-1 scheduling. Representative responses:

- CSP-1 scheduling was good, necessary, and critical.
- Basic scheduling seemed to work well.
- Schedule was at fault in crowding finishing trades.
- Schedule had no logic whatsoever.

They also exhibited disparate views on their own role in schedule development, as:

- Plenty of opportunities for comment and input.
- Original schedule was not developed with proper input from contractors. We spent another $2000 refining our own schedule.
- Activity-by-activity schedule cannot be developed without contractor input; that is, not until after award of bids.

Most contractors were in agreement that detailed scheduling must be post-contract, although some commented:

- Pre-bid schedule is important help.

- Great need for pre-bid meetings to explain schedule.

However, this was negated by one who admitted:

- Contractors never really look at schedules prior to award.

The clearest recommendation, repeated several times, was:

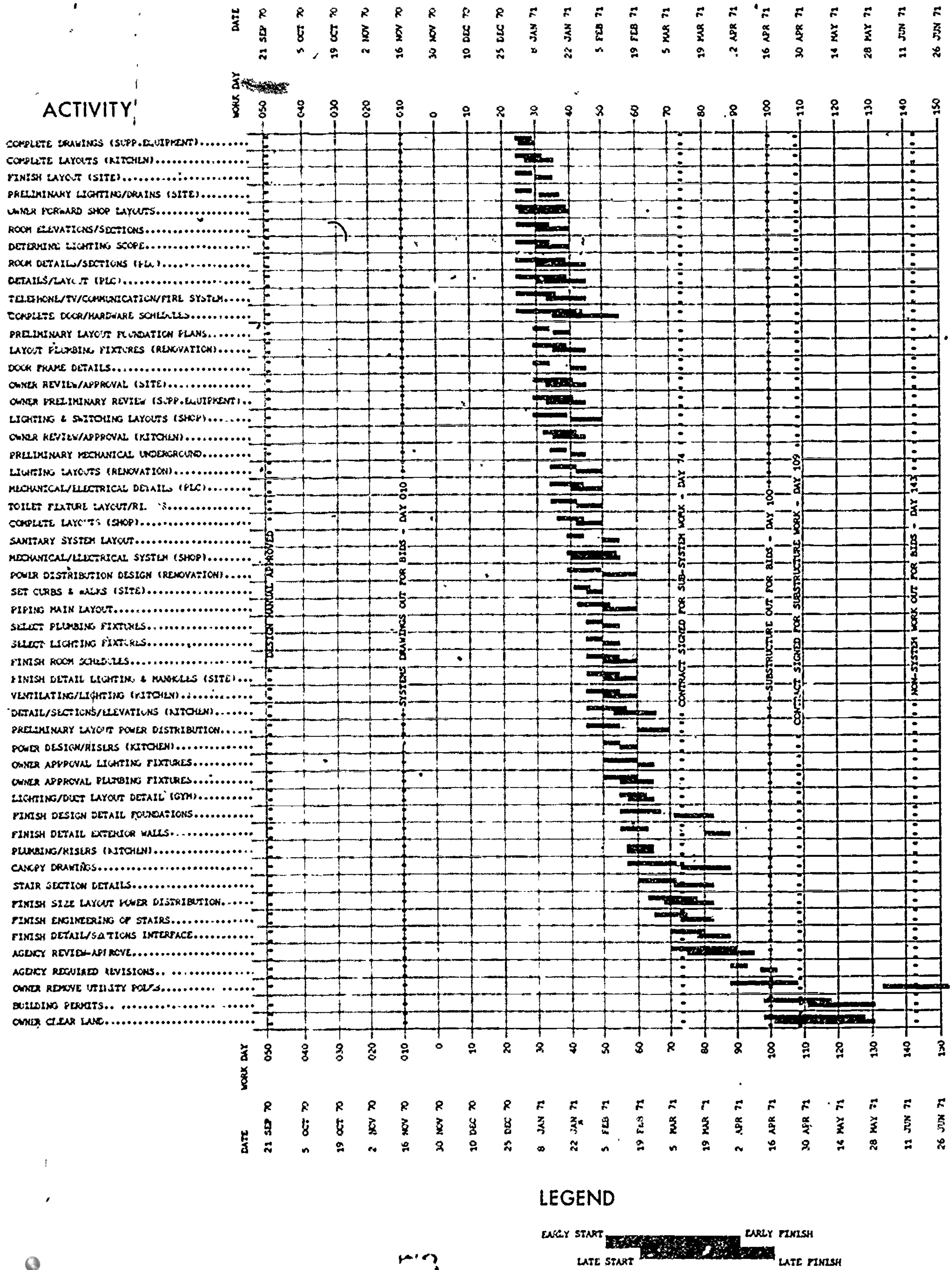
- Add a specific schedule for contractor-prepared working drawings for early bid subsystems and for all shop drawings.

8. <u>SUMMARY of RESPONSES on DEVELOPING the SCHEDULES:</u>

Everyone on the building team is affected by scheduling and is cognizant of its importance, but there is limited agreement on just how to achieve effective results. Because contractors and suppliers are usually the targets of scheduling thrust, it is not surprising that some were antagonistic toward CSP-1 methods. However, their responses were mild compared to architects, most of whom were very hostile to the "Document Preparation Schedule." As mentioned in the "Background" section of this topic, the CSP-1 separation of management from scheduling elicited some questions and criticism during the construction phase. However, there were surprisingly few recommendations to merge the two functions. Even some of the management contractor group who had to work most closely with the schedules could see advantages to an independent scheduler.

The single most recurring recommendation was that shop drawings (or other types of pre-engineered submissions from contractor-bidders) be more carefully scheduled. There was agreement on the soundness of the CSP-1 concept of broadening scheduling to off-site activities, such as shop fabrication, regulatory agency approvals, and document preparation. Understandably, most participants view scheduling from their own narrow perspective (i.e., by trade or by project). Although there were disagreements with the construction logic or disapproval of the methodology, the great majority of participants came to accept the validity of the CSP-1 schedules and to work successfully within their tempo. As one participant concluded, "Finally, most of us changed our opinion, and concluded it was a good schedule."

PRE-CONTRACT AND DOCUMENT SCHEDULE FOR TYPICAL CSPI SCHOOL



IV. B. UTILIZING the SCHEDULES:

1. Background:

Developing a schedule is part of the battle; getting all the many participants to adhere to it is the greater struggle. In a program with four architectural firms, twelve separate prime contractors, and very many ancillary personnel, whose responsibility is it to watch the clock and blow the whistle? As explained in the "Background" portion of the preceding section, the primary role in schedule development belonged to an independent consultant commissioned by the owner. However, the most active role in implementation fell to the management contractor who provided day-to-day, on-site supervision and expediting.

The contractual agreements to maintain completion dates were explicit, but when several hundred personnel are involved on and off the sites, and when hundreds of separate activities are itemized, a massive problem in communications emerges. How do you keep everyone well informed and up-to-date? The diagram on page 85, "Scheduling Analysis for Typical CSP-1 School," is a much-simplified graphic summary of what was scheduled and what actually transpired during construction. Although the buildings were completed on schedule, it is evident there were discrepancies in phasing. Was this the fault of the schedule or the contractors? The answers are important only if they can help to build more expeditiously another time.

2. Representative Questions:

a. Do you feel all the CSP-1 contractors used the construction schedules advantageously?

b. Would you comment on the effectiveness of the CSP-1 schedule format as presented?

3. Responses of Owner Administrators, Staff & Consultants:

Most felt contractors failed to use the developed schedules advantageously. A number added criticisms:

- Detroit area contractors resist schedules.
- Some contractors just didn't bother.
- There was unwillingness to understand, followed by inertia.

Owner's representatives seemed to feel that schedules are for contractors rather than for themselves; however, there was at least one different view:

- The healthiest aspect of CSP-1 was to impose some discipline on the owner's time table.

There were other favorable comments:

- Schedules were helpful at job meetings.

- Fewer problems with CSP-1 schools than conventionally because whole process was speedier.

About the schedule format, a number protested:

- Too complex; orm more difficult than schedule itself.

- Some contractors and some of our own staff could not read schedules.

- Contractors respond better to bar charts and arrow diagrams than computer print-outs.

- Some of management staff had trouble reading schedule; many meetings spent trying to figure it out.

However, the criticisms were countered:

- Computer-printed bar charts are so simple it's ridiculous, but for some reason people will not look at them. It's a human psychology problem.

- It became a very popular game for a while . . . to find fault with the scheduling documents rather than perform.

- Simple bar graphs are not the answer; we need greater sophistication on part of our field superintendents.

The most specific recommendation:

- What seems best is to print bar graphs some weeks in advance, listing activities by trades, then giving out separate mimeographed sheets every couple of months.

4. Responses of Project Architects:

A majority viewed contractors' utilization of construction scheduling as ineffective, and they tended to blame the management contractor staff:

- Delays were more fault of MC.

- Scheduling could have been improved with more energy and follow-up on part of MC.

- To make the schedules work, pin the contractors down more.

There were different -- although contradictory -- opinions:

- Several major contractors used schedules very well.
- Schedule was done well, but no one used it.

When asked about scheduling format, architects were quick to complain:

- Schedule was very hard to understand; too vague; too complicated. Computer print-outs too difficult to comprehend.
- Form hard to follow; did not pay much attention to it.
- We developed our own special bubble diagram as a translation to help contractors understand renovation schedule for our project.
- All schedules too complex. Schedules should be simplified and reproduced on 8½" x 11" pages instead of bulky computer print-outs.

Most architects would prefer a simple bar graph for readability; however, some of the communications problem may be revealed by two answers:

- I cannot recall any direct participation with schedules.
- Architects don't work with construction schedules.

5. Responses of Project Engineers:

Because their involvement with on-site construction tends to be limited by time or scope, engineers were not asked the general question about contractors' use of schedules. However, one volunteered:

- Contractors used construction schedule well.

Two focused on the format questions, disagreeing with each other:

- Schedules would be better as bar graphs. CSP-1 contractors couldn't follow computer sheets.
- Presentation was OK; most contractors understand CPM.

Their major concern was not with the construction schedule, but with the document preparation schedules which, they felt, had "ganged up" on them by expecting their work for four different projects to be produced simultaneously:

- Scheduler failed to understand engineers' problems.

- CSP-1 schedules unrealistic and impractical.

However, two assigned the blame elsewhere:

- Real problem was with delays by owner in getting decisions.

- Problem was with owner input, but it's hard to criticize owner who pays the bills.

The primary recommendation for a subsequent program was to involve engineers more completely.

6. <u>Responses of Management Contractor Personnel</u>:

In a rare spate of unanimity, they agreed that contractors failed to use the construction schedule to best advantage:

- Certain contractors fought schedule.

- Contractors distrusted schedule.

- Contractors distraught about schedule.

- Subsystems contractors used schedules, but some nonsystems contractors didn't look at them.

The scheduling format came in for heavy criticism:

- Method not the best; monitoring excessive and too costly.

- Owner was buying too much "quality" of scheduling.

- I've spent hours and hours, and I still can't explain it to contractors.

- Contractors couldn't understand schedule; too sophisticated; depends on personal drive of scheduler to move things along.

Although there were several pleadings for simple bar graphs, one MC representative observed:

- A simple bar graph would not be adequate; however, a precedence technique would be preferable to the I-J node method.

Another disagreed:

- Bar chart scheduling has proved adequate on far larger projects than CSP-1.

7. Responses of Contractor Representatives:

A majority felt they had not been fully effective in utilizing the construction schedules. Their justifications were diverse:

- Contractors have grown cynical about schedules because they are so often used as an instrument of hostility.
- You can't fault the schedule; real problem was communication between trades.
- Nobody but scheduler can fully grasp all facets; important for contractors to have confidence in scheduler.
- Utilization marred by lack of rapport between scheduler and MC.
- Not realistic to talk of "contractor input" to scheduling when there is a penalty clause. Everyone pads the time estimates.

Although not asked at this point, several volunteered recommendations pertaining to project authority:

- Followup and control could be better; need a "central figure."
- Schedule enforcement should have been stronger.
- Owner needs to dictate more to contractors.
- CSP-1 schedule suffered from lukewarm application and lack of clarity as to administrative responsibility.

Most contractors found fault with the scheduling format:

- Many couldn't read schedules; they like bar charts!
- Most subtrade superintendents cannot read computer printouts.
- Contractors mean well, but they can't read CPM. You need a scheduler who can sell schedule!

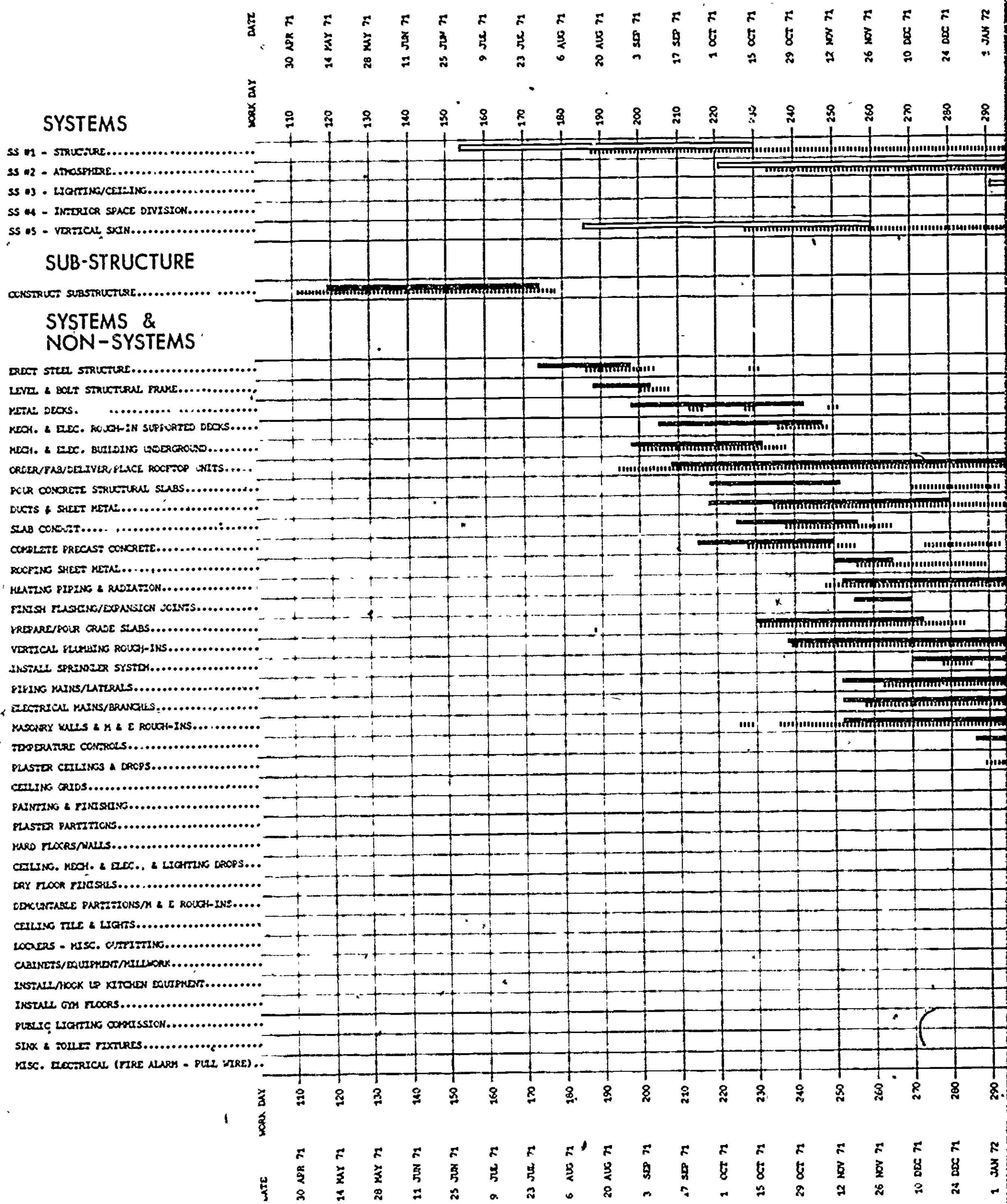
Other recommendations included: 1) more exact scheduling of shop drawings, 2) clearer separation by trades in the schedules, 3) more emphasis on pre-bid meetings to explain overall construction schedule. Suggestions about scheduling format were primarily the recurring, "Keep it simple!"

8. SUMMARY of RESPONSES on UTILIZING the SCHEDULES:

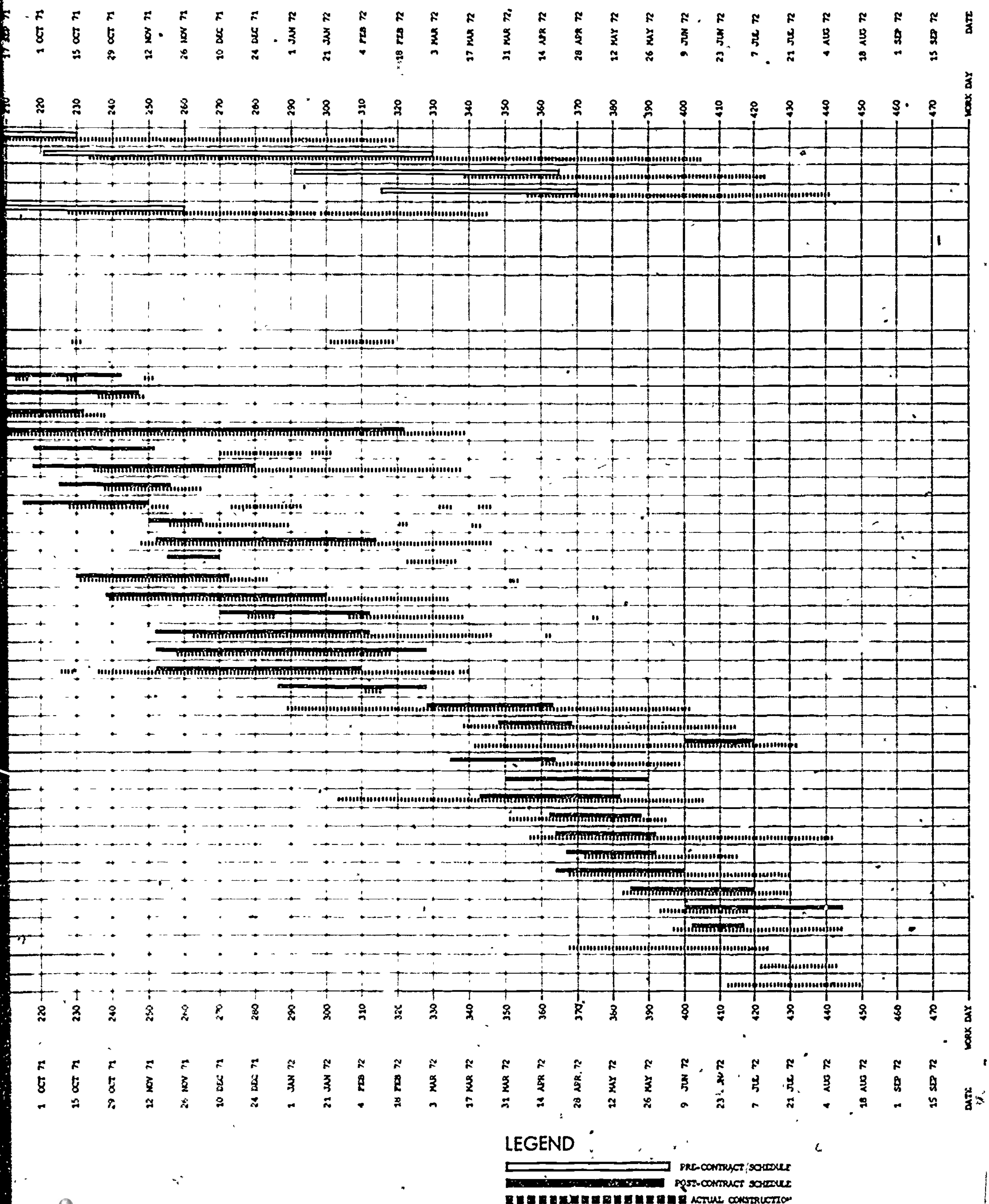
The most persistent note among the five categories of interviewees was dismay over the presentation technique. Participants find difficulty reading computer print-outs, even when they have been manipulated to resemble more traditional bar charts. Less evident, but more significant, is that most participants had not read carefully the scheduling sections of the specifications. Most did not understand that a construction schedule that is also a contract document (complete with financial penalties and rewards) is inevitably complex and somewhat legalistic.

That the basic construction schedule worked successfully is apparent from the fact that four CSP-1 schools were finished and occupied by the appointed day; thus, it is surprising to read far more complaints than congratulations. Perhaps it was the nature of the questions that made the contractors the "culprits." Most interviewees ignored the effect of their own delays in design, organization, and operation. As one contractor expressed it, "Schedules are valuable, but it's more important who administers them." Although the architects and owner's staff personnel tended to blame contractors for inaction, the contractors pleaded for more effective leadership. Several specifically asked for "stronger control." Engineers were particularly critical of owner indecision. Improvements can be made in translation and communication of schedules (i.e., the format), but a careful reading of the comments suggests that more effective management is the key to acceleration.

SCHEDULING ANALYSIS FOR TYPICAL CS



TYPICAL CSP I SCHOOL



IV. C. ACCELERATING the WORK:

1. Background:

CSP-1 schools were completed and occupied on schedule. As noted in "An Assessment of the Detroit Public Schools Construction Systems Program," prepared by Richard L. Featherstone, Ph.D., Michigan State University, the average 14.2 months from groundbreaking to essential completion represents a saving of 10.2 months or an improvement of about 44 percent over five recent similar Detroit school projects. Despite the alacrity, many persons associated with the projects observed the construction sites were often not heavily manned. Perhaps this should be interpreted as achievement of the goal of industrialization through utilization of more productive off-site labor. On the other hand, it could suggest much greater acceleration is possible. Predecessor systems programs in Toronto (SEF) and Florida (SSP) have demonstrated that conventional construction time can be halved through the experience of repeated program packages.

Obviously, there is a point when speed may be either unnecessary or too expensive. Most observers, however, believe that quickly-built buildings cost less; the thoughtful owner seeks the most advantageous cost/time balance. In creating new public school facilities, pre-planning and organization nearly always take longer than actual construction. Thus, the entire process needs examination. In addition to some acceleration techniques discussed in preceding sections of this report, there may be design procedures and conventional construction procedures which can be accelerated.

2. Representative Questions:

a. The CSP-1 construction process for the additions took approximately 14 months from groundbreaking to effective occupancy. Could this be compressed and, if so, by how much time?

b. Have you any suggestions as to how the overall schedule for building Detroit schools can be compressed, including time spent on programming, design, and construction documents?

3. Responses of Owner Administrators, Staff & Consultants:

Every respondent was certain construction time could have been shortened from CSP-1's 14.2 months. Estimates ranged from 8 to 12 months to accomplish similar work. Regarding the construction phase:

- The real time savings is in building simple space, putting up skeleton and skin, leaving both guts and cosmetics until later.

- Another time we should speed up subsystem phase. We could do a lot of tightening. Each phase needs better control.

Most assumed that time is money and that a speed-up is desirable, but there was one dissenting view:

- Schedule could be compressed, but there would be no cost savings. Accelerating schedule may cost you more.

This group was concerned about the total expenditure of time, rather than just the construction period:

- Major savings of time could be in Board of Education activities, such as project advisory committees.

- Big savings in administrative decision making.

- We would save time by simplifying our planning and using stock plans, at least for individual rooms.

- Board of Education should allocate money for design to be done early and separately, so it's finished when official release to build occurs.

Architects received particular criticism:

- Slack was in document production. Architects failed to move ahead with working drawings. The architects' philosophy was, "When in doubt, do nothing."

- Architects' time for design and working drawings could be reduced more than construction time savings.

4. <u>Responses of Project Architects</u>:

All believed substantial cuts could be made in construction time. Speculation ranged from 10 to 12 months total duration. However, they had very few specific suggestions about the building period:

- Major delays were in mechanical and electrical work. Great need for prefab assemblies instead of on-site plumbing and wiring.

- Demand HVAC and other mechanical shop drawings earlier.

- Eliminate paper work; it was voluminous because of multiple contracts.

Several references were made to serious delays in public utility work and public agency reviews:

- Earlier involvement of public bodies is required.
- Owner needs to put pressure on agencies through top city officials.

The architects were much aware that non-construction phases take longer than actual building, and every one of their comments focused on owner delays, rather than their own operations:

- Real savings could be with planning time of project advisory committees.
- Greatest time saving lies within complete control of owner.
- We wasted 3 to 4 months waiting for answers from owners.
- Compress project advisory committee time to 3 or 4 months. Let Board of Education suggest; then let community comment.
- Bureaucratic organizations are always off base; they'll never change.

5. <u>Responses of Project Engineers</u>:

Each agreed that 2 months could be lopped off the construction period. Twelve months from groundbreaking to occupancy appeared to them a reasonable schedule for a similar program. Their suggestions for acceleration included:

- Cut subsystem bid review from 8 to 4 weeks.
- Separate out utility work; for example, eliminate indoor electrical vaults.
- Establish firm rule that shop drawings cannot be kept by one office over 5 days.
- If you use early bid subsystems, require more adequate pre-engineering, particularly from the atmosphere contractor.

They were conscious of the overall time lag:

- Architects and engineers have developed a mystique about design time; they could operate a lot faster than they do.
- Real savings are in early planning time by owner.
- The need is for greater adherence by the owner's staff to handling review procedures.

6. Responses of Management Contractor Personnel:

Only one of this group felt that the construction time could not have been abbreviated; others believed 10 to 12 months duration was quite feasible. Many of their more specific suggestions about building methods had been noted earlier, as in Sections II-B, C, & D, pertaining to industrialization, systemization, and standardization. However, they added:

- Underground mechanical work, substructure, installation of doors, frames, and hardware could all be accelerated.

- In remodeling, covering up is a lot faster than replacing; also, less expensive and better looking.

About their own work:

- MC needs to speed up his handling of paperwork.

- Perhaps MC should apply penalties to contractors sooner.

Although they were [illegible]t involved in preconstruction phases, they felt they knew enough about the overall problem to comment:

- Owner needs to select architects more carefully, particularly in regard to their ability to perform in a certain time.

- I suggest initiating cost penalties for architects and engineers not meeting the document preparation schedule.

7. Responses of Contractor Representatives:

Reducing the time schedule seemed promising to every contractor representative interviewed. Suggested as reasonable construction periods were estimates of 9 to 12 months. When asked their recommendations, for acceleration, they reiterated some of their prior comments about early bidding of: 1) site work, 2) structural work, 3) mechanical (interior plumbing, as well as underground utilities and all HVAC work). Related comments:

- Seek standard materials and products for rapid delivery.

- Follow strict schedule for shop drawing review and approval.

- Focus on early stages of job to avoid usual pile-up of finish trades.

- Secret is precoordination or interfacing of subsystems.

Because of the specialized nature of their interests, contractors were not asked the question on preconstruction operations.

8. SUMMARY of RESPONSES on ACCELERATING the WORK:

Virtually every participant stated that buildings like the CSP-1 schools should be built in 12 months or less. Contractors seemed particularly convinced of the speed-up potential. While a couple of estimates ranged as low as 9 months, none of the interviewees was thinking in terms of the 6 to 8 month construction periods demonstrated successfully in certain other locales. All of the recommendations were only modifications to conventional operations.

When acceleration of work prior to construction was considered, architects received adverse criticism, particularly from owner's representatives, because of slow preparation of documents. Architects, on the other hand, directed their blame at the total planning process. They were emphatic in recommending a compression of time spent on project advisory committees (school/community planning groups which meet, with architect participation, in preparing educational specifications and other programming recommendations). Delays by the owner received criticism from every group -- including the owner personnel themselves, who pleaded for prompter administrative action. All categories of respondents made the comment, "Start earlier!" regarding specific activities. The one consensus of participants is that the owner could accelerate building through speedier decision-making.

IV. D. REDUCING CONSTRUCTION COSTS:

1. Background:

The data which accompanied the proposal initiating CSP pointed out that building costs are higher in Detroit than in its suburbs or further outstate. Subsequent evidence indicates that Detroit's costs have continued upward at about the same percentage rate as the state generally. From the outset, a major concern has been to analyze whether Detroit's higher costs were self-generated or were caused by implacable outside forces. Several aspects of CSP-1, including industrialization and bulk bidding, hoped to encourage cost reduction. The use of phased bidding was perceived as permitting the owner to get an earlier firm hold on costs. The result of these efforts, as documented in "An Assessment of the Detroit Public Schools Construction Systems Program," prepared by Richard L. Featherstone, Ph.D., Michigan State University, was that subsystems bidding came in well under budget. Nonsystems came in slightly over budget, and certain bids had to be reduced by negotiation. However, the overall saving was approximately 14 percent when compared with five recent similar school buildings in Detroit.

For detailed information as to the CSP-1 experience, refer to "Cost Analysis" data and diagrams on pages 99 through 113, which show the development of estimates and expenditures through five major checkpoints for each of the four schools. The owner provided the cost estimates for subsystems through an independent consultant. For nonsystems work, each architect provided his own estimates. In both situations, however, the owner became much involved in budgetary approvals and cost-cutting decisions. In addition to practical concerns of cost reduction techniques, other questions arose. How can an architect or an owner encourage competitive bids? In the owner-architect relationship, whose real responsibility is it to establish and adhere to building budgets? Problems related to budgeting are far more complex than simply reducing building area or substituting lower-cost materials.

2. Representative Questions:

a. Can you compare the costs of the various subsystems on CSP-1 projects with the same costs in other schools with which you are familiar?

b. Have you suggestions where further economies, either with subsystems or nonsystem portions of the work, could be accomplished?

3. Responses of Owner Administrators, Staff & Consultants:

Virtually all commented favorably on CSP-1 economies, but some had qualifications:

- Costs trends are up. Buildings costing $100/square foot are not far off. When that happens, those who want a custom building will pay $100; a systems building will cost $75.

- Costs were good on CSP-1 schools compared with conventional projects. In addition to air conditioning, lighting and partitioning are improved over standard; however, quality of construction is still barely adequate.

- CSP-1 schools were on time and saved money because of fewer extras and bulletins; however, they may cost more for long term maintenance of roof top mechanical units and poor hardware.

- We must encourage more competition by generating a lot more pre-bid design development. Owner should maintain an active program of research on product development. The architects should be doing this, but they're not.

Regarding possible future economies:

- Cost is closely related to complexity. Detroit's "chopped up" architecture is a reflection of its fragmented programs. Some other school systems do not have the same territorial prerogatives defined by departments. Detroit has many redundant spaces. The need is for educational reform.

- Detroit costs are higher because of vandalism, administrative problems that result in slower approvals, and Equal Employment Opportunity problems. E.E.O. requirements add at least 10 percent to costs, and this will soon reach 25 to 30 percent.

- Important cost cutting should be done at design stage, before the owner even sees the plans; however, architects are not up on pricing. Budgets are established carelessly and perfunctorily by architects. The owner must establish basic cost parameters.

4. Responses of Project Architects:

Only one question about economies was asked of the architects in this section because they had earlier responded to several supplemental cost-related questions pertaining to industrialization, systemization, and standardization. (Refer to Sections II B,C,D.) Regarding future cost cutting:

- Take an objective approach to management.

- Expand systemization to the very limit of its possibilities to save more money; for example, expand and diversify interior space division subsystem and eliminate nonsystem interior masonry walls.

- Compress early time in committee work and planning, thereby reducing escalation of construction costs by building sooner. Planning could be a lot faster if there were a person who could make quick decisions on the owner's part, and who would follow the project all the way from the very beginning to final completion.

One architect added a caution:

- There is too much concern about saving money and not enough in producing a quality building that will be good in training children's minds.

5. Responses of Project Engineers:

(No questions asked on this topic.)

6. Responses of Management Contractor Personnel:

Because these respondents were not involved with CSP-1 budgeting, they were not asked to make economic comparisons with other school projects. Their suggestions on possible cost cuts were limited to:

- Revise performance specifications. Lighting-ceiling standards, for example, are unnecessarily high and too expensive.

- Loadings for structural steel are over-designed.

- Require standardized door sizes and types; including hardware.

- Increase systemization, including panelization of masonry.

- Delete floors from structural subsystem for better bids from steel suppliers.

- Higher quality sash would, in the long run, be more economical from the standpoint of maintenance.

- Prewire electrical service panels.

- Reduce design development time.

- Use only one architect for multiple projects.

One of the management personnel added:

- Architects are not familiar enough with costs to estimate accurately; MC should do all estimating.

7. Responses of Contractor Representatives:

When asked to compare CSP-1 costs with other schools, nearly every contractor quickly pointed out what they believe to be Detroit's unique budgetary problems:

- We have to crank more in our Detroit bids for plumbing inspectors and Equal Employment Opportunity.
- Contractors bid Detroit work 5 to 10 percent higher because of all the owner involvement in inspections, et cetera, which reduce profits.
- All Detroit Board of Education jobs cost more, but that is because of your 30 or 40 page punch lists.
- I've reviewed Detroit school jobs, and I can't really suggest any way to save money. They certainly aren't goldplated in any way.

For future work, they had these comments or recommendations:

- Encourage greater use of bulk bidding and multiple projects.
- Detroit's labor costs are very high; savings are to be made primarily in reducing on-site labor.
- "I am convinced that total subsystems -- like ceiling and lighting combined with air distribution -- cost less than buying the same thing in parts and pieces.
- Use aluminum conductors, plastic pipe, and plastic conduit wherever permitted by code.
- Electrical distribution centers should be more centrally located to reduce wiring costs.
- Owner paid for a lot of plumbing pipe chases in demountable partitions which could have been reduced with better planning.
- Keep structural bay sizes to minimum and keep building massing simple.
- Get rid of roof top multi-zone units, and go to central chilled water with variable volume ventilation.

- Avoid demolition when altering existing buildings; replace or cover up, rather than repair.

Finally, one contractor's summary comment:

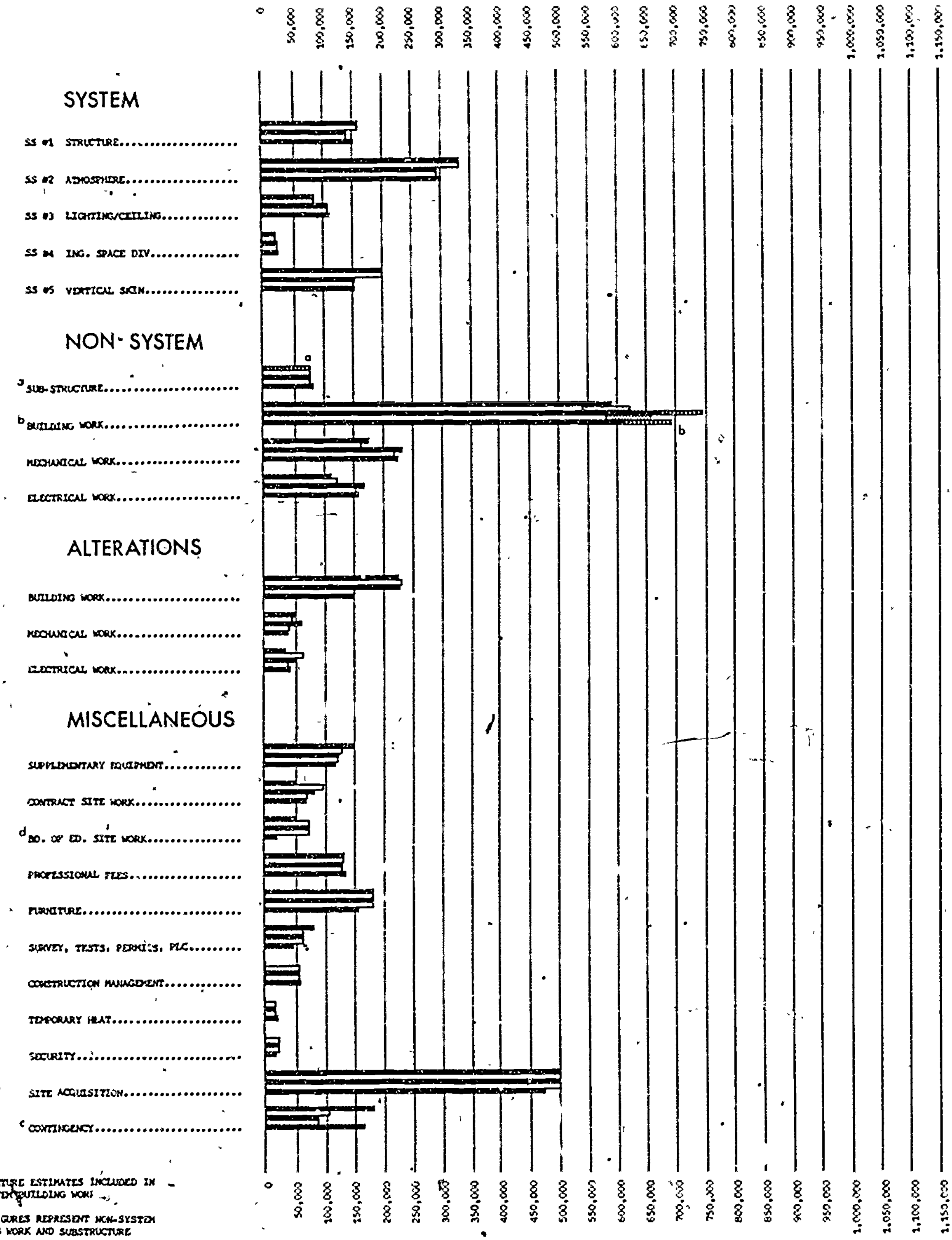
- Thank God for extras! Architects' omissions are an important supplement to my income.

8. SUMMARY of RESPONSES on REDUCING CONSTRUCTION COSTS:

Prior sections of this report asked interviewees to evaluate the financial effect of particular organizational methods. This section was viewed as more general and recommendatory. No one claimed to have simple or easy answers to the problems of rising costs, but nearly all the comments that emerged were supportive of CSP-1's diversified approach. A recurring view was that architects like those who participated in CSP-1 -- small firms in private practice -- are unable to maintain close touch with economic trends and are unable to estimate building costs with assurance. There is a strong feeling -- stated or implied -- that the owner must continue to be much involved with budgeting, estimating, and cost control. Probably this is true whether or not the owner provides the services of an independent cost consultant.

The owner's role was stressed in at least two additional ways. First, several respondents suggested it is the basic building programming -- not in the way architects and engineers assemble parts -- that the most significant cost determinations are made. Second, the answers from contractors stressed that building in Detroit is more expensive for particular reasons. Perhaps not all the difficulties can be eliminated; yet the fact remains that it is to the owner's benefit to attract contractors and, thus to stimulate competition. In this regard, the responses echoed those of a 1967-68 study, "Contractor Attitudes on School Construction," jointly undertaken by the Detroit Chapter of the American Institute of Architects and by the Builder's Exchange of Detroit, which presented recommendations on: 1) inspection procedures, 2) disbursement of contract funds, 3) construction techniques, 4) bidding practices, 5) construction documents, 6) cost control. At least some of the recommendations of that study, which was a major precursor to CSP, have been carried out, and with apparent success.

BOYNTON ADDITION COST ANALYSIS



a SUBSTRUCTURE ESTIMATES INCLUDED IN NON-SYSTEM BUILDING WORK

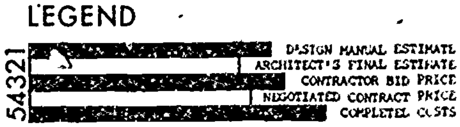
b FINAL FIGURES REPRESENT NON-SYSTEM BUILDING WORK AND SUBSTRUCTURE

c ADDITIONAL EXPENDITURES NOT INCLUDED IN CONTINGENCY:

INSURANCE	3,412
PUBLIC ADDRESS & TV	14,443
COORDINATION & SUPERVISION	30,689
TOILETS	750
FENCE & SIGNS	1,250
COST ESTIMATE & SCHEDULING	8,629
PRINTING COST	5,010

d F[illegible] [illegible]STRUCTION PLANS CUT BACK IN O[illegible] [illegible]ICIPATE IN OPEN SPACE PROGRAM

LEGEND



CONSTRUCTION SYSTEMS PROGRAM
COST ANALYSIS DATA - JANUARY 1974 UPDATE.

BOYNTON JUNIOR HIGH SCHOOL

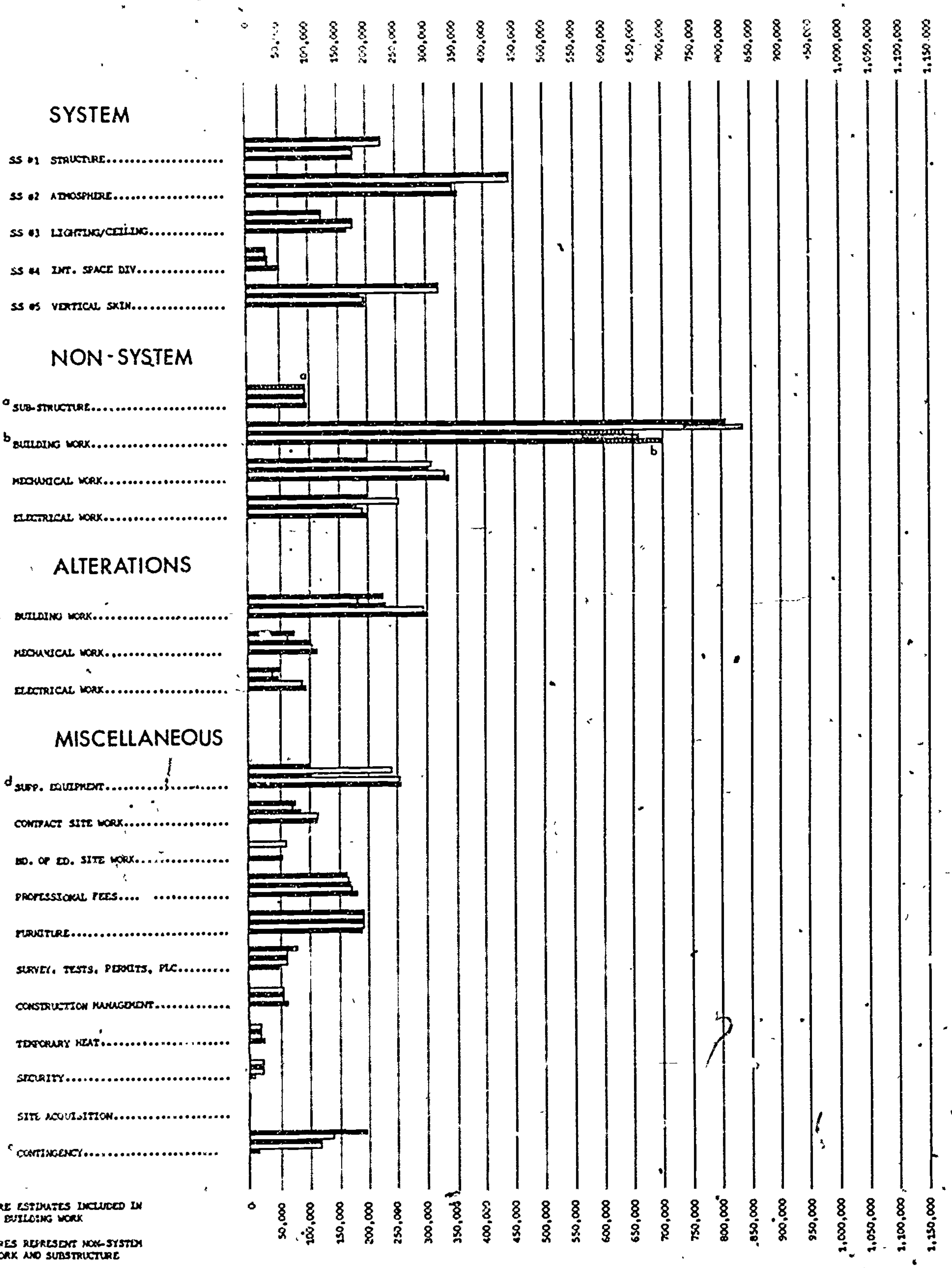
ADDITIONS AND ALTERATIONS
AREA OF ADDITION = 54,625 SQ.FT.

CATEGORY	1 DESIGN MANUAL ESTIMATE	2 ARCHITECT'S FINAL ESTIMATE	3 CONTRACTORS' BID PRICE	ADD/DEDUCT PRE-CONTRACT	4 NEGOTIATED CONTRACT PRICE	COST PER SQUARE FOOT [1]	ADD/DEDUCT POST-CONTRACT	5 COMPLETED COSTS
Systems Work								
SS/1	159,000		139,837	-	139,837		+10,450	150,287
SS/2	332,000		293,000	-	293,000		+ 7,655	300,658
SS/3	86,900		108,000	-	108,000		+ 2,933	110,933
SS/4	20,000		24,000	-	24,000		+ 1,950	25,950
SS/5	200,000		151,749	+ 112	151,861		+ 585	152,446
Subtotal	797,900	714,803			716,698	13.08	+23,576	740,274
Substructure	(incl. in BW)	77,000	77,000	-	77,000	1.41	+ 3,689	80,689
Nonsystems Work								
BW	593,000	539,694	659,000	-75,789	583,211	10.68	+14,159	597,370
MW	174,187	164,000	232,600	-10,605	221,995	4.06	+ 5,168	227,163
EW	109,250	119,000	165,655	-11,130	154,525	2.83	+ 3,220	157,745
Subtotal	876,437	822,694	1,057,255	-97,524	959,731	17.57	+22,547	982,278
CUMULATIVE TOTAL	1,674,337	1,614,497			1,753,429	32.06	+49,812	1,803,241
Alterations								
BW	228,000	233,453	230,000	-79,806	150,194		- 1,470	148,724
MW	48,000	45,000	57,900	-17,861	40,039		- 1,781	38,258
EW	34,000	63,000	49,000	- 9,703	39,297		+ 2,982	42,279
Subtotal	310,000	341,453	336,900	-107,370	229,530		- 269	229,261
CUMULATIVE TOTAL	1,984,337	1,955,950			1,982,959		+49,543	2,032,502
Suppl. Equip.								
SEW		113,500	108,627	-	108,627		- 3,204	105,423
FSW		16,000	13,650	-	13,650		-	13,650
Subtotal	150,000	129,500	122,277	-	122,277		- 3,204	119,073
Site Devel. Contract	50,000	96,000	81,000	-8,585	72,415		- 760	71,655
CUMULATIVE TOTAL	2,184,337	2,181,450			2,177,651		+45,579	2,223,230
Bd. of Ed.	50,000	75,000	75,000		75,000			18,629
Site Subtotal	(100,000)	(171,000)	(156,000)		(147,415)			(90,284)
Prof. Fees	130,000	130,000			129,600		+ 2,173	131,773
Furniture	175,900	175,900			175,900			155,141
Miscellaneous								
Survey/Tests/ Permits/PLC	80,000	80,000			80,000		(21,501)[s] (19,179)[t]	40,680
Const.Mgt/ Security	--	54,000			75,000		(58,638)[c] (17,208)[x]	75,846
Site Acquisition	500,000	500,000			500,000			475,000
Contingency	179,763	103,650			86,849			179,701
TOTAL	3,300,000	3,300,000			3,300,000			3,300,000

[s] Surveys
[t] Temporary Heat
[c] Construction Mgt.
[x] Security

[1] Cost figures corrected for building work (BW) on Boynton Addition. Other costs as computed in 1972 and reported in "An Assessment of the Detroit Public Schools Construction Systems Program."

CERVENY ADDITION COST ANALYSIS



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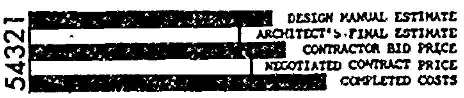


a SUBSTRUCTURE ESTIMATES INCLUDED IN NON-SYSTEM BUILDING WORK

b FINAL FIGURES REPRESENT NON-SYSTEM BUILDING WORK AND SUBSTRUCTURE

c ADDITIONAL EXPENDITURES NOT INCLUDED IN CONTINGENCY:

INSURANCE	4,212
PUBLIC ADDRESS & TV	20,916
COORDINATION & SUPERVISION	29,075
TOILETS	750
FENCE & SIGNS	2,500
COST ESTIMATE & SCHEDULING	6,544
[illegible] COST	3,474

d [illegible] 4,4[illegible] GRANT FOR 75% OF [illegible] KITCHEN EQUIPMENT

CONSTRUCTION SYSTEMS PROGRAM
COST ANALYSIS DATA - JANUARY 1974 UPDATE

CERVENY JUNIOR HIGH SCHOOL

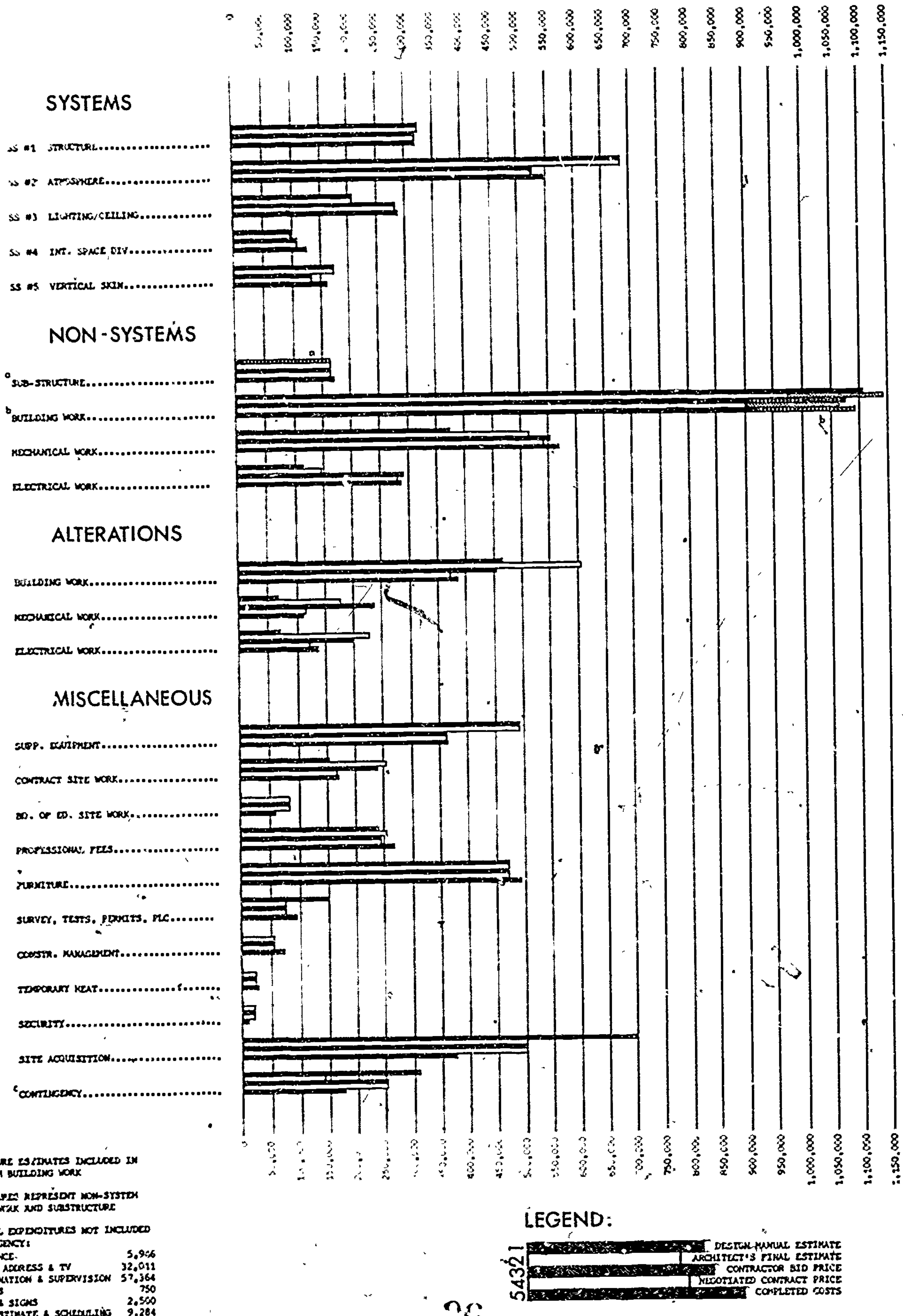
ADDITION AND ALTERATIONS
AREA OF ADDITION = 74,600 SQ.FT.

CATEGORY	1 DESIGN MANUAL ESTIMATE	2 ARCHITECT'S FINAL ESTIMATE	3 CONTRACTORS' BID PRICE	ADD/DEDUCT PRE-CONTRACT	4 NEGOTIATED CONTRACT PRICE	COST PER SQUARE FOOT[1]	ADD/DEDUCT POST-CONTRACT	5 COMPLETED COSTS
Systems Work								
SS/1	224,500		178,425	-	178,425		-	178,425
SS/2	440,000		347,000	-	347,000		+ 5,452	352,452
SS/3	121,300		179,364	-	179,364		-12,230	167,134
SS/4	32,000		34,370	-	34,370		+15,880	50,250
SS/5	320,000		188,602	+ 8,205	196,807		-	196,807
Subtotal	1,137,800	936,278			935,966	12.55	+ 9,102	945,068
Substructure	(incl. in BW)	93,816	93,816	-	93,816	1.26	+ 2,897	96,713
Nonsystems Work								
BW	806,200	737,688	543,380	+21,000	564,380	7.57	+35,815	600,195
MW	200,000	309,172	303,100	+32,333	335,433	4.50	+ 4,565	339,998
EW	200,000	252,560	183,698	+ 8,365	192,063	2.57	+ 5,535	197,598
Subtotal	1,206,200	1,299,420	1,030,178	+61,698	1,091,876	14.64	+45,915	1,137,791
CUMULATIVE TOTAL	2,344,000	2,329,514			2,121,658	28.45	+57,914	2,179,572
Alterations								
BW	225,000	184,184	229,500	+62,000	291,500		+ 8,745	300,245
MW	75,000	61,295	100,700	+ 750	101,450		+10,580	112,030
EW	50,000	39,100	47,172	+38,846	86,018		+ 5,790	91,808
Subtotal	350,000	284,579	377,372	+101,596	478,968		+25,115	504,083
CUMULATIVE TOTAL	2,694,000	2,614,093			2,600,626		+83,029	2,683,655
Suppl. Equip.								
SEW	85,000	96,076	89,387	+ 28,113	117,500		+ 100	117,600
FSW (Bd. share)	15,000	148,010	16,200	+123,000	139,200		+ 185	139,385
Subtotal	100,000	244,086	105,587	+151,113	256,700		+ 285	256,985
Site Devel.								
Contract	75,000	71,662	82,000	+ 31,124	113,124		- 500	112,624
CUMULATIVE TOTAL	2,869,000	2,929,841			2,970,450		+82,814	3,053,264
Bd. of Ed.	--	60,000	60,000	- 60,000	--			50,512
Site dev. Total	(75,000)	(131,662)	(142,000)		(113,124)			(163,136)
Prof. Fees	163,000	167,300			169,333		+12,646	181,979
Furniture	191,400	191,400			191,400			188,420
Miscellaneous								
Survey/Tests/Permits/PLC	80,000	80,000			80,000		(23,971)[s] (23,000)[t]	46,971
Const.Mgt./Security	--	54,000			75,000		(62,419)[c] (8,231)[x]	70,650
Site Acquisition	--	--			--			--
Contingency	196,600	128,459			118,217			12,604
TOTAL	3,500,000	3,611,000**			3,604,400*			3,604,400

[s] Surveys
[t] Temporary Heat
[c] Construction Mgt.
[x] Security

** Includes $111,000 for 75% of FSW estimate
* Includes $104,400 grant for 75% of FSW cost
[1] Costs as computed in 1972 prior to occupancy and reported in "An Assessment of the Detroit Public Schools Construction Systems Program"

COOLEY ADDITION COST ANALYSIS

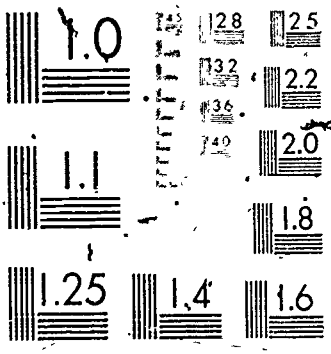


a SUBSTRUCTURE ESTIMATES INCLUDED IN NON-SYSTEM BUILDING WORK

b FINAL FIGURES REPRESENT NON-SYSTEM BUILDING WORK AND SUBSTRUCTURE

c ADDITIONAL EXPENDITURES NOT INCLUDED IN CONTINGENCY:

INSURANCE	5,946
PUBLIC ADDRESS & TV	32,011
COORDINATION & SUPERVISION	57,364
TOILETS	750
FENCE & SIGNS	2,500
[illegible] ESTIMATE & SCHEDULING	9,284
[illegible]NG COST	1,185



MICROCOPY RESOLUTION TEST CHART

CONSTRUCTION SYSTEMS PROGRAM
COST ANALYSIS DATA - JANUARY 1974 UPDATE

COOLEY SENIOR HIGH SCHOOL

ADDITIONS AND ALTERATIONS
AREA OF ADDITION = 105,000 SQ.FT.

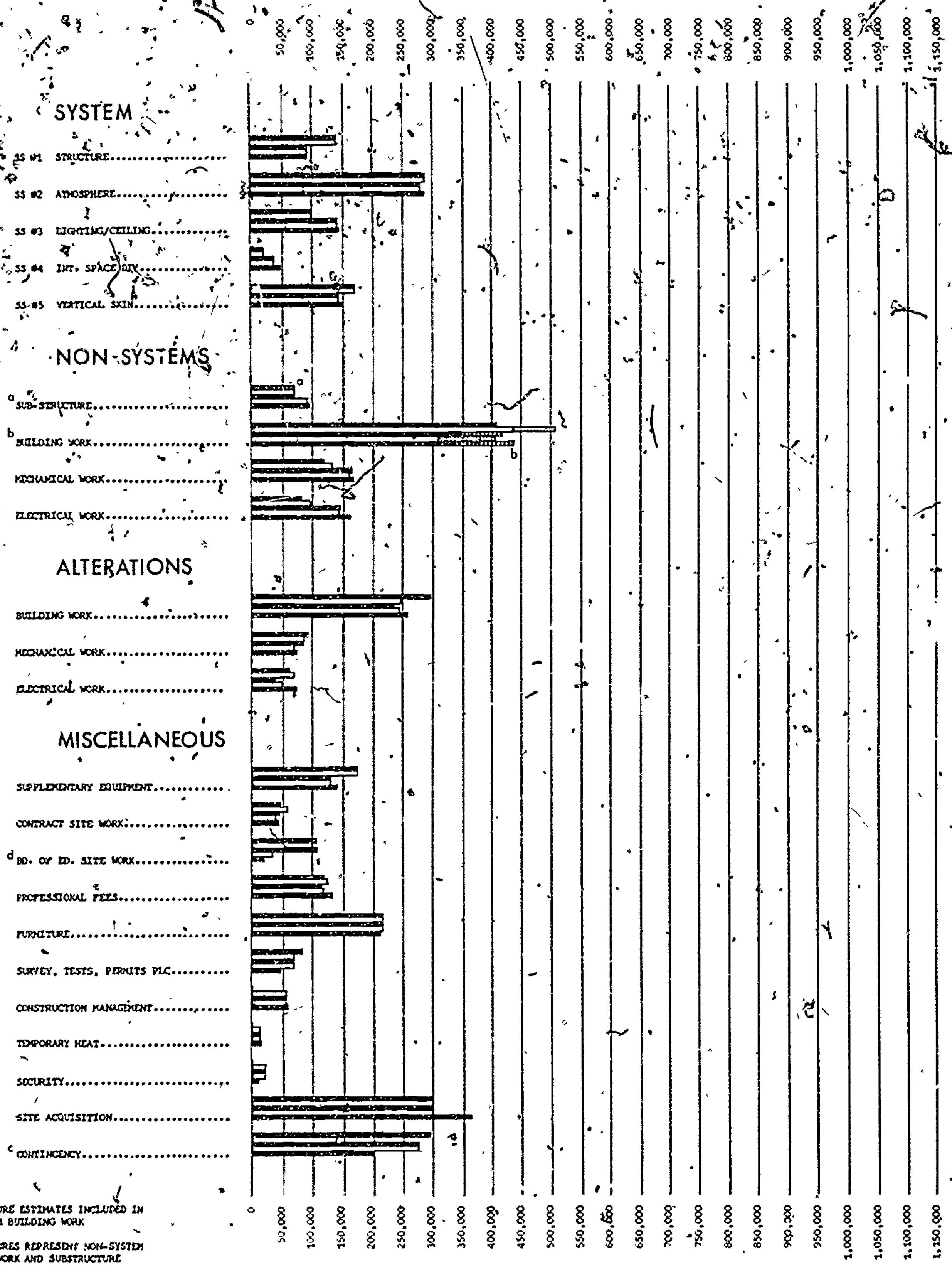
CATEGORY	1 DESIGN MANUAL ESTIMATE	2 ARCHITECT'S FINAL ESTIMATE	3 CONTRACTORS' BID PRICE	ADD/DEDUCT PRE-CONTRACT	4 NEGOTIATED CONTRACT PRICE	COST PER SQUARE FOOT	ADD/DEDUCT POST-CONTRACT	5 COMPLETED COSTS
Systems Work								
SS/1	324,000		318,726	-	318,726		-	318,726
SS/2	680,000		525,000	-	525,000		+ 23,077	548,077
SS/3	207,800		284,219	-	284,219		+ 3,968	288,187
SS/4	97,000		106,500	-	106,600		+ 19,815	126,415
SS/5	175,000		137,641	+ 20,713	158,354		+ 80	158,434
Subtotal	1,483,800	1,392,765			1,392,899	13.26	+ 46,940	1,439,839
Substructure	(incl. in BW)	166,668	166,668	-	166,668	1.59	+ 2,895	169,563
Nonsystems Work								
BW	1,104,662	976,432	905,141	- 5,090	900,051	8.57	+ 23,510	923,561
MW	374,019	509,798	553,900	- 9,092	544,808	5.19	+ 23,930	568,738
EW	112,934	147,157	290,428	- 7,625	282,803	2.69	+ 5,265	288,068
Subtotal	1,591,615	1,633,387	1,749,469	-21,807	1,727,662	16.45	+ 52,705	1,780,367
CUMULATIVE TOTAL	3,075,415	3,192,820			3,287,229	31.30	+102,540	3,389,769
Alterations								
BW	462,000	(605,595)	454,000	- 82,438	371,562		+ 12,675	384,237
MW	68,000	(177,760)	236,800	-124,000	112,800		- 2,850	109,950
EW	70,000	(226,462)	197,954	- 76,576	121,378		+ 16,290	137,668
Subtotal	600,000	(1,009,817)*	888,754	-283,014	605,740		+ 26,115	631,855
CUMULATIVE TOTAL	3,675,415	3,842,820			3,892,969		+128,655	4,021,624
Suppl. Equip.								
SEW			248,359	-	248,359		+ 1,720	250,079
FSW			160,750	-	160,750		- 880	159,870
Subtotal	494,900	494,900			409,109		+ 840	409,949
Site devel. Contract	151,815	255,416	238,168	- 74,499	163,719		+ 5,200	168,919
CUMULATIVE TOTAL	4,322,130	4,593,136			4,465,797		+134,695	4,600,492
Bd. of Ed.	--	80,000	80,000		80,000			78,000
Site dev. Total	(151,815)	(335,416)	(318,168)		(243,719)			(246,919)
Prof. Fees	241,000	255,500			249,393		+ 20,441	269,834
Furniture	477,350	477,350			477,350			494,110
Miscellaneous								
Survey/Tests/Permits/PLC	150,000	100,000			100,000		(93,918)[s] (31,369)[t]	125,287
Const. Mgt./Security	--	54,000			75,000		(70,999)[c] (10,252)[x]	81,251
Site Acquisition	700,000	500,000			500,000			375,000
Contingency	309,520	140,014			252,460			176,026
TOTAL	6,200,000	6,200,000			6,200,000			6,200,000

[s] Surveys
[t] Temporary Heat
[c] Construction Mgt.
[x] Security

*Alteration work directed to be reduced in cost to $650,000

[1] Costs as computed in 1972 prior to occupancy and reported in "An Assessment of the Detroit Public Schools Construction Systems Program."

SHERRARD ADDITION COST ANALYSIS



a SUBSTRUCTURE ESTIMATES INCLUDED IN NON-SYSTEM BUILDING WORK

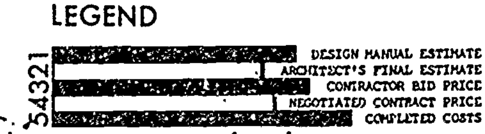
b FINAL FIGURES REPRESENT NON-SYSTEM BUILDING WORK AND SUBSTRUCTURE

c ADDITIONAL EXPENDITURES NOT INCLUDED IN CONTINGENCY:

INSURANCE	2,726
PUBLIC ADDRESS & TV	19,100
COORDINATION & SUPERVISION	31,112
TOILETS	750
FENCE & SIGNS	1,250
COST ESTIMATE & SCHEDULING	8,659
...TING COST	1,103

...ND CONSTRUCTION PLANS CUT BACK IN ...O PARTICIPATE IN OPEN SPACE PROGRAM

LEGEND



CONSTRUCTION SYSTEMS PROGRAM
COST ANALYSIS DATA - JANUARY 1974 UPDATE

SHERRARD JUNIOR HIGH SCHOOL

ADDITION AND ALTERATIONS
AREA OF ADDITION = 44,000 SQ.FT.

CATEGORY	1 DESIGN MANUAL ESTIMATE	2 ARCHITECT'S FINAL ESTIMATE	3 CONTRACTORS' BID PRICE	ADD/DEDUCT PRE-CONTRACT	4 NEGOTIATED CONTRACT PRICE	COST PER SQUARE FOOT[1]	ADD/DEDUCT POST-CONTRACT	5 COMPLETED COSTS
Systems Work								
SS/1	136,500		91,416	-	91,416		-	91,416
SS/2	288,000		284,000	-	284,000		+ 3,662	287,662
SS/3	100,000		138,900	-	138,900		+ 2,559	141,459
SS/4	22,000		37,287	-	37,287		+10,596	47,883
SS/5	170,000		141,220	+ 9,130	150,350		- 689	149,661
Subtotal	716,500	701,956			701,953	15.95	+16,128	718,081
Substructure	(incl.in BW)	93,426	69,646	+23,780	93,426	2.13	+ 3,325	96,751
Nonsystems Work								
BW	406,500	435,187	347,979	-39,586	308,393	7.01	+34,570	342,963
MW	118,500	132,000	161,000	- 2,867	158,133	3.59	+ 6,620	164,753
EW	78,500	99,000	145,569	- 2,070	143,499	3.26	+16,380	159,879
Subtotal	603,500	666,187	654,548	-44,523	610,025	13.86	+57,570	667,595
CUMULATIVE TOTAL	1,320,000	1,461,569			1,405,404	31.94	+77,023	1,482,427
Alterations								
BW	299,750	247,257	232,000	+14,477	246,477		+ 6,740	253,217
MW	88,800	87,500	81,000	-13,412	67,588		+ 1,970	69,558
EW	59,200	64,000	33,800	+16,150	49,950		+18,340	68,290
Subtotal	447,750	398,757	346,800	+17,215	364,015		+27,050	391,065
CUMULATIVE TOTAL	1,767,750	1,860,326			1,769,419		+104,073	1,873,492
Suppl. Equip.								
SEW		159,000	114,961	-	114,961		+ 6,570	121,531
FSW		16,000	14,900	-	14,900		-	14,900
Subtotal	175,000	175,000	129,861		129,861		+ 6,570	136,431
Site Devel.								
Contract	45,000	55,734	44,000	- 6,400	37,600		+ 6,650	44,250
CUMULATIVE TOTAL	1,987,750	2,091,060			1,936,880		+117,293	2,054,173
Bd. of Ed.	105,000	100,000	100,000	+ 5,000	105,000			19,210
Site dev. Total	(150,000)	(155,734)	(144,000)		(142,600)			(63,460)
Prof. Fees	119,300	125,500			116,610		+ 15,730	132,340
Furniture	213,000	213,000			213,000			210,716
Miscellaneous								
Survey/Tests/ Permits/PLC	80,000	80,000			80,000		(44,737)[s] (13,665)[t]	58,402
Const.Mgt. Security	--	54,000			75,000		(58,389)[c] (10,231)[x]	68,620
Site Acquisition	300,000	300,000			300,000			360,103
Contingency	294,950	136,440			273,510			196,436
TOTAL	3,100,000	3,100,000			3,100,000			3,100,000

[s]Surveys
[t]Temporary Heat
[c]Construction Mgt.
[x]Security

[1]Costs as computed in 1972 prior to occupancy and reported in "An Assessment of the Detroit Public Schools Construction Systems Program."

IV. E. DIRECTING PAYMENTS:

1. Background:

The economies derivative from competition are dependent on getting proposals from a number of qualified bidders. CSP planners knew from past experience, reinforced by emphatic consultant recommendations, that Detroit needed to make a special effort to attract competent contractors. Because money is the lubricant to keep construction running smoothly, the CSP-1 subsystem specifications contained certain innovative clauses (General Conditions, Articles 32.1-4) that require the owner to pay approved payment requests promptly or be penalized by paying the contractor claimant an additional amount of interest on the sum of the certificate, based on the then current prime bank lending rate. Careful records of CSP-1 payment processing have documented that steps were accelerated over conventionally-bid prior projects. This fact was perhaps obscured by the multiplicity of contracts and, in the case of several contractors, disputes over completion of work for the final payment request.

CSP was also interested in using money as a stimulant for improved contractor performance. Addendum No..1, "Scheduling Requirements" includes "Payment Incentives" (Article A1.14) to reduce retainage of construction funds to 3 percent from the traditional 10 percent. Further, the following section titled "Assessment for Delinquent Work" (Article A1.15) prescribes a penalty of $300 per day to be paid by each contractor for failure to comply with the published "Project Schedule," if the delay is his responsibility. Such adjustments to pay requests were joint decisions of the management contractor and the scheduling consultant, agreed to by architect and owner. A review of CSP payment certificates reveals that the reward of reduced retainage was extensively used; the per diem penalty was rarely applied.

2. Representative Questions:

a. How did the payment procedures used by the Detroit Public Schools for the CSP-1 projects compare in speed and efficiency with typical prior projects, and what suggestions have you for improving procedures?

b. A system of penalties (per diem charges of $300/day) and rewards (retainage reduced to 3 percent) was used to encourage contractors to perform. How successful was this arrangement?

3. Responses of Owner Administrators, Staff & Consultants:

Every person who answered these questions spoke with praise:

- Payment procedures very much an improvement on CSP-1.
- Improved with CSP. The old way of holding money simply reduced the competition, and we pay for it whether we like it or not.
- Penalty clause, although little used on CSP-1, did accelerate at least one very important contractor.
- Bonus system works. People really dig that!

The only qualification was about the basic premise:

- Most of the crying by contractors about Detroit's slow payments is not valid. If they get the work done, they are paid within a few days.

Recommendations for future action included:

- It would be adequate to have contractors send payment requests directly to architects, with only a record copy going to MC; however, to make this work, architects would need to be up on scheduling better than they were with CSP-1.
- Penalties should be proportional to contract size and urgency, but emphasis should not be punitive. We should try zero retainage for contractors on schedule.
- A bonus syst m for early completion should be started.
- Certain phases of work are critical to schedule, and they should carry heavier penalties for lateness.
- If we had a bonded management company, we could let them handle disbursement of funds and need have very little involvement by owner in accounting.

4. Responses of Project Architects:

Several commented they lacked experience to make a comparison of prior payment procedures. Of those who replied, reactions were mixed:

- CSP-1 payment procedures improved. Requests moved more quickly through Board of Education offices.

- No particular improvement; CSP-1 at disadvantage because of multiplicity of contracts.

- No problems for architects.

- It may have been faster, but it was more difficult because payment requests went to two more offices (MC and CSP).

- System worked. Three hundred dollar a day penalty was enough to stimulate getting job done.

- Reduced retainage worked well. Penalties worked somewhat, but needed more push by MC.

- System of penalties and rewards did not seem to work very effectively; more attention and energy needed by MC.

Recommendations for possible future improvements were:

- CSP-1 procedures worked well, but could have been even faster if pay requests channeled only through architects, bypassing MC.

- Owner could issue a monthly amount of money to MC and let him issue payments directly to contractors.

- We need to link level of pay requests more closely with work performed. "Front end loading" is generally practiced and accepted at every level of the industry.

- Real answer is for owner to be more selective with contractors, and to ban from future work those who do not perform.

- With exception of final payment request, I would recommend zero retainage if contractor is ahead of schedule.

5. Responses of Project Engineers:

(No questions asked on this topic.)

6. Responses of Management Contractor Personnel:

Although not experienced to compare prior procedures of the owner, they evaluated results from general knowledge:

- Pay procedures were better and quicker than a normal job.

- Procedures worked well; all the steps taken were needed.

- There was improvement in pay procedures on CSP-1, according to what I've heard of Board of Education's poor reputation in this regard.

- Many contractors will not bid Detroit work because of reputation for slow payment and indecision.

- Only one architect did painstaking job of checking pay requests.

- Most of slow handling of payments was because of infighting between MC and scheduling consultant.

- Sometimes contractors went around MC directly to architects. I admit we caused some problems with delays, but we belatedly assumed more responsibility.

Regarding penalties and rewards, responses were contradictory:

- Penalty and reward system worked, but was not handled in fair or uniform way.

- Penalty and reward system did not work because these contracts were too small; need more leverage of bigger contracts.

- System did work ultimately; should have started sooner.

- System has merit, but owner pays more for it.

- Penalty and reward system somewhat disappointing; you do not get performance by threatening someone.

- Increasing retainage does work in getting contractors to perform.

Recommendations were:

- Could there be a financial penalty imposed on architect or MC for failure to process pay requests promptly?

- Provide for prompt payment to contractors for complete shop drawings. For pre-engineered subsystems, retainage should be applied to design and shop drawing phases of contractors' work. This might encourage better interfacing.

This last item involves industry participation in design, a topic considered more completely in Sections III C & D, where similar suggestions appear.

7. Responses of Contractor Representatives:

Predictably, contractors had strong opinions on the topic of being paid (or not paid) for their services:

- Payment procedures were very good and very attractive on CSP-1.

- Process was pretty good; Detroit is OK!

- Pay procedures of owner were OK -- except for that horrendous final payment. In that regard, CSP was no better than other work.

- There was improvement on CSP. Only problem was in tie-up of paperwork at MC's office.

- Money talks. Whoever controls payment controls job. MC had all the authority they needed to coordinate work, but they didn't use it.

- It should be defined in contract documents, how and when pay requests will be handled.

Several stressed the important relationship between payment and economy of construction:

- Prompt payment has a very important bearing on the pricing of a project.

- CSP procedures were excellent. We do not bid work for slow payers. After we got adjusted to the routine there was no problem.

- CSP an improvement. On a future job we would bid more favorably if we knew payments would be handled as quickly.

They were generally satisfied with the inducements:

- Penalties and rewards worked for CSP, but penalties were inadequately enforced.

- System worked well; reduced retainage good.

- System worked well, except we don't take threats of penalties seriously. I don't think anybody ever prosecuted a penalty successfully.

- Detroit retainage payment policies more than generous. Only problem was in getting paperwork through architect's offices.

c. SUMMARY of RESPONSES on DIRECTING PAYMENTS:

Nearly all persons who replied to these questions had praise for the efforts of CSP in handling construction-related money matters expeditiously. The owner's group were pleased, perhaps because they know better than others what had occurred previously. Of particular significance -- since it is they who wait for the money -- was the extremely favorable contractor reaction. Part of this is attributable to former subcontractors or suppliers enjoying their prime contractor status, and not having to wait for a general contractor's largess. Architects had a mixed response, but a careful reading seems to reveal most of their objections pertain to the multiplicity of contracts (12 separate prime contracts on each school) and the attendant paperwork. There were other criticisms of the processing sequence (contractor to MC to architect to CSP) before the approved payment requests actually reached the owner's business and accounting office.

In a multi-project program with multiple contracts, not everyone can know everything that is going on. Therefore, some of the replies on penalties and rewards appear more contradictory than they are. One contractor may, in fact, have had a totally different experience from another. The fact that the overall work was completed on time would seem to indicate the success of the process. However, explaining why is more complex. Attracting good contractors -- and rewarding their efforts -- seems vital. The effect of penalizing poor contractors, which was done very little on CSP-1, is less clear. It is significant that not only the management contractor personnel but some contractor representatives recommend more diligent enforcement of penalties. Throughout most of the responses there is recognition of the need for stronger control of construction administration.

V. A. CONTRACTING for MANAGEMENT SERVICES:

1. Background:

For Detroit schools, as for many other institutional owners, the historic pattern had been for owner's staff and architects to provide contractors with very extensive off-site support (expediting, approvals, et cetera) and on-site supervision during the construction. Although such activity may not have been labeled "management," that is, in fact, what much of it was. As explained in the introduction of this report, these procedures in Detroit had grown increasingly slow and cumbersome. Prior to CSP-1, a few school districts in Michigan and elsewhere had, with apparent success, consolidated some of these diverse responsibilities under what they termed "construction management" (CM). Such services cover a great range of options and must be defined for the needs of each individual project. In addition to on-site supervision, CM may include: 1) design participation, such as material selection; 2) scheduling; 3) budgeting and estimating; 4) coordination of inspections, tests, permits; 5) labor negotiations over jurisdictional disputes; 6) the broad category of "paperwork" related to processing shop drawings, payment requests, progress reports, job-site records, et cetera.

Although CSP had from its inception proposed to "early bid" subsystems, the plan was to assign the approved subsystem contractors to a general contractor who would have "an overall coordinative managerial responsibility." Subsequently, it was decided to experiment with a different type of arrangement similar to "construction management." However, because the proposed services were to be limited both in scope and duration, a slightly different name was selected: management contractor (MC). As it evolved, construction phase responsibilities were shared by the owner (represented primarily by the construction coordinator), by an independent scheduling consultant, and by a firm (management contractor) designated to provide continuous on-site field supervision, expediting and coordination. After considering a number of candidates for the latter role, Detroit selected a firm that was a new subsidiary of an established general contractor organization. On-site construction was just beginning and so the problems were practical and immediate. The MC was paid on the basis of a negotiated lump sum professional fee. The role was unfamiliar for everyone involved, and the following section is an attempt to probe how all participants responded to the new player on the building team.

2. Representative Questions:

a. How successful or unsuccessful was the management contractor arrangement used for CSP-1 schools, and how might it be improved?

b. Would you expand or alter the management contractor responsibilities, or would you recommend earlier involvement in design and scheduling phases?

3. Responses of Owner Administrators, Staff, & Consultants:

The arrangements were praised by a sizeable majority:

- Overall management good.
- MC did very well.
- Fewer crises using MC.
- On a multi-project program, MC can alleviate arguments between architects.

There were two dissents:

- MC performance went very badly; they were not prepared for nature of the task.
- Outside-management not desirable; owner's own in-house team should be developed.

Although most respondents endorsed the management of CSP-1, nearly everyone had auxiliary opinions and/or recommendations for improvement. The most common were in regard to start-up time:

- MC should be expediter for delivery; should be hired early -- certainly by time subsystems are designated.
- MC should be hired by time architect begins design.
- Should start early to get involved in code problems and scheduling.

Despite virtually unanimous agreement that the MC should begin work sooner, there was a wide range in ideas on scope of management duties:

- We would have been better off to have included responsibilities for scheduling and cost estimating, and to have had less field supervision from owner's staff.
- Responsibilities should include design review and scheduling and such "General Conditions" items as clean-up and security.
- MC should be given greater financial freedom and authority; should have discretionary funds, with bi-weekly review by owner.

Although most respondents saw need for expanded and early management services, they gave totally contradictory recommendations as to who should provide them:

- An architect could provide the same service.
- Dominant role in directing project must remain with architect.
- None of the architects had knowledge and experience necessary for MC responsibilities.
- Architects do not have the knowledgeable construction field superintendents who are needed.
- Owner could do MC job better.
- Owner not capable of providing MC services; nonetheless, vigorous owner participation is very important.
- We should consider use of a nationally-successful construction management firm.

Several respondents concluded their observations with variations of the following recommendation:

- Choose MC on basis of qualifications -- not cost -- and keep him independent and free of political pressures.

4. Responses of Project Architects:

A slight majority expressed dissatisfactions with the MC arrangement:

- Use of MC counterproductive -- a bust! Just another conduit for paperwork which increased the cost and time of doing business for us.
- MC not very successful; responsibilities not clearly defined.
- Underlying assumption is that paying a contractor a "professional fee" is going to make him honest; the implications are insulting to contractors.

However, there were also more sanguine views:

- Necessary for a multi-project program.
- Advantage of MC is that he is more objective and independent. It's a better arrangement than having a general contractor who is primarily concerned with his own financial venture. Also, advantageous in attracting some other types of bidders who do not like being assigned to a general contractor.

Some architects who felt their authority was diluted by use of MC want to expand their role:

- We can do it -- and have done it.
- Most architects could and should be able to provide MC services as well as scheduling and cost consultation.

When specifically asked about taking on the MC tasks, two architects backed off, saying:

- Architect could do it if he hired specialists.
- We could not provide MC services, nor could many architects.

However, one summarized:

- Architect has to change his role to get more involved in total process of construction. Management services are coming. In the future, drawings may be incidental because, if you're geared into "systems," all the preliminary thinking has gone into schematics. Architect's work may be 10 percent drawings and 90 percent management.

Despite the reservations of certain architects about the advantages of having a management contractor, they were unanimous in recommending having the MC on the job earlier than on CSP-1. Other recommendations -- many of them contradictory -- included:

- MC needs stronger and more central authority.
- Add scheduling and estimating to MC responsibilities.
- Assign all contracts to MC and make him a GC.
- Jobs need more energy and follow-up from MC than was evidenced on CSP-1.
- MC should be selected on basis of ability -- not price.
- All MC services should be done by owner.

5. Responses of Project Engineers:

(No questions asked on this topic.)

6. Responses of Management Contractor Personnel:

Obviously, these interviewees had a stake in pronouncing this -- their first experience with this type of management -- a success. However, all admitted imperfections that they explained thus:

- Some contractors' attitudes poor.
- Architects failed to do all they should.
- We may not have taken full advantage of authority.
- Started slow; failed to grasp responsibilities. MC became increasingly effective.
- MC failed to crack down on late performance by some contractors.
- MC got bogged down in paperwork in CSP-1 -- particularly with shop drawings -- but that was not necessary. Much of it could have been handled by MC field superintendents at jobsite offices.

All recommended an earlier start and, generally, more comprehensive involvement:

- Successful arrangement but could have worked even better if MC started sooner.
- Hire MC at initial planning stage.
- At absolute minimum, employ MC before start of bidding and detailed scheduling.
- Earlier involvement should include cost and scheduling responsibilities.
- MC responsibilities should include some on-site work, particularly clean-up.
- MC would be more effective with authority to hire subs for work not done by contractors, then backcharge contractors.
- MC should take over many architect responsibilities, such as material selection, preparation of bid packages, and bid evaluation.

When asked an auxiliary question as to whether MC duties could be handled successfully by the owner, they replied:

- Owner could not do it as well.
- It would not work for owner to do MC job because of difficulty of getting rapid, independent decisions.

- Does not matter if MC is public or private; you need doers, not thinkers. That's why contractors would be better than architects.

- Yes, owner could do it if a small separate office was set up like CSP.

- No, owner should be totally separated from management activities.

7. Responses of Contractor Representatives:

Every person but one in this category had praise for the basic MC arrangement, although many had qualifications:

- Very successful; could be improved.

- Concept OK, but MC was sometimes a bottleneck.

- Successful, but MC stumbled; authority degenerated. Biggest problem was in their handling of shop drawings.

- Very creditable job. Systems projects function better with MC than GC.

- Fine! It would be even better if architect was MC, but most are not capable of doing it.

The only dissenting opinion:

- Not very successful. You're looking for a superman who doesn't exist.

Many recommended modifications to the MC role, such as:

- Earlier involvement. The CSP-1 projects were so different the MC was at a real disadvantage.

- MC should be employed by start of bidding.

- Responsibilities should include scheduling.

- Architect services should be limited only to design phase; then architect should be terminated and building process turned over to MC.

- Much paperwork could be eliminated if shop drawings went directly to architect, with only copy to MC.

All the contractors praised the CSP-1 decision to give MC authority to issue "instant" change orders up to $500 without formal owner approval.

To a supplemental question on who is best qualified to serve as MC, most reiterated their satisfaction with CSP-1 arrangement of using an independent affiliate of a general contracting firm. Two added:

- Could be owner or architect, as long as whoever has the designation has got the authority.
- The owner should stay out of construction phase completely. The architect can see that school is built. The owner should just get out!

8. <u>SUMMARY of RESPONSES on CONTRACTING for MANAGEMENT SERVICES</u>:

By and large, the management contractor came out with high marks from a diverse group of participants. Not surprisingly, the addition of a new player on the building team caused a few existing members a sense of anxiety. Most owner's staff liked the arrangement, but some are unwilling to set aside the architects' dominant role. Also, a few of the owner's staff prefer their prior position of inspection authority. The architects were the most disapproving, perhaps because they recalled some construction phase conflicts with the MC. However, most architects endorsed extending the management concept. Predictably, the managers themselves were supportive, but they are convinced the process can and should be improved another time. Of special significance is the strong support from contractors because one of Detroit's major cost/time construction problems (as diagnosed by several prior consultants) has been its failure to attract interested competent bidders. From every group there were recommendations that MC services be extended in time by an earlier start and that the management group be given authority for more decisive action.

Nearly everyone agreed that the construction process will continue to stumble without strong leadership of both on-site construction activities and off-site support services. The contradictions in the answers as to who should provide the needed leadership are reflective of the widespread debate in the industry about the efficacy of "construction management." These interviewees had disparate views as to whether management services should include design phase consultation, budgeting, estimating, agency review procedures, and such activities as shop drawing review, payment requests, reports, and records. However, they agreed that the owner group could not effectively undertake all these diverse responsibilities. The implication is that some kind of efficient controlling organization -- whether it is called MC or CM or carries a different label -- be established for each project or group of projects.

V. B. SUPERVISING CONSTRUCTION:

1. Background:

Although the most vital decisions affecting a project's cost and time may be made much earlier during programming and design, the single most troublesome aspect of building is supervision -- when action is taken on judgments as to whether an owner is getting his money's worth. That is when most of the personal confrontations occur, and when decisions are made under intense scheduling pressures. Supervision is a province that always has created distress for owners, whether the tasks are theirs or are assigned to an architect. In Detroit, supervisory responsibilities have usually been shared between architect and owner's in-house staff -- to no one's complete satisfaction.

In structuring CSP-1, and in deciding to use a management contractor for the multi-project program, there was no illusion that all the supervisory problems would vanish, but an attempt was made to keep a better watch on construction by having the MC assigned "administration, expediting, and on-site supervision for all contracts," including responsibility to "arrange and conduct job-site meetings." Under terms of this owner-manager agreement, however, only the architect was to "authorize deviations from contract documents," or "approve shop drawings, materials, . . . tests and inspections." The MC was required to provide full time supervision at each of the projects. The architect's standard contract outlining responsibilities for "Administration of Construction Phase," including inspection, was unchanged.

Because of recurring contractor and architect complaints, dating back many years, about the multiplicity of owner representatives and other redundant inspection authorities, the effort was to channel all owner input through one person called "CSP Construction Coordinator." In essence, the architect would judge quality, the MC would judge quantity, and the "Construction Coordinator" would provide information and owner approvals needed to keep all projects moving swiftly.

2. Representative Questions:

a. Were the responsibilities of field supervision adequately handled for the CSP-1 projects, and have you suggestions for reassigning these responsibilities between management contractor, owner, architect, or consulting engineer?

b. In another program for the Detroit Schools would you favor a continued active role for the owner in the person of the "Construction Coordinator"?

3. Responses of Owner Administrators, Staff, & Consultants:

Reaction to the question on adequacy of field supervision split the owner's group right down the middle. Half believed performance standards were met and supervision was adequate; the other half believed some items were not inspected rigorously enough. Ancillary questions revealed confusion as to who should be primarily responsible for on-site inspection and, in particular, the aspect of quality judgment:

- MC should verify quality; I cannot think of anyone else who should be responsible.
- Only architects and engineers should judge quality.
- Verification of quality joint responsibility of MC, owner, and architect.
- The schedule did put extraordinary pressures on architects to approve some items of questionable quality. No doubt they could do a better job if their fee was increased to cover full time on-site inspection and some off-site in-plant inspection.
- Maybe we'd better stop looking for an architect with field experience, and just hire inspection services separately.

There was general agreement that the owner should be represented by only one person. Several believed all projects could have succeeded better with less owner participation:

- Owner needs a continuous active role, but it would be desirable to be less embroiled than we were with CSP-1. MC should be owner's "rep" during construction.
- Great responsibilities thrust on owner partly our own fault because architects often selected by a political process, rather than chosen by competency of work.
- Retain a single representative for owner, but he could be part of MC team. MC could be the architect, but he must have scheduling, supervisory, and fiscal abilities.
- We should have only one representative; however, the person is more important than the position. Direct, honest communication is key to success.

Despite their desire for a simpler owner role, nearly all concluded that owner isolation is unfeasible:

- Active owner role inevitable for multi-project program including more than one architect.
- Owner role must be a vigorous one; must maintain continuity of personnel or management team will be virtually unguided.

4. Responses of Project Architects:

On adequacy of CSP-1 supervision, the initial response was mostly positive:

- Work was OK.
- We did everything we could to insure good quality.
- We rejected unsatisfactory work, just as usual.

However, every interviewee wanted to add certain qualifications. One was emphatic, as well as misinformed:

- It was not the architect's responsibility to watch or judge quality and installation. We assisted the owner, but it is owner's responsibility to match specification's quality. It is difficult for us to accept responsibility when we did not have full control of design and specifications.

The preceding comment alludes primarily to the use of the bulk bid subsystems. Although the architects had agreed to use performance specifications and had reviewed the specifications in their preparatory stages, there was some feeling they did not have their usual obligation to inspect subsystem installation. Actually, the owner-architect agreement was comprehensive and conventional, and the ordinary obligations were recognized by some:

- It is architect's responsibility to verify quality -- even if they do not like everything they see.

Another had less noble motives:

- We do not necessarily want responsibility, but accept it because we do not want to alienate a client involved perpetually in construction.

A majority of architects were not satisfied with the overall situation regarding supervision. Most of their comments reflected some measure of helplessness:

- Architects did not feel they had right to reject off-site manufactured items for which they did not prepare specifications. Perhaps architects had more control than they thought.

- Architect cannot really approve a product unless he has authority to hire an independent testing laboratory to verify quality. An architect is reluctant to stick his neck out.

- Architect does not have the leverage to control problems of bad workmanship and poor quality materials.

- Architect is capable of providing supervision, but responsibility was diluted on CSP-1. We need a clearer definition.

- If there were any defects, we couldn't stop to correct them because of need to stay on schedule.

5. Responses of Project Engineers:

Adequacy of supervision was not a worry for these respondents. When asked who had responsibility for supervision, they all recognized they had an active role:

- It is engineer's responsibility to supervise. MC should not be making out a final punch list. MC, like the owner, should rely on design professionals for technical judgments.

- Supervision should be shared between MC and the architect or engineer.

One volunteered:

- We would like to "sell" more field supervision. That is, we would like to increase our fee to provide more time, but most clients are not willing to buy it.

Unsolicited comments emerged about the relationship between supervision and subsystems:

- Basic problem is in trying to work with schematic drawings and performance specifications. Contractors failed to demonstrate completely the test results. More tests should have been required and performed.

- When you use a performance specification, you let in all the cats and dogs.

- If you're going to use performance specifications you should narrow latitude; choices should be reduced.

Despite the consulting engineers' usual dismay with anything "pre-engineered," they apparently felt able to supervise and to assure the owner he had gotten what was specified. In response to an auxiliary question about the owner's participation, the engineers were unanimous in their compliments:

- Owner's role in jobsite activities very good and helpful.
- Owner's "rep" valuable in getting answers and information.
- Yes, quick responses important.

However, one cautioned:

- Owner should only get involved if absolutely necessary, as when there is a sizeable cost adjustment; otherwise, owner should stay away and let MC do job he was hired to do.

6. <u>Responses of Management Contractor Personnel</u>:

They expressed belief that supervision was adequate, but they felt they had insufficient help from the architects:

- It's a grey area. Responsibility should be shared by MC and architect, but architect is not around enough to do it. On my job, architect was hardly ever at jobsite, and never showed up for meetings, to boot!
- Architects had ultimate responsibility, but they were often away, and it fell to MC.
- Should be the architect, but they claimed they were not paid to make quality judgments.
- MC is an enforcer, but he cannot replace professional judgment of A-E.
- Certain architect rather uncooperative. He would just say, "You take care of it."

Although most blame was directed at the architects, the MC interviewees were also critical of the owner:

- Greatest need is for owner to clean up his own internal red tape.
- All owner needs is one capable man. We had too many others hanging around.

They felt strongly on the benefits of solo representation from the owner. Asked about the "Construction Coordinator," they said:

- Quite effective! Another time keep it just as it was.
- Usually, we could get answers without going through a lot of people at owner's offices.

- Yes, such a person is required; however, sometimes contractors used his presence to beat schedule to death. Sometimes owner got a little too involved.

- Owner's "Construction Coordinator" should be one -- and only one -- person who starts early and sticks with the job.

7. Responses of Contractor Representatives:

Most expressed satisfaction with the supervisory procedures. However, one candid contractor said, "Supervision not adequate," and then refused to make further comments. Certain others expressed themselves in ways to make an owner wary:

- Quality OK. Basically, it was left up to contractors to perform.

- Supervision was handled properly. Jobs were profitable!

Although the contractors generally had favorable comments on the management arrangement (refer to page 128), it was apparent some were uneasy with the shared supervisory authority:

- Contractors should be able to go directly to architects or engineers for answers without going through MC.

- Architects were not in control.

- MC should be able to do it all.

When asked about the owner's role in field supervision, a few contractors voiced complaints:

- CSP office did not have control it needed.

- Anytime you get an owner on the job, you got problems.

- Multiple layers of inspections make Detroit's jobs cost more.

However, the majority had high praise for the owner's role in CSP-1:

- Very definite time saving for contractor in having owner's "rep" close at hand to help with decisions affecting money.

- CSP office very prompt and helpful.

- CSP office made tremendous effort to help. Really great!

- Excellent relationship with owner; much better than on most projects.

- Success due to single owner's representative who was fair and created an independent atmosphere and who got decisions quickly.

- Owner's role in CSP-1 was well planned and executed.

8. SUMMARY of RESPONSES on SUPERVISING CONSTRUCTION:

Although most respondents in all categories recognized the unique problems of supervising multiple projects and were sympathetic to the experiment of sharing responsibilities with a new "partner," the management contractor, many problems that always have plagued construction supervision persisted. Contractors, understandably, resist supervision and always will; however, they welcomed the owner's efforts to consolidate several inspection authorities in one "Construction Coordinator." So, too, did other respondents asked to comment on that topic. The MC's work was principally supervisory -- a new experience for men with general construction backgrounds who were accustomed to doing the work themselves. They would have liked more help from the architects.

Although the owner-architect agreement was a standard one, some architects felt that use of performance-oriented subsystems absolved them of supervisory functions. Only one architect-respondent was truly adamant on that point, but the problem emerged with others, as well as with the engineers. The experience emphasizes the importance of defining more clearly what the owner expects in supervision (including review of shop drawings) of "pre-engineered" components for building. The fine points of CSP-1 responsibility assignments (i.e., quality for architects and quantity by MC) were not understood by many. And, although their colleagues on the building team would like the owner's staff to be unobtrusive, the indications are that an active owner participation will be required. The development of construction management nationally reflects, to some extent, the feeling of owners that they must buy more supervision than they have been receiving from design professionals.

V. C. COMPLYING with TESTS & CODES:

1. Background:

As used in connection with this building program, the word "tests" refers to documentary proof that materials or assemblies meet standards of performance outlined in the specifications. Compliance with "codes" refers to legal requirements of city or state regulatory bodies. CSP-1 performance specifications for subsystems placed unusual responsibility on bidders for compliance with both test requirements and codes. However, architects and engineers, working under the traditional agreement with the owner for design services, were not relieved of their responsibilities. Also, the city building department continued to insist that documents be marked "Approved" by the architect-of-record. Nonetheless, the overall pattern was a shift of initial compliance to the manufacturers or contractors who submitted bids.

Actually, another transfer of responsibilities commenced earlier, far in advance of the preparation of contract documents, when the owner initiated early liaison with the regulatory agencies. The CSP office, through its Advisory Committee, had sought contact with state officials concerned with building regulations. Also, the CSP office arranged several very early meetings between its systems consultants and the city building department. Later this liaison was reinforced by employment of a CSP codes consultant. As a result of the early contacts, a number of important decisions were made including; 1) revision of city codes covering area limitations, 2) changes in live load structural loadings in classrooms, 3) permission to use plug-in electric wiring for flexible ceiling lighting. Although the owner was involved much earlier and more intensively with building code considerations than had ever occurred previously, there still were problems. Some of the difficulties were generated by a state fire law (enforced by city inspectors) which was in process of revision throughout the entire period of design and construction. However, the fundamental question is who on the building team must take primary responsibility to see that specified standards are met, and that governmental regulations are followed.

2. Representative Questions:

a. Were testing requirements included in CSP-1 specifications adequate, or are there improvements you would recommend in testing procedures for a future program?

b. Have you suggestions for changing the process of dealing with regulatory agencies in securing permits and code approvals?

3. Responses of Owner Administrators, Staff, & Consultants:

Although several from this group said CSP-1 testing was adequate, most felt the owner would be better served by more extensive tests. Rather than waiting for the design professionals to act, they felt the owner must take the initiative:

- Owner should be more consistent and explicit in identifying testing requirements; should clarify who will pay for tests.
- More tests would be better; owner should make specific advance cost allowances for testing.
- Test data should be submitted by contractor-bidders prior to contract awards.

Mention was made of the need for better tests of: 1) acoustics (both through-wall and ambient noise level of HVAC); 2) roofing. To a related question about value of a test structure, most answered it would not eliminate need for specific tests of actual buildings.

They lamented problems associated with securing approvals:

- Contractors need help from owner in obtaining regulatory agency approvals; however, owner cannot assume responsibility.
- Traditional interpretation (derived from state law) is to hold architect-of-record responsible for code compliance. Owner needs to investigate legal ramifications, as we seek to shift some or all code compliance to component contractors.
- There appears a vast lack of knowledge of building codes on the part of both design professionals and contractors.

The most specific recommendation:

- CSP-1 had unclear, overlapping and intermittent code interpretation involvement by owner's staff and others. In the future, the owner needs one competent codes consultant continuously available.

4. Responses of Project Architects:

Nearly all the architect-interviewees expressed approval of CSP-1 testing. Most of them could foresee benefits to the owner in expanding scope of testing. They recommended further tests on: 1) soils; 2) demountable partitions (noise transfer, rigidity, durability); 3) acoustics within instructional areas; 4) lighting levels; 5) fireproofing of structural steel. All architects rejected as impractical the idea of a prototypical test structure. Most recommended securing validated test data prior to contract award.

One architect failed to grasp the concept of new responsibilities given to the construction industry through the use of performance specifications:

- It doesn't behoove us to require tests from contractor-bidders except under unusual circumstances. An architect already has an idea if a manufacturer is meeting performance criteria, and it is unreasonable to ask him to incur more expense.

The predominant view, however, was different:

- It is in owner's best interest to require tests.

Most complained of code approval problems:

- Public agency work -- particularly by the electrical utility company -- was a serious delay; so were regulatory inspections. All these steps require very careful advance scheduling.

One architect summed up:

- There were delays with code approvals with CSP-1, but no more than normal with school construction.

5. Responses of Project Engineers:

Requiring test data and reviewing it seemed a normal exercise to the engineers. Most felt CSP-1 requirements had been reasonable. One asked for more complete air balancing reports from the HVAC contractor. All rejected the idea of a test structure except for a very large multi-project program. Two stressed the need for tests from independent testing laboratories, particularly for new products:

- It is contractor's responsibility to demonstrate test results; it is engineer's responsibility to inspect, but we failed to do this adequately on CSP-1. More tests should have been required and provided.

Three of the engineers had encountered very few problems with codes or permits, and seemed satisfied to have the contractor-bidders secure necessary approvals. One commented:

- The city's building department was very cooperative.

Another engineer, working in another specialized area had a different view:

- We tried to anticipate problems, but fire marshal's office will never give definite or final answers. There is no solution for the problem of governmental agencies changing their minds.

6. Responses of Management Contractor Personnel:

Virtually all these respondents were satisfied with CSP-1 test requirements. One suggested additional testing data on air volume and balancing. Another commented:

- At first we didn't really understand our responsibilities for seeing tests were conducted; we fell down on checking backfill and concrete.

Most agreed that a test structure would be impractical:

- That would be expecting a lot from industry and would probably deter local contractors involved in bidding.

The recurring problem of assigning responsibility for component coordination was further exemplified:

- A test structure or model is a good idea, but it comes right back to architect who is designing interface.

Managers were not involved in early phases of building permits and code compliance, but they had extensive exposure to on-site regulatory agency inspections. They all agreed that this aspect causes serious snags:

- Whole problem is that fire marshal's opinions are so untimely. Inspections need to be scheduled and accomplished much earlier.

- Fire inspections are a farce; no clear answers; ridiculously non-committal. Inspectors not only do not study plans, but they lack knowledge of their jobs.

7. Responses of Contractor Representatives:

Not all had contact with requirements for providing test data, but most who did had no objections:

- Each manufacturer should have his own test facilities -- or hire it done by an outside laboratory -- and be able to document or demonstrate the required results.

- Tests should be very clearly spelled out in the performance specifications.

One contractor-bidder complained:

- Underwriters' Laboratories tests are so expensive that competition is limited. Only one company may have test data, giving unfair advantage to a large corporation.

Contractors were almost unanimous in describing difficulties in securing permits or code approvals:

- Biggest problem is with fire marshal who asked for innumerable changes.

- City inspection charges are unreasonable.

They were emphatic about wanting to unload these problems:

- Performance specifications put responsibility for code compliance on contractor. How can contractors know all state and city codes? Architects should do this work.

- "It should not be responsibility of contractors to get regulatory agency approvals. I know CSP-1 contract documents called for us to do this, but there are a lot of things we take for granted, qualify, or take someone else's word.

- National maufacturers have no idea of intricacies of state and city codes. It is better to give code compliance responsibilities to local architect.

- Despite attempts to thrust code compliance on contractors, problems will recur. Owner has to get heavily involved and to publicize the problem of unreasonable demands by state and local governments.

- Owner should get code approvals.

Agreement as to a recommendation was typified by:

- Only way to help with permits is to start early.

- There's no real solution with codes dilemma except pre-bid meetings and close personal contact with regulatory agency officials.

8. <u>SUMMARY of RESPONSES on COMPLYING with TESTS and CODES:</u>

A basic concept of this and other systems programs has been industrialization. Intrinsic are benefits derived from industry's ideas, in addition to its potential for productivity. Inevitably the greater involvement of industry has brought contractor-bidders into component design and, ultimately, into controversies over standards and regulations. Judging by the responses to the questions in this section, no one objects to requiring stringent test data of contractor-bidders. Even the contractor representatives are attuned to that idea. Owners and architects urged broadening the scope of testing beyond that practiced in CSP-1. Representatives from two other groups suggested that past requirements are adequate, but more rigorous enforcement is needed.

The answers about compliance with governmental building codes were less clear. The owner's group foresees their own sustained active role, but certainly doesn't want full responsibility. The management contractors, who were closely involved with on-site inspection problems, felt most strongly about the inefficiencies, inconsistencies, and scheduling delays of the present procedures engaged in by regulatory agency personnel. However, it was the contractor representatives (to whom, more than anyone else, code compliance is sometimes a painfully expensive experience) who spoke most anxiously about unloading this responsibility on someone else. The one idea that would achieve wide agreement with all these groups is, when it comes to codes, responsible parties should start early to promote liaison, collaboration, and accord.

V. D. COMPLETING & EQUIPPING the BUILDINGS:

1. Background:

Construction projects seem always to lag and falter over their own complexities. Then, if they are to be finished on time, they grow crowded and pressured in their last critical period of building. The CSP-1 projects were no exception to the pattern. During the early months the job sites had seemed quiet to the point of being undermanned. Mostly, this was the result of fabrication of sub-systems components off-site. The last weeks were, by contrast, frenzied. Occasionally, inefficiencies seemed apparent as non-system tradesmen jostled to complete their work. The final stages of equipping the new buildings was highly complex, especially in the altered areas of existing schools where the logistical problems of moving or storing furniture were acute. Most of the spaces, new or altered, were equipped on time. However, as the buildings opened for students, a few special subject areas were still un-equipped, and had to be kept out of service temporarily.

Historically in Detroit schools delays in securing equipment have been troublesome, particularly in vocational-technical subject areas where curricular specialties are highly departmentalized. Procedures of planning, purchasing, and installing equipment are handled by the owner organization through a series of six or more separate departments. Except for architect-planned cabinetry and food service equipment, furnishing and equipping of buildings (including communications systems) was not part of the CSP responsibility. However, architects and engineers were expected to adjust to the traditional procedures and the requirements of owner-purchased equipment. In this final section on completion of the buildings, participants involved with equipment aspects were given an opportunity to comment about their experience, along with their more general observations on construction operations.

2. Representative Questions:

a. In what ways could construction be accomplished more easily and successfully?

b. What recommendations do you have for improving the coordination or the installation of owner-purchased equipment?

3. Responses of Owner Administrators, Staff, & Consultants:

Answers to the initial question tended to be random. Overall, however, they constituted an endorsement of basic CSP-1 principles:

- Expand systemization.
- Achieve greater uniformity of owner requirements.
- Phase bid multiple contracts, particularly earlier bidding of items critical to schedule.
- Encourage technological innovation by industry via additional areas of performance specifications.

A number again chose to speak of architect selection:

- No need to give each project to a different architect. Give multiple projects to one firm.
- Owner needs to exercise greater care in choice of architects.
- Owner too involved. We should get good architects and then rely on them completely.

The most emphatic comments were directed at their own organization:

- Real problem is delegation of adminstrative decision-making responsibility within the owner group.
- Problem is not so much technical. Owner needs much greater awareness of administrative procedures in other cities, including research into unsuccessful or terminated programs as well as successful ones.
- CSP-1, which is in my judgment a successful way of building better than before, will result in some changes in relationships and responsibilities within the owner organization. The next step is the challenge: How do you bureaucratize what you have learned as being successful in improving the construction process?

More than other participants the owners suffered the embarrassment of having CSP-1 school space finished precisely on schedule while leaving a few rooms unusable because certain owner-purchased equipment was months late in being ordered and delivered. On this rather sore subject, the respondents were unanimous in suggesting, "Start sooner." However, there are further complications:

- Problem is with our own staff who did not seem to know spaces were going to be available. There are at least five different departments involved within owner's central staff organization, and no overall control.
- Delays were result of educational staff disputes over who has authority to decide what equipment goes in schools.

- Owner's staff not adaptable to rapidly-built schools; they simply did not believe schedule.

- Part of problem is lack of standardization which prompts educators to develop new equipment specifications for each school; however, CSP-1 was better than past Detroit school projects in this regard.

- Owner kept changing equipment layouts after original approval.

- We got bogged down in the review process. Sometimes there were as many as nine different layouts for a single space.

- Location of responsibility is an administrative decision which has not yet been made.

There were a few suggestions for improvement:

- Perhaps all equipment should be combined as a subsystem interfaced with other subsystems.

- Owner needs greater standardization of special subject rooms.

- I would like to see an architect's capability directed toward this problem.

- There is a need for bulk purchase by grouping equipment orders.

- The situation may eventually change if we have more CSP's because the educators would finally begin to see the reasons.

On the special considerations involved with communications systems, one added:

- Owner should make all audio-visual, signal, and communications work part of architect's responsibility, rather than contracted separately by an in-house group as currently practiced.

4. Responses of Project Architects:

Rather than focusing on the construction phase itself, all these respondents answered the first question by amplifying personal concerns about preliminary phases:

- Improve scheduling through greater participation by everyone involved in building team.

- Establish higher design qualities in the performance specifications.

- Eliminate vertical skin subsystem, and thereby eliminate visual pollution.

- Get regulatory agency approvals earlier, and seek to make them more definitive.

- Reduce time spent on project advisory committees.

- Encourage a greater number of bidders.

- Completely detach systems program from Board of Education operations.

- Revise specifications to put greater emphasis on durability; we need to recognize destructive tendencies of children.

Apparently architects see few opportunities for improving construction completion phases because their only suggestions were very general:

- Define responsibilities more clearly for MC and architect.

- Quicker responses from owner are needed.

Architects were concerned about delays that occurred in equipping certain rooms, and they responded sharply and unanimously:

- All the delays were in the owner's operation.

- Much of the problem is with individual school principals.

- Owner caused the delays; this work should be carefully scheduled and the schedule adhered to.

- There were late changes in room layouts by owner.

- If owner is going to purchase equipment, he must do it prior to preparation of mechanical and electrical working drawings.

A recurring suggestion to alleviate equipment delays:

- Total equipment design and bidding should be under architect's jurisdiction. We know from our experience in hospital work that this works better.

However, not every architect wants to undertake the total task of equipment design, coordination, and bidding:

- Owner needs to move faster, but the present procedure of owner-purchased equipment is probably best.

- Equipment could be handled by owner, but it ought to be early-bid, possibly as a complete separate subsystem.

5. Responses of Project Engineers:

These interviewees stressed the organizational phases as a more beneficial aspect to change than actual construction:

- Another time, postpone preparation of nonsystems working drawings by architects and engineers until subsystems contracts are awarded.
- For a better engineering design performance, owner should try commissioning engineers simultaneously and co-equally with architects, rather than having them as consultants employed by architects.
- "Fast track" conventional trade categories in lieu of using early subsystems bidding; innovative design from industry will never be generated by the size of program Detroit can muster.
- Although technical review of engineering drawings was handled better on CSP-1 -- with savings of both time and money by avoiding some of owner's traditional double-checking procedures -- owner needs to further streamline his review process.

Although engineers were less aware than other participants of problems associated with late-arriving equipment, they observed:

- Information on owner-purchased equipment was very late, making it very difficult for us to design service connections for power, water, drainage, gas, et cetera.
- Owner was slow coming up with approved layouts and there was a lack of information; then many areas were revised repeatedly.

6. Responses of Management Contractor Personnel:

Firm control of the entire building process was the aspect uppermost in the minds of the manager group. Several thought they could and should do more themselves:

- Have MC do scheduling.
- MC should do budgeting and estimating.
- Provide for earlier and greater MC involvement.
- Broaden MC responsibility to include bidder recruitment, design review, guard service, temporary services, et cetera.

However, some recommendations also urged more centralized authority from other participants:

- Stronger and more decisive owner role is important. One man should fill this job.

- Use one architect -- one who cares how buildings go together. It is an industry-wide problem that architects are disinterested in field work and supervision.

- More comprehensive scheduling is needed -- and a method of forcing everyone to meet schedules.

Other suggestions were random:

- Owner needs to quicken pace; the biggest potential time savings are pre-bid, prior to any real building industry involvement.

- Some architects on CSP-1 had a poor attitude. Find good architects!

- Owner should work with industry in early stages. For example, I would recommend working with masonry contractors to develop an improved vertical skin subsystem. These contractors are willing to learn and to try new things, but they completely lack engineering expertise.

The MC personnel were little involved with the problems of owner-purchased equipment; therefore the second question was not asked.

7. <u>Responses of Contractor Representatives</u>:

Virtually all answered the question on construction completion by re-emphasizing prior statements relating to particular concerns:

- Standardize more elements of building design.

- Get code approvals prior to bidding.

Like other respondents, they recommended a firmer hand on the rudder:

- CSP-1 lacked clear administrative head. Responsibility was split between MC, owner, and architect. Most important problem to solve is who is going to be in command.

- Give design commissions for several simultaneously-built projects to one architect.

Contrary to predictions, however, contractors confirmed their acceptance of the MC as coordinator of separate prime contracts:

- I recommend bringing in the MC earlier to help with bidding.

- We prefer bidding directly to owner; a subcontractor may never get paid by a GC.

- Have MC handle scheduling.

On other topics there was less agreement. On performance specifications, these contradictions:

- Early bid certain trade sections such as all of underground mechanical work. Plumbing should be included as a subsystem bid with performance specifications. This makes sense because there are plenty of plumbing codes to protect owner.

- Next time, use only prescriptive specifications.

- Use all available methods of expediting -- phased bids, bulk bids, CPM scheduling -- but do not use performance specifications because they leave engineering of components to contractor.

Also there were mixed views on interface responsibilities:

- Next time, contractors should be encouraged to do more homework -- that is, interfacing -- prior to bidding and those agreements should be in writing.

- Interfacing is an imposition; it forces me to divulge information to another contractor.

- On CSP-1, bidders did not pre-engineer or interface adequately. If we are going this direction, owner must insist on more thorough engineering and interfacing prior to bidding. Also, owner must insist on identification of all subcontractors and suppliers in order to deter post-bid "shopping" that lessens quality.

Several contractors expressed concern with communications. They recommended owner devote extra effort to pre-bid information meetings. Others stressed related aspects:

- Job meetings should be more formally organized and more carefully documented. Also, they should be chaired by someone who knows how to run a meeting. New techniques should be used. For example, a tele-copier at each job site would be a good investment; bulletins could be out in five minutes.

- Owner contract forms are archaic -- as even the owner's business office admits. The forms should be revised.

Because most contractor representatives were not involved with owner-purchased equipment installation, they were not questioned on that topic. However, one interviewee, concerned with the slow procedures he observed in installation of communications work, remarked:

- The owner would find it advantageous to put all public address systems, signals, TV, and so on, under a basic contract with the work designed and supervised by the architect and engineer. Alternatively, the owner could bid this work separately, and then assign it to the prime electrical contractor.

8. SUMMARY of RESPONSES on COMPLETING and EQUIPPING the BUILDINGS:

Although the questions focused on construction completion and the equipping of buildings, a large proportion of interviewees made summary recommendations that pertained to preparatory activities of pre-construction nature. A concern with preliminary planning stages was particularly evident with the architects, doubtless because they are most directly affected. The engineers took the occasion to reiterate their dissatisfactions with sharing engineering responsibilities with others. Like the engineers, the management contractor personnel expressed a willingness to take on greater responsibilities. Their basic plea, however, was for the entire construction operation to be organized under firmer control. Contractor representatives had many opinions, sometimes contradictory, about smoothing out construction procedures. Although not every contractor likes performance specifications -- nor interface responsibilities -- they have all accepted the idea of separate prime contracts, bid early or late as required, and managed by an agent of the owner.

When asked to respond to the quite general question on how construction could be accomplished more easily and successfully, a preponderant number of participants affirmed support for major concepts of CSP-1 (systemization, industrialization, phased bids, bulk bids, et cetera). They generally directed major complaints or recommendations for change at other participant groups. However, the owner administrators, staff, and consultants were most critical of their own organization. Flaws and failures in the owner's decision-making process were emphasized. The criticisms were numerous and diverse, particularly in regard to equipment procurement functions. Architects joined in verifying the nature of these delays. The consensus of all participant groups is that administrative rather than technical problems principally inhibit a prompter completion and equipping of buildings.

VI. OWNER'S POSTSCRIPT & PERSPECTIVE:

The popular phrase "building team" is a convenient euphemism for interconnected relationships that are basically adversary — if only because they are contractual. In either conventional arrangements (owner-architect/engineer; owner-general contractor) or in non-traditional patterns like CSP-1 (owner-architect; owner-management contractor; owner-multiple prime contractors) the building team is a carefully balanced group of skilled performers fulfilling contract agreements. They may be cooperative, but they have different motivations and viewpoints. Certainly, the views of the forty-two participants recorded in the preceding pages are disparate. Often the recommendations are contradictory. Yet, in the balancing act of building, the owner creates the team and is the fulcrum of every contract. These concluding pages review the overall process and identify major points of consensus which, from the owner's standpoint, will assure better future performance.

A. DESIGN & ORGANIZATION:

1. Cluster projects. For the owner, particularly, there are fewer serious problems with a coordinated multi-project endeavor. The great majority of participants favor further developments similar in nature to CSP-1. Indications are the owner should organize improved programs somewhat larger than the initial one.

2. Seek commitment. A very few participants were reluctant to adapt to changed roles imposed by systems methodology. For a future program, earlier and broader owner staff participation should be encouraged. Careful attention should be given to recruiting architects committed to the basic concepts.

3. Expand industrialization. On-site construction costs continue to rise more steeply than off-site fabrication costs, a fact demonstrated by CSP-1's lower subsystem prices. Most participants advocate a future program organized to expand industrialization.

4. Increase systemization. Two of the CSP-1 subsystems (ATMOSPHERE and VERTICAL SKIN) received significant criticism, and should be reconsidered for a subsequent program. However, there was strong endorsement for the basic approach. Most participants favored adding several new component groupings for increased savings of cost and time.

5. Encourage standardization. Although no one recommended "stock plan" schools, there was encouragement for greater use of repetitive elements including not only building systems components (e.g., standard doors, frames, hardware) but certain equipment

layouts for specialized instructional areas (e.g., shops, laboratories) which are common to many secondary schools. In addition to initial cost savings, long term maintenance economies were cited as an important inducement for the owner.

6. Encourage flexibility. Agreement was general that CSP-1 schools are more adaptable to educational change than conventional buildings. Participants recommended that the owner revise educational specifications to clarify performance standards and to identify commonalities of program in order to reduce curricular compartmentalization and encourage use of simple, wide-span, flexible spaces to accommodate diverse functions.

7. Retain architect talents. Despite encroachments on the architect's traditional role and despite occasional adverse criticisms all participants agreed that an architect is needed to synthesize and personalize owner requirements. The evolving pattern is to preserve the architect's role by limiting it and/or reinforcing it with supplemental services.

8. Simplify construction. As predicted, a multi-project program the size of CSP-1 will not generate technological innovation from industry. However, such a program, although basically conventional in component design, fosters the development of more logical and adaptable subsystems by adding to national production and influencing local building codes, thus simplifying subsequent construction programs.

VI. B. DOCUMENTATION & BIDDING:

1. Recruit bidders. Industrialized construction requires the interested participation of both national manufacturers and local labor forces. The owner, it was suggested, should actively recruit representatives of both groups and seek to encourage their joint venture bidding.

2. Limit performance specifications. Few participants fully understood or supported the intent of performance specifications to take advantage of industry expertise and, thus, to create new options for the owner. Design professionals and local contractors were particularly dissatisfied with the shifting of responsibilities brought about by use of performance specifications. The general view is that their use should be limited to very large multi-project programs where national manufacturers will take an active developmental role, or to particular subsystems where the owner's needs are simply not met by an available component. If performance specifications are used, it was agreed, responsibility of bid review and approval must be carefully assigned and defined from the outset.

3. Demand pre-bid documentation. An area of particular difficulty with performance-type specifications was the responsibility of subsystem bidders to meet "mandatory interface" requirements. Indications are that the problem would be alleviated in a future program by insistence on more precise and complete contractor-prepared documentation at bid time, including identification of bidder-employed engineers.

4. Specify review responsibilities. Under CSP-1 contract agreements, the owner expected architects and engineers, who were presumably paid the usual full professional fee, to review "pre-engineered" drawings prepared by fabricators. The owner's expectation was met by strong objections from certain engineers, indicating that future owner-architect/engineer agreements must be even more explicit in outlining these tasks when contractor participation in design is intrinsic to the process.

5. Utilize phased bidding. Phasing of bids to get an early start on construction or to get an early firm determination of specific costs, is now acceptable to virtually all building team participants. An important secondary advantage occurs because of a more direct and responsive relationship between the owner and the multiple prime contractors.

6. Expand bid packages. All groups expressed belief in the economic advantages of bulk bidding of multiple projects which have component commonalities. The recommendation was that the owner seek to cluster projects with characteristics of similarity and simultaneity in groupings of sufficient size to attract the area's most competent contractors.

VI. C. CONTROL of TIME & MONEY:

1. Economize via procedures. No one suggested that Detroit's schools are other than austere. Most participants believed that further economies will be in the area of procedural change rather than product change. They were in general agreement that the architect's ability to control costs is quite limited, and that most time-cost factors are in the owner's hands.

2. Attract bidders. Although most high costs associated with building in a metropolitan area are unavoidable, some of the owner's higher-than-average costs are self-generated. To encourage the economies inherent in competition the owner must be concerned with his own reputation in the local construction industry. He must seek to make his projects more attractive to competent contractors through such means as speeding payment procedures and eliminating superfluous or redundant inspection authorities.

3. Economy via acceleration. CSP-1 construction experience provided further evidence of the close correlation between speed and economy, thus emphasizing the importance not only of off-site fabrication but modular coordination and interface to facilitate rapid on-site assembly of components.

4. Compress preliminaries. Major delays occur in preliminary phases, prior to construction and outside of contractor jurisdiction, prompting the recommendation from all respondent categories that scheduling control must expand to cover all owner activities, and must commence at project outset.

5. Strengthen schedule enforcement. The schedule is the instrument of communication which knits together myriad diverse building team activities. Although most participants resist being forced to adhere to precise time constraints, all recognize the importance of scheduling. A repeated recommendation was for schedules to be enforced more vigorously.

6. Improve schedule comprehension. The predominant view is that computer technology is inadequate to express scheduling ideas understandably. Computer printouts need graphic illustration such as bar charts, as well as personal translation and even persuasion. However, a more serious problem is that specifications incorporating schedules are often unread. In a future program, bidders must be compelled to read and understand binding schedules incorporated in contract documents.

7. Retain inducements. Among time control techniques proven to work for CSP-1 were financial penalties (per diem charges) for being late and financial rewards (reduced retainage) for being on time. Practically all participants favored the use of cash flow to regulate the pace of construction, and most recommended that the penalty and reward methods should be used more precisely and rigorously another time.

VI. D. MANAGEMENT of CONSTRUCTION OPERATIONS:

1. Expedite contract awards. All CSP-1 participants recognized that phased bidding and bulk bidding techniques require very prompt owner action. Implicit in the successful management of a future program is continuation of a policy that authorizes owner's staff to award contracts within established budget limitations.

2. Centralize owner supervision. There was virtually unanimous support from participants for CSP-1's effort to channel all the owner-oriented construction phase activities through one staff person designated as Construction Coordinator, rather than using specialized and diverse inspection/supervision authorities. A similar arrangement was emphatically recommended for future programs.

3. Clarify supervisory tasks. Use of certain construction components designed or engineered by bidders prompted the feeling on the part of particular architects and engineers that they were somehow absolved of the design professional's normal supervisory functions. This limited viewpoint points up the importance of defining explicitly in owner-architect/engineer agreements the nature of supervision expected.

4. Employ professional manager. Although there were repeated requests for strong owner direction, practically all participants recognized that the owner could not undertake all the diverse tasks of budgeting, estimating, scheduling, inspections, reports, and records. Despite conflicting opinions as to who is qualified to be a construction manager or management contractor and despite disagreements on the exact scope of such responsibilities, there is consensus that someone must fill this role, serving the owner on a professional basis for either phase bid or multi-project programs.

5. Strengthen management role. Although most owner's personnel prefer the more personalized relationships and centralized responsibility of traditional contracts with architect and general contractor, the need for economic controls has called for alternative managerial relationships. From every group there were recommendations that management services be established earlier for a subsequent program, and that the management group be given authority for more decisive action regarding on-site construction activities.

6. Enforce testing requirements. Responses indicate that bidders do not object to rigorous test requirements and the submission of testing data, even though they do object to shouldering major responsibility for investigating building codes and dealing directly with regulatory agency personnel. Recommendations to the owner

were for more tests, stricter enforcement, and more thorough evaluation of documentation accompanying proposals.

7. Retain codes consultant. A major unanswered question is who, under the changed relationships, is responsible for securing regulatory agency approvals. The owner is well advised not only to define these tasks clearly in the professional and/or construction contract documents, but to retain a codes consultant to monitor the operation from the outset of design.

8. Concentrate equipment planning. Equipping of buildings by the owner has been delayed because of excessive departmentalization both in design and delivery. The majority recommendation to avoid late completion of projects was for more direct and consolidated owner authority, particularly in preliminary design phases.

9. Assign equipment responsibility. Participants unanimously recommended compressing the equipment planning process and initiating it sooner. Many recommended assigning architects to be responsible for design, bidding and installation of all furniture, machines and other instructional equipment, as well as all audio-visual and communications equipment now handled by the owner. However, there also were somewhat opposing recommendations that the owner retain the present economic advantages of direct bulk purchase and delivery, but employ architectural advice as a supplemental service in order to provide the necessary earlier and more complete design participation.