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Computer Assisted Examination of Building Plans

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ABSTRACT

The paper describes a technique for using digital computers for reviewing building plans. Although the programs developed are based on the recently enacted New York City Building Code, the principles discussed are applicable to the general problem of plan examination and building code compliance. A prototype system has been developed and is discussed to demonstrate the feasibility and practicality of such a system. The advantages of the technique are considered and a number of procedures for its implementation are evaluated with respect to their effect on the overall plan examination process.

Within this decade the vast energies and technological know-how of the American people will have to be redirected towards the solution of one of our most pressing domestic problems—urban decay and all its associated evils, whether they be physical, social, or economic. This will require a concerted effort on behalf of everyone involved in the many steps necessary to build or rebuild a city. One of the last operations in the process is the actual construction of the desired facilities. This step is in itself fraught with numerous hazards, obstacles, and detours which tend to delay its successful completion. Yet by the time the necessary decisions have been made to begin construction so much time has usually elapsed that people are impatient and want to see action fast.

One phase of the construction project which even now can cause delays, and which prevents that first spurt of physical activity, is that of obtaining

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approval of plans by the responsible municipal agencies. As construction rates increase to meet the demands of the cities the work loads of these agencies grow in proportion. Even now the New York City Department of Buildings reviews over 50,000 sets of plans annually.

New York City Moves Ahead

In 1968 New York City forged ahead in the area of building regulations and plan examination by adopting an entirely new building code based on the *Building Officials Conference of America (BOCA) Model Code*. In addition to the code, a number of new concepts were instituted with it in an attempt to alleviate some of the problems which existed with the old code. These problems included delays in plan approvals, increasing work loads, differing interpretations of the code, and differences in review techniques among the plan examiners.

One concept which was not considered when the code was adopted, but which has been used extensively by engineers and planners in the solution of highly complex urban problems, is the electronic digital computer. Computers are being used by many organizations for almost every conceivable purpose—from data banking of real property information to monitoring police communication systems. With all the flexibility of modern hardware and software systems there is no reason why this vast potential can not be put to use in the area of building code compliance and plan approval.

Feasibility Study

To properly evaluate the many different schemes which could be used for an automated plan examination system it is necessary to define and evaluate the functions, properties, and requirements of such a system.

Figure 1 illustrates the major uses of the program and identifies the major groups which would utilize the system. However, it does not illustrate the vast potential of the program for assisting industry members. When a new code was adopted in New York City (December, 1968) a decision was made to give the design professions greater responsibility for their work; thus, the Department of Buildings might only provide supervisory checks of most plans. Under such an operating procedure the designer might use this type of programming system to review his work and then submit the output, rather than the plans, to the reviewing agency. The plan examiner could review the report knowing that the project has been carefully and accurately examined. In this mode the work load would be distributed back to the designer but without relinquishing the legal responsibility of the reviewing agency. If this system is undesirable it is still possible for the reviewer to prepare the necessary input and run the review himself.

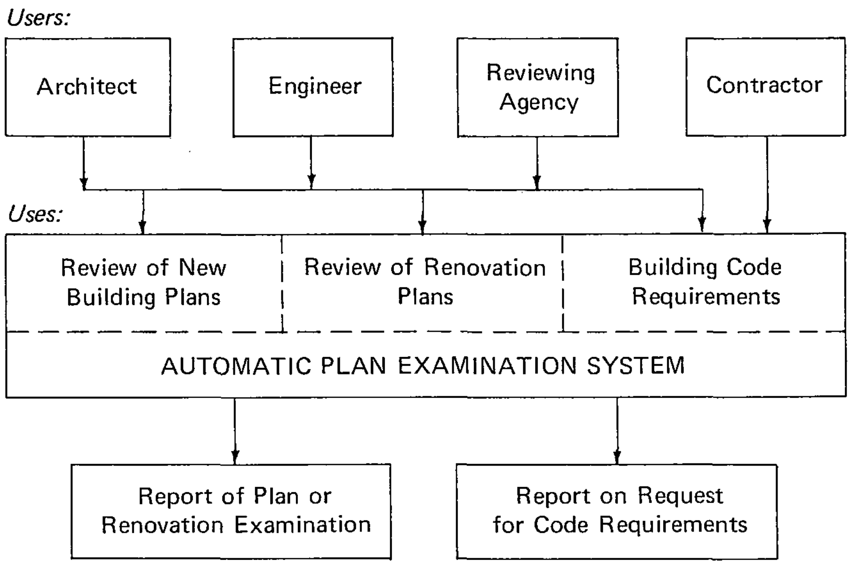


Figure 1. Potential Users and Uses of an Automated Plan Examination System.

Considering the potential users and uses of the system, a number of criteria can be drawn up for use in evaluating any developments or techniques which might be proposed. The first set of properties involves the design of the system and include:

1. *A System Based on Current Computer Technology*: The area of computer applications and software development is a very dynamic one. New programming techniques and applications appear quite regularly and research continues on many others. While it is necessary, and in fact vital, to consider these new advances when developing a specific programming system, it is also necessary to carefully analyze the exact nature of any new technique. Many of these schemes are developed with one particular use in mind. Their application outside this narrow range may involve extensive research, modification, and testing. There is always the possibility that the results will not be satisfactory. On the other hand, if a well established technique or programming system is adopted whose properties are more widely known and proven, there is less chance of consuming large periods of time while achieving no definite results. This can be most important where the available time is clearly limited.
2. *A Technique Geared to Commonly Available Hardware Components*: This prerequisite is aimed at avoiding development of a programming technique

which is heavily dependent on one specific type of hardware unit. This is especially true where the unit involved is new and would have to be obtained by most users before being able to make use of the programming system. Even if the hardware is not new but just uncommon, the chances for acceptance of the program, no matter how useful it appears, are greatly reduced.

3. *A Program Which is Basically Machine Independent*: If a program for computerized plan examination is to be used by all members of the design professions it must be readily available to them on their own computers, at commercial data processing centers, and at the municipal agencies involved. This would indicate that a variety of machine sizes and operating systems will be used. A consultant may have a very small machine with some form of direct or sequential storage device as the major storage unit. A commercial service would probably have a very large system with large storage capacity both in and out of core. They may also provide a time sharing system in which customers have terminals in their offices. Another important factor is that of the *programming language* since we are talking about a program which will be loaded into a number of computer systems, produced by more than one manufacturer. The language must be one which is available, in a generally compatible form, on all machines. In general, the program should be of a design that can be implemented on many different computers with a minimum amount of modifications.

While these rules govern the overall design features of the system there is another set of criteria which define the operating properties of the program. These are the features which affect the day to day use of the program and are of vital concern to the average user. The more important criteria include:

1. *Easy to Use*: Although a majority of the recent college graduates in engineering and architecture have received some introduction to computers, there are still many people in the industry with little or no training, and no experience, in computer techniques and usage. For this reason use of the program should be geared as much as possible to the one thing all potential users have in common—the Building Code itself. Thus the input should use the terminology of the code and follow its organization and structure as closely as possible, even to the point of sacrificing some efficiency.
2. *Usable Output*: Businesses have long realized the advantages of using computers not only for record keeping purposes but for the generation of every conceivable type of business report. There is no reason why engineers and plan examiners should not make use of this procedure. Although all programming languages are not equally suited to the production of comprehensive reports, the difficulties can be resolved with a little extra programming effort. This effort will be required for this

program in order to make it possible for anyone involved in the building design-review process to take the output directly from the machine and use it, for whatever purposes he desires, with no rewriting and no translating of the results into common terminology. Besides requiring a neat, comprehensive engineering report this also implies that the output must follow the code in the same manner as did the input.

3. *Simple Modification Procedure*: One of the problems encountered with the old New York City Building Code was that it could not be easily changed to keep pace with a rapidly changing technology. To remedy this problem a new, simplified procedure was adopted for amending the new code. It is hoped that this will make it possible to regularly update the code to keep it in line with the latest advances in design practices, new material developments, and construction techniques. If a computerized system is to be used effectively it must be capable of accommodating these changes as readily as the code itself.

With these major requirements clearly defined, a number of different techniques and procedures were evaluated in an attempt to find the one which would best satisfy as many of the above criteria as possible. Three distinct procedures were investigated to determine their applicability to this problem.

The first of these was the use of a microfilm storage and retrieval system. A review of the state of the art revealed that hardware systems were available which could retrieve specific items of the code, based on a sophisticated indexing system. However, this would not solve the main problem of plan examination, or, in other words, once the appropriate code section is found, how does it get used for reviewing plans. In addition, once a particular microfilm storage technique is adopted all users must obtain access to the specific hardware unit. This violates a number of the conditions and requirements previously stated. Thus, microfilming would not be an acceptable tool for an automated plan examination system.

A second procedure considered was the use of an information storage and retrieval system. In this scheme the information (the Building Code) is stored in a form very close to its normal one. Through one of a number of indexing and searching procedures specific facts can be extracted. Here again, the problem arises when it becomes necessary to use the facts to review a set of plans. Information storage and retrieval systems were originally developed for cataloging purposes. While work is being done to develop systems able to use the retrieved information, much remains to be done. To use this procedure a considerable amount of research would be required and it is questionable whether satisfactory results could be obtained.

Since neither of the first two ideas seemed applicable, a third procedure was studied. This involved using a programming language to specify the code requirements. By using a language such as FORTRAN IV which is specifically geared to scientific and engineering applications, there is no need to spend long periods of time investigating its applicability to the problem. Anyone with a good knowledge of the language should be able to write the necessary programs. In addition, there is no need for two major developments as with the earlier proposals. Both of the earlier techniques would have required one programming system for storing and retrieving the code and a second for using it in the review process. By putting the code directly into the language both steps have been combined. Thus, it was felt that this approach would best satisfy most of the requirements stated earlier.

System Organization

With the basic criteria and the mode of operation defined, the specifics of the system structure and operation can be laid out. Since the code requirements will form the actual program blocks it is impractical to expect the same coding to be capable of both reviewing a plan and identifying a code requirement. For this reason these two functions will be separated at the present time and the idea of identifying code requirements (which could probably be done quite well with an information storage and retrieval system) will be given a lower priority than that of reviewing building plans.

To satisfy as many of the above mentioned criteria as possible the following specific features were adopted as the basis for all programming:

1. To make it possible to operate the system on a variety of machine sizes the programming should be constructed as a series of small subroutines, each of which will perform one very specific operation. By doing this the system can be stored off-line and executed in parts through overlaying techniques.
2. The overall operation will consist of four main steps–data input, image printout of the data, review of code requirements, and production of the report. These four operations will also be separated to achieve further flexibility. Specifically, by isolating the input and output phases from the actual review steps it will be fairly easy to interchange input-output modes and make use of card or terminal input and printer or terminal output. Furthermore, the changeovers could be made without interfering or in any way tampering with the actual review coding.
3. To make the output more usable for reports without any rewriting, a variety of minor rules or guidelines were formulated. These did not require any formidable programming tasks. But when combined, the end result is a neat engineering report which could be used directly for submission or other technical purposes. The most important features were careful

attention to margins, page numbering and headings, and an easy to follow format combining tabular output and textual information.

4. The use of a modular programming style is a major tool for producing an easy to modify program system since each subroutine contains the coding for a limited number of operations. To further aid the process there are a few simple programming techniques which should be adhered to. Besides the obvious one of using large numbers of comment cards to annotate the coding, variable names should be selected with some thought so that they have some relation to their function. Furthermore, since the code is so well organized into articles, subarticles, sections, subsections, and paragraphs, each of which is numbered, the programming should be similarly organized into specific blocks within each subprogram. Each block should be set off with comments to identify the exact lines of the building code to which it refers.

Prototype Developed

The first block of programming required is the control section—the programs which govern the operation of the system. This framework, or skeleton, is shown by the blocks along the heavy line in Fig. 2. The function of each program is listed below:

1. MAIN – calls the remaining six programs in sequence.
2. CODEIN – reads building code data tables into memory. In a fully operational system the code data would be stored permanently on a disk or other storage medium and this program would be unnecessary.
3. INPGL – (Input General) controls the first major programming block which reads the specific job data into core. In addition, it also reads in job titles and control information which identifies what the user wants from the system.
4. REVIEW – controls the second programming block which contains a series of subroutines which perform the actual review process.
5. COVER – begins the printout of the report by printing title pages and introductory information.
6. IMAGE – controls the third block of subroutines which print-out an image of the input data when requested by the user.
7. REPORT – controls the final block of subroutines which produce the report of the results of the review process.

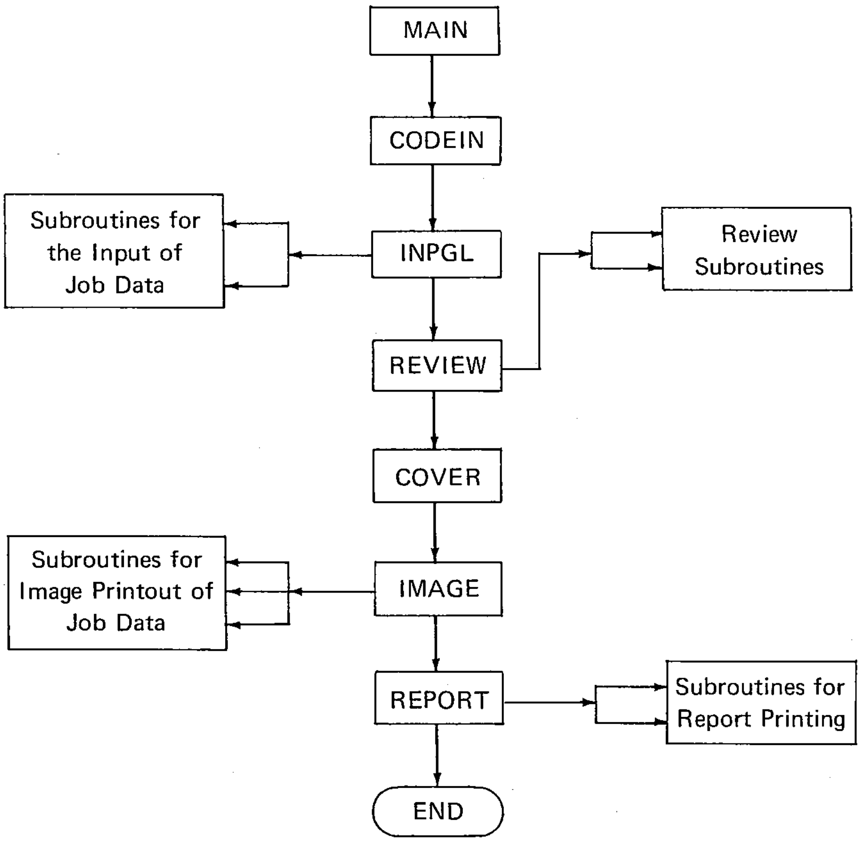


Figure 2. General Flowchart for a Computer Assisted Plan Examination System.

These programs, specifically INPGL, REVIEW, IMAGE, and REPORT, have been structured to accept all the subroutines for all the code articles, with almost no reprogramming. The second group of programs required form the actual bulk of the system and are contained within the four blocks shown on Fig. 2. These four blocks, parallel in structure, consist of a series of subroutines, each of which performs the specified function for one code article.

The first set of programs reads the data describing a particular building. In keeping with the general criteria established earlier, the data is organized into a series of distinct sections, each of which contains the required information for one code article. Because of the many interrelationships between the articles it is necessary to read all the data before beginning any reviewing, but the careful subdividing of the data makes it much easier to use. Furthermore, by physically separating each data set with header cards, manipulation and modification of specific data items can be done without searching through the entire data set.

To use the system in a batch mode (data stored on cards) some form must be prepared for the plan examiner or designer to indicate what information is to be punched on the cards and in what format. For the designer to use this layout the instructions must be very explicit. As an example, Article 4 of the New York City Code is entitled "Building Limitations" and deals with allowable floor areas, building heights, limitations inside and outside of defined fire districts, and projections beyond the building face. The data required includes a description of each segment of exterior building wall, floor area, and any projections. Factors such as building occupancy group, construction classification, and height, which are also used, are obtained from other data sets. The input form of Fig. 3 was prepared as an example of how the data can be transferred from the plans to the cards in a clear, easy to follow manner.

Since time sharing is a rapidly growing feature which many organizations are adopting it is important to consider this market in developing a plan examination program. The most significant difference in time sharing is that the user sits at a terminal and interacts with the machine. His data is entered piece by piece as the system requests it rather than as a complete block of cards. To do this the information must be requested in a very clear style. One procedure is through a comprehensive conversational input technique which has been demonstrated for this system. A typical page of output from the terminal is shown in Fig. 4.

Each of these input systems has its own unique properties, advantages, and disadvantages. Because of this, and the growth of time sharing services, it seems vital to maintain both techniques in order to give the user the widest possible choice of operating procedures. This can be done quite easily with the modular format already discussed.

One of the major disadvantages of this particular terminal input technique is that it is time consuming and, after a while, becomes very boring for the user. As a person becomes very familiar with the system he will know how to respond to the questions long before the system finishes typing them out. Thus he must sit at the terminal waiting, wasting time, and a good deal of paper. To solve this problem a modified terminal input system would be required which would produce much fewer instructions for the user. This would obviously necessitate a much more informed user, and a question arises as to the exact background of the majority of the potential users. Lacking this precise information it may be necessary to provide both types of terminal input systems; but this may be considered going to extremes. Regardless of

AUTOMATIC PROJECT EXAMINATION AND EVALUATION SYSTEM
INPUT FORM 4 BUILDING PERIMETER

CORNER: X = ☐☐☐☐☐ Y = ☐☐☐☐☐

FRONTAGE CHARACTERISTICS

___ Public Street
Location [1]
Curb dist. ft.

___ Private Court
Location [2]
Width ft.
Access by

___ Alley/Drive
Location [3]
Width ft.

___ Building
Location [4]

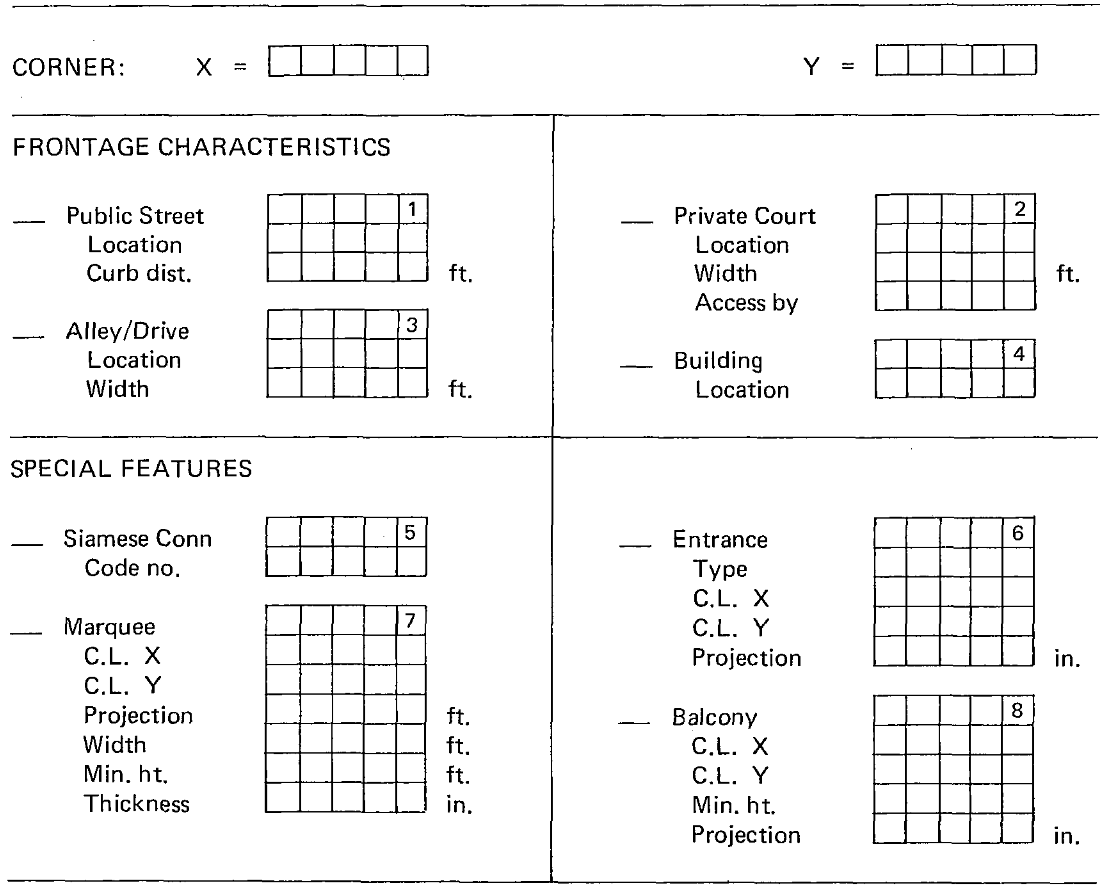
SPECIAL FEATURES

___ Siamese Conn [5]
Code no.

___ Entrance [6]
Type
C.L. X
C.L. Y
Projection in.

___ Marquee [7]
C.L. X
C.L. Y
Projection ft.
Width ft.
Min. ht. ft.
Thickness in.

___ Balcony [8]
C.L. X
C.L. Y
Min. ht.
Projection in.



CORNER: X = Y =

FRONTAGE CHARACTERISTICS

— Public Street
Location
Curb dist. (1) ft.

— Private Court
Location
Width
Access by (2) ft.

— Alley/Drive
Location
Width (3) ft.

— Building
Location (4)

SPECIAL FEATURES

— Siamese Conn
Code no. (5)

— Entrance
Type
C.L. X
C.L. Y
Projection (6) in.

— Marquee
C.L. X
C.L. Y
Projection ft.
Width ft.
Min. ht. ft.
Thickness in. (7)

— Balcony
C.L. X
C.L. Y
Min. ht.
Projection (8) in.

Figure 3.

```
    1.  ENTER COORDINATES OF CORNER, X AND Y
 ?0 80

    2.  DOES THIS SECTION FACE A:
                    1.  PUBLIC STREET
                    2.  PRIVATE COURT
                    3.  ALLEY/DRIVE
                    4.  BUILDING
     TYPE A 1, 2, 3, OR 4 IN COLUMN 1

 ?2

    3.  ENTER LOCATION CODE:
                    1.  FRONT
                    2.  SIDE
                    3.  BACK
 ?1

    4.  ENTER WIDTH OF COURT IN FEET
 ?80

    5.  ENTER ACCESS CODE FOR COURT
 ?1

    6.  ENTER CODE NUMBER FOR SPECIAL FEATURE:
                    1.  NONE
                    2.  SIAMESE CONNECTION
                    3.  ENTRANCE
                    4.  MARQUEE
                    5.  BALCONY
 ?2

    7.  ENTER SIAMESE CONNECTION NUMBER, (4 DIGITS
 ?101
```

Figure 4.

the input procedure used, the data are stored in specific locations which are then called by the next set of programs which perform the review.

Each review program operates independently of the other review programs and independently of the programs for the other three phases of the system.

It is also possible for the user to specifically omit certain programs and, in effect, review only particular phases of his plans.

A typical review program would appear as a series of tests of the supplied data against the code requirements together with some calculations of various items. Throughout the data sets only the very basic data, in its rawest form, is requested; wherever possible, any more complex information is calculated by the system. This relieves the user of the task of performing a series of basically simple, but time consuming steps. It also eliminates a potential source of errors.

The code requirements may be listed in data tables or specified right in the coding. As an example of this consider the requirements governing building marquees. The restrictions are contained in Article 4, Section C26-408.1 (a)(4), and are reproduced in Fig. 5a; the corresponding coding is shown in Fig. 5b.

Since the printing of the results is delayed until all reviewing is complete it is necessary to save all the pertinent results. A series of "solution arrays" are used for this purpose. These arrays contain the results of significant calculations–floor area, building height, frontage length–performed during the review process. More importantly, they store triggers or markers which indicate the outcome of specific tests. It is these triggers which identify the proper output statements in the report phase. As an example, in evaluating the floor area there are a number of possible results, each of which is identified by a different numerical value stored in a particular location of the solution array. The possible results and their indicators are:

0 = there is no code limit on the floor area for this type of building.

1 = this building type is not permitted.

2 = The area is within the code limits as provided in Section C26-405.1.

3 = the area is within the code limits only after considering a bonus as provided under Section C26-405.3.

4 = the area exceeds the code limit of Section C26-405.1 and does not meet the requirements for a bonus as specified in Section C26-405.3.

5 = the area exceeds the allowable limit even after including a bonus as allowed in Section C26-405.3.

One of the major drawbacks of this separation of steps appears if it is found desirable to use a terminal to its fullest capabilities. Under this operating procedure the user, sitting at the terminal, would expect to see the results printed out, step by step, as the program is executed. In this way he could make changes as needed to overcome objections or to experiment with alternate ideas. While this offers the designer obvious and significant benefits, the system has been designed more for the examiner than the designer. At the

(4) MARQUEES—Marquees may be erected on public buildings, theaters, hotels, terminals, large department stores, supermarkets, multi-family dwellings, and similar buildings of an essentially public nature, or upon a warehouse or market in an Established Market Area as designated by reference standard RS4-3, so as to project beyond the street line, but not nearer than 2 ft. to the curb line, provided that no parts of such marquees are less than 10 ft. above the ground or sidewalk level. Marquees must not be more than 2 feet to curb lines hereafter established or changed. When measured from top to bottom, marquees shall not be thicker not shall the fascia be higher than 3 ft. This dimension shall include all decorations, but shall exclude any tension supports suspending the marquee from the wall. Marquees shall be supported entirely from the building and be constructed of noncombustible materials, except that the roof or any part of the roof may contain skylights complying with the requirements of section C26-503.8(d). Marquee roofs shall be drained in accordance with the provisions of Article 16. When the occupancy or use of a building with a marquee projecting beyond the street line is changed to an occupancy or use for which a marquee is not permitted by this section the marquee shall be removed.

Figure 5a. Section C26-408.1 (a) (4) of the New York City Building Code regulating the location, and design of building marquees.

```
C     ------------------------------------------------------------
C     MARQUEE                (7)
    7 ANSO4(IAN) = K1
      ANSO4 (IAN + 1) = 0.0
      DO 31 NA = 1,26
      IF( USE .EQ. PMAR(NA)) GO TO 32
      IF( USE .LT. PMAR(NA)) GO TO 33
   31 CONTINUE
   33 ANSO4 (IAN + 1) = 1.0
   32 IF (PER(K1+3) .GT. (PER(K11+4)-2.0)) ANSO4 (IAN+1)=ANSO4 (IAN+1)
     1   + 5.0
      IF (PER(K1+5) .LT. 10.0) ANSO4 (IAN+1) = ANSO4 (IAN+1) + 3.0
      IF (PER(K1+6) .GT. 36.0) ANSO4 (IAN+1) = ANSO4 (IAN+1) + 7.0
      K1 = K1 + 7
      GO TO 10
C     ------------------------------------------------------------
```

Figure 5b. Section of programming which corresponds to the requirements shown in Fig. 5a. The fourth through seventh lines determine whether the building used is one of those listed where marquees are permitted. If it isn't, the trigger is set to 1 (statement 33). The next three lines check the projection, the height above the ground, and depth of the marquee, respectively. In each case a failure results in a specific increment being added to the condition code.

same time though, it is possible to add some additional coding in the review step to provide printouts at the conclusion of each review subprogram (after each code article). Although this does not completely resolve this problem, it should prove satisfactory.

After all desired reviewing has been completed, the printout of the building data begins. This is the first part of the two part printout and it includes a complete copy of all the input data, unless the user specifically instructs the system to omit certain parts.

The output style (for both the image printout and the review results) combines two different formats in an attempt to achieve the best possible appearance and organization. Some data, such as the description of the building, which appears only once, is best presented in outline form as shown in Fig. 6. Other data, such as the description of spaces and rooms, which consists of numerical data, is best presented in a tabular form, but inbetween these two extremes is a large bulk of data which is not all numerical but which is repeated many times. An example of this is found in Fig. 7 which is part of the description of the building perimeter. Because of the variety of the data a typical table would not suffice. For this reason the data are presented in a list where each item is identified with a brief name which is similar to the description used in the code itself. The theory here is that the system should be geared as much as possible to the user rather than the other way around. The auxiliary features such as headings and page numbers make it possible to use the output directly in a report.

After all the input data which the user requested has been printed, the system switches to the final block of programs which prints the second part of the output, the results of the review. The same format and style used in the image printout is applied here. In addition, wherever possible, the specific code limit and its section number are included in the output to assist the user. (See Fig. 8.)

An interesting feature of this system is demonstrated in statement 1 of Section C (Fig. 8). The New York City Building Code was written as a "performance type code," that is, one in which as many regulations as possible are written in terms of a desired result rather than an exact material or procedure. Where this is not possible the "or equal" phrase is used to allow the designer the widest possible latitude in his work. This freedom creates a serious obstacle to computerization in that it requires judgment and experience on behalf of the reviewer.

The example cited in Fig. 8 involves a marquee on a building. In the New York City Code (Section C26-408.1(a)(4)) marquees are permitted ". . . on public buildings, theaters, hotels, terminals, large department stores, supermarkets, multi-family dwellings, and similar buildings of an essentially public nature." While it is possible to define all these specific building types, how

PAGE 2

NICHOLS BUILDING
144 JOHNSON STREET
BROOKLYN, NY 11201

A. BUILDING DESCRIPTION

1. BUILDING CCCUPANCY CLASSIFICATION IS:

G EDUCATIONAL

2. PRINCIPLE BUILDING USE CODE: 3.750

3. CONSTRUCTION CLASSIFICATION:

I-C NONCOMBUSTIBLE 2 HR PROTECTED

B. DESCRIPTION CF SPACES AND ROOMS

FLOOR	SPACE	USE	OCC	AREAS GRCSS	NET	OCC. LOAD
BSMT	9C	9.4CO	D-1	5CCO.	250.	12C.
	2C	5.100	F-4	47000.	42250.	328.
1	10CC	3.750	G	20CCO.	18000.	235.
	150C	1.551	F-1	32COO.	3C000.	42C.
2	2CCC	3.750	G	39COO.	30500.	287.
	285C	13.030	D-2	13COO.	11385.	1C1.
3	3000	3.750	G	4CCOO.	36827.	25C.
	365C	15.200	E	12COO.	8200.	86.
ROOF	C	0.0		0.	0.	0.

Figure 6.

can the term *of an essentially public nature* be defined for a computer system. Rather than just ignoring the problem, the appropriate indicator in the solution array instructs the system to print out a message to the effect that it can not reach a decision. It then prints a signature line so that the

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                                                                 PAGE 3

                                                          NICHOLS BUILDING
                                                          144 JOHNSON STREET
                                                          BROOKLYN, NY 11201

C.  BUILDING PERIMETER

       COORDINATES
 X        Y         X        Y        ITEM AND DESCRIPTION
*************************************************************************

   0.     80.      100.     80.     FACES:          PUBLIC SPACE
                                                    LOCATION        FRONT
                                                    WIDTH =          80. FT.
                                                    ACCESS BY:        1.

                                     ITEM:          SIAMESE CONN
                                                    NUMBER           101.0

-------------------------------------------------------------------------

 100.     80.      100.      0.     FACES:          PUBLIC SPACE
                                                    LOCATION        FRONT
                                                    WIDTH =         100. FT.
                                                    ACCESS BY:        1.

                                     ITEM:          MARQUEE
                                                    C.L. X COORD:   100.0
                                                    C.L. Y COORD:    40.0
                                                    PROJECTION       20.0 FT.
                                                    WIDTH =          50.0 FT.
                                                    MIN. HT. =       11.0 FT.
                                                    DEPTH =          31.0 IN.

                                     ITEM:          ENTRANCE
                                                    TYPE:  PEDESTRIAN
                                                    C.L. X COORD:   100.0
                                                    C.L. Y COORD:    40.0
                                                    PROJECTION       16.0 IN.

-------------------------------------------------------------------------

 100.      0.      200.      0.     FACES:          PUBLIC ST.
                                                    LOCATION        FRONT
                                                    DIST TO CURB =   25. FT.

-------------------------------------------------------------------------
```

Figure 7.

reviewer will be aware of the problem and can make the necessary decision to sign it or reject it. This obstacle in no way interferes with the overall review process and the system continues to function as though the problem did not exist. This capability for man-machine interaction is a very important one

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                                                            PAGE 9

                                                   NICHOLS BUILCING
                                                   144 JOHNSCN STREET
                                                   BROOKLYN, NY 11201

 2.  FIRE DEPARTMENT ACCESS

     THE PORTICN OF THE BUILDING PERIMETER FACING A STREET OR PUBLIC
     SPACE EQUALS OR EXCEEDS THE CODE MINIMUM OF  8. PERCENT

 3.  AREA LIMITATIONS

     THERE IS NC LIMITATICN ON THE FLOOR AREA FCR THIS TYPE CF
     BUILDING.

 4.  HEIGHT LIMITATIONS

     THE BUILDING HEIGHT IS WITHIN THE LIMIT OF   85 FEET, AS
     SPECIFIED IN SECTION C26-406.1

     THE NUMBER OF STCRIES IS WITHIN THE LIMIT OF     7 FLOORS
     AS SPECIFIED IN SECTION C26-406.1

C.  PERMISSIBLE PROJECTIONS

 1.  MARQUEE ON THE FRCNT   OF THE BUILCING AT CCORDINATES 100.0,   40.0
     IS NOT SPECIFICALLY PERMITTED ON THIS CLASS BUILDING.   BUILDING
     DEPARTMENT APPROVAL REQUIRED.

               APPROVED BY: ____________________________

               DATE:        ____________________________

 2.  MARQUEE ON THE FRONT   OF THE BUILCING AT CCCRDINATES 100.0,   40.0
     MEETS ALL CODE REQUIREMENTS

 3.  ENTRANCE CN THE FRONT    OF THE BUILDING AT COORDINATES 100.0,   40.0
     MEETS ALL CODE REQUIREMENTS

 4.  MARQUEE ON THE SIDE    OF THE BUILCING AT CCORDINATES 200.0, 200.0
     DOES NOT MEET THE CCDE MINIMUM OF 10 FEET OF CLEARANCE CVER SIDEWALK

 5.  ENTRANCE ON THE SIDE     OF THE BUILDING AT COORDINATES 200.0, 200.0
     MEETS ALL CODE REQUIREMENTS
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Figure 8.

which could probably be used to a great degree in a programming system of this nature.

An Operational Plan Examination System

While the programming described here is only a very small demonstration system it does authenticate the theory that a computer can be used successfully to review and evaluate building plans. The potential benefits of a fully implemented computer assisted plan examination system are wide ranging and would change the entire operation of that phase of the construction industry.

Some of the more obvious benefits to be gained by the widespread use of this type of system include: improved accuracy and standardization of the review process, a uniform report output, and reduced time for plan approval. Beyond this point the potential of the system increases vastly. If it is assumed that the programs are available to all architects and designers (through commercial data processing centers) it is not beyond the limits of practicality to expect each designer to review his designs himself and then submit only the output to the reviewing agency. The detailed printout of the input data would serve as a digital description of the building, possibly eliminating the need for submission of the plan drawings.

At the other end of the spectrum is a comprehensive terminal system where the user could receive his results immediately Although, legally, he might still be required to submit some formal report and await its approval, he could proceed with other work knowing that his plans will be accepted.

Regardless of the operating procedure adopted, the benefits to the reviewing agency are probably of the most importance to everyone since this is where delays would most likely occur. Any procedure whereby the designer is required to submit his plans in a carefully standardized format, whether it be input layouts or the final output, will no doubt reduce the work load of the plan examiners. Even if it is decided to perform the actual review within the examining agency, tasks such as data preparation and inputting can be performed by technicians, relieving the highly skilled examiners of this job. For the plan examiner this will mean the elimination of much of the repetitive and time consuming tasks. It will allow him to spend more time reviewing those plans and sections which involve a high degree of judgment, experience, and engineering know-how.

Conclusions

Computers have been used in many phases of the construction process, from the design of structural elements to the scheduling of job steps and material delivery. In all these cases, it has resulted in a noticeable improvement over the conventional procedures. One of its prime advantages is that it allows man to use his energies in a more creative and satisfying way by relieving him of many repetitive and time consuming tasks. These same powers can and should be applied to the problem of plan examination. The procedure should be equally applicable to almost any code (the New York Code is based on the BOCA Model Code), and regardless of the exact style and operating system used the benefits to the industry and the public at large are limited only by the imagination and foresight of the people responsible for the design and implementation of the system.

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2. The New York City Building Code, December, 1968.