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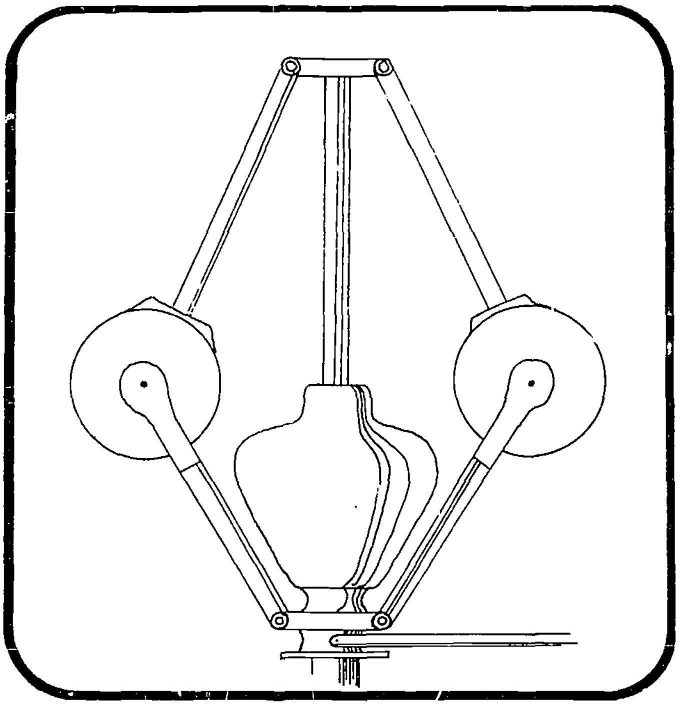
ABSTRACT

A computerized system, developed at Florida State University, is designed to locate students and resources on a geographic network. Using addresses of resources and students as input, the system quickly and accurately locates the addresses on a grid and creates a map showing their distribution. This geographical distribution serves as an invaluable aid in planning and resource allocation, and can be used to determine the best transportation routes, facility sites, and redistricting plans. (Tables 3-4 and figures 2-4 may reproduce poorly because of marginal legibility.) (RA)

Demographic Mapping Via Computer Graphics

A Technical Report



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DEMOGRAPHIC MAPPING VIA COMPUTER GRAPHICS

This paper is a report on the development of a computerized system for locating students and resources over a geographic network.

The computerized system was developed to meet the following objectives:

1. The system, given a list of students' addresses and/or a list of addresses of resources, will assign geocodes or grid numbers to each address.

2. The system, given a specific activity code for resources will locate either the students as users of the resources and/or the resources pertaining to the specific code.

3. Given summarized geocoded data from the second objective, the system will geographically locate the data over a computer produced map of the area.

4. The system will permit usage of already existing computer programs such as SYMAP. The SYMAP program was selected as "SYMAP is the best known, most comprehensive, and most widely used computer mapping program currently available." [22]

While there are many pressing problems and issues in education today one problem has tended to elude the administrator. The problem is one of contriving several alternative solutions to allocative problems in education. Further, each alternative should consist of a different mixture of resources yet be designed to satisfy the same goals or objectives. When more than one alternative solution to a problem exists then a decision has to be made. In the past very few alternative solutions to problems of an allocative nature have existed and thus the decision making function of the administrator has been infrequently exercised.

No doubt accountability will demand more frequent and accurate decisions on the part of the administrator. To support such decisions, one must have information regarding the current status of a system. The system discussed in this report can supply the decision maker with up-to-date information regarding the location of the users (students) of resources over a geographic network.

Three trends which appear to perplex education decision makers are:

1. The shortage of public school facilities. To be more concise, 68,684 classrooms or 1.03×10^8 square feet were needed to overcome inadequate facilities and accommodate student growth in 1969-70, and 1.15×10^8 square will be needed in 1972-73; [15]

2. The increasing concern to "open" the educational system in an attempt to reduce the gap between the learning environment and work environment. Perhaps President Johnson, in 1966, was one of the first to take a stand on this issue in an address to the American Association of School Administrators (AASA). The President conveyed the message that schools in the future must reach out into the community, into the art galleries, theatres, and factories in an effort to bridge the gap between the educational environment and real life. [10] "Freedom is not something spoon-fed in a civics class. It is a state of being and it must be experienced as a matter of daily affirmation;" [3]

3. The trend to individualized instruction. This process requires a far greater variety and quantity of resources than are presently in the system. "Space is needed where individualized, highly automated instruction in the skill-development area can be converted. There should be space for specialized activities where students can pursue their own interests. Students should have space in the community for community projects." [5]

Where are additional resources located which might be used as educational facilities? Are there facilities in the community, either publicly or privately owned, which might be used within the educational system? Are these facilities vacant and/or for sale?

The computerized system described throughout the remaining part of this report was developed to provide the decision maker with information regarding the above questions. Perhaps more important, the locator system can be used to display both the students, who will be or who are currently using the resources, and the resources over the same geographic network. The system, in its present form, makes no assignment decisions or suggestions as to how one might optimally bring the students and resources together. The visuals produced by this system, however, provide the planner with information which places him in an excellent position to devise alternative solutions to problems which might be of an allocative nature.

The locator system developed by the Systems and Planning Center was applied to the Model City Neighborhood Area (MNA) in Tampa, Florida. The reader should note, that the computerized locator system is but one subsystem of the total system which holds promise in offering a solution to some of the allocation problems or needs which were discussed earlier. For example, one must have a system which will project resource needs, which specifies resources needed and how much or how many are required, before one can consider the location of the resources. One also requires some information on the population which will be or are currently the users of the system. Further, once the resources and the users have been geographically located, one needs a system which will bring the users to the resources or vice versa. In the above sense, the system to tackle the needs of the study area, the MNA, should entail at least three subsystems; a system for projecting resource needs, a locator system, and an activity system to bring the users and resources together. To date, two of the subsystems have been completed. The third system, the activity system, should be completed in the near future.

RELATED RESEARCH

The following is a cursory review of techniques used to locate students and resources over a network. The specific areas researched were school transportation, physical plant location, redistricting, and the use of geocoding systems.

Transportation Models

The literature related to transportation models has been well documented and reviewed by Zakaria, [25] Davis, [2] and Ma. [13] The basic objective of the transportation models reviewed by the above three authors has been to minimize the total cost of transportation from pick-up points to destination while sending the maximum flow through the network.

The transportation problem is far from being solved, and to date, most of the routing and computations are done by hand which is extremely time consuming as well as costly. [16] The United States is currently spending over $700 million dollars a year and transporting over 16.5 million students each day. [1]

Perhaps the most widely used transportation model is the International Business Machines system/360 Vehicle Scheduling Model (VSP). [9] One factor currently limiting the success of the VSP is the tremendous amount of manual preparation required before using the program. A second factor possibly limiting the success of the VSP in educational transportation problems might result from the fact that the VSP was originally designed to solve distribution of goods problems. [9]

Recently, Tracz and Norman, using an algorithm similar to that used by the VSP, designed a transportation model specifically for education. [21] The model was found to be about as successful as the VSP. The researchers were not, however, able to reduce the manual preparation required before using the model. For example, the grid system, student locations and school locations were still prepared manually for input.

Plant Location

Education is far behind business when it comes to locating or relocating physical facilities. Not only are the locational techniques of business more automated than those in education, but they are also more comprehensive and sophisticated in nature. Spielberg, for example, using a computerized algorithm included a tolerance parameter which sped up the search for the optimal solution and also produced a solution which was more consistent with the system objectives. [20] A further study took twenty-six variables into consideration, many of which required a great deal of manual preparation before use as input for the model. [18]

While educational planners take fewer variables into consideration in planning new physical facilities the manual preparation of their data is perhaps more time consuming than that in a business situation. For example, the main tool for school location has been the school plant survey which is strongly concerned with only one variable, that of population. [19] Data gathered by region or district, and in many cases the forecasts or projections, are manually determined. Data are then located on base maps and recommendations made. [19]

Grossman has perhaps proposed the most encompassing approach to school plant location. He suggested that educators consider at least twelve variables and keep in mind that careful consideration of the twelve variables does not guarantee success, but that only through a more thorough analysis can planners improve their techniques. [7]

While the variables and techniques used by business and educational planners in locating physical plants differ, their techniques for gathering data are very similar. Clearly, the amount of work necessary in planning for new plant or school locations, when much of the locative data are gathered manually, is additive.

As was mentioned earlier, business has automated its locative algorithms, but its base data are still manually tabulated. Thus mistakes can be made in locating new plants regardless of the sophistication that the computer can provide.

Redistricting

A great deal has been written lately on districting and redistricting. The literature and rationale for redistricting has been well documented by Heckman, [8] Dinich [4] and Gangwish. [6]

As in the review of the literature of school bus scheduling and plant location, almost all of the base data in districting and redistricting has been tabulated by hand and manually located on maps. Two of the better known models such as Marker and Hoover's [14] and Ploughman's [17] are good examples of the manual preparation of base data required before using a model of districting or redistricting.

Regardless of the recency of the study, data collection and assignment to grid or census by area has been largely a manual task. It is conceivable that the frontier of planning school bus scheduling, plant location and redistricting will at best continue to increase at a creeping pace unless base data and its assignment to geographic location can be computerized. Perhaps it was this need, among others, which has lead to the recent interest in geocoding systems.

Geocoding Systems

A recent review of the literature regarding the use of geocoding systems found four local systems in existence and three packaged systems which are available to interested persons. [11] The four locally developed systems referred to above were used or are currently being used in Albuquerque, Kansas City, St. Louis, Missouri, and New York City. The three packaged systems mentioned above refer to (1) the Street Address Matching System (SAMS) which is available through Urban Data Processing Incorporated; (2) the Street Address Conversion System (SACS) which is available through the Urban Data Center, University of Washington, Seattle; and (3) the Admatch-DIME* System which is available through the United States Bureau of the Census. Essentially all of the above programs or techniques attempt to assign either geographic coordinates or grids to street addresses.

The DIME technique, which was experimented with in the New Haven study and used as a basic planning tool, was considered to be fundamental to the planning process. This direction was taken as the task force in the study felt that

> fundamental to urban planning and analysis is the geographic location of activities, facilities and conditions throughout the city. Precise geographic identification is particularly important for the analysis of data about small areas, such as groups of blacks comprising locally designated special areas such as police beats, school attendance areas and health districts. [24]

To date very little has been done with the DIME Technique in educational planning. Most of the uses of census data in school administration fall into three categories: (1) demographic data; (2) socio-economic data; and (3) housing data. [23] In the case studies where census data were used educational planning and decision making were as follows: (1) Hamden's Newhall Street School Study; (2) Special Tabulations for Branford; (3) New Haven Special Tabulations; (4) New Haven School Redistricting; (5) Intracity Migration: The Use of School Transfer Records; and (6) Socio-economic Status of Elementary Schools. [23] Data for the above studies were produced in the majority of the cases, in table form rather than computer maps. The

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*Dual Independent Map Encoding.

prospect of using computer maps concurrently with table data in educational planning looks bright. "Computer maps, such as those produced by the Census Use Study would also be valuable in the school planning process." [23]

Use of the DIME file for computer mapping and locative purposes has not been entirely limited to the Census Study. Loubal, for example, used the DIME File technique in a study designed to allocate residents to bomb shelters. [12] The DIME file was used with the Address Coding Guide (ACG) and the number of people along each boundary segment was determined using census data. The result being a map showing segments with the population summed along each segment. [12] In this sense, individuals were located by segment and assigned to that segment on the map. Given distances and maximum capacity of each shelter, Loubal's model then made segment assignments to shelters with the objective function being to minimize the distance that persons would have to travel to reach the shelter. [12] The result was a graphic printout showing those segments assigned to each shelter and those segments not assigned to any shelter. [12]

PROCEDURES

A pilot study using the computerized locator system was implemented in the MNA, Tampa, Florida. Figure 1 illustrates the procedure followed throughout this study. The pilot study involved five phases which are briefly discussed in the succeeding pages. The reader will find it helpful to refer to Figure 1 to support the brief description for each phase.

Phase I

The first phase of this study involved the securing of a student record tape from the proper authorities and adjusting the student addresses for computerized retrieval. The computer program AD-SHIFT was used for this purpose.* A new tape containing the edited student addresses for the county was constructed. It was this tape that was passed against the address coding guide (ACG) for the MNA or target area.

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*AD-SHIFT, written Fortran IV, was designed to shift numerical and alphabetical characters in addresses to their proper columns.

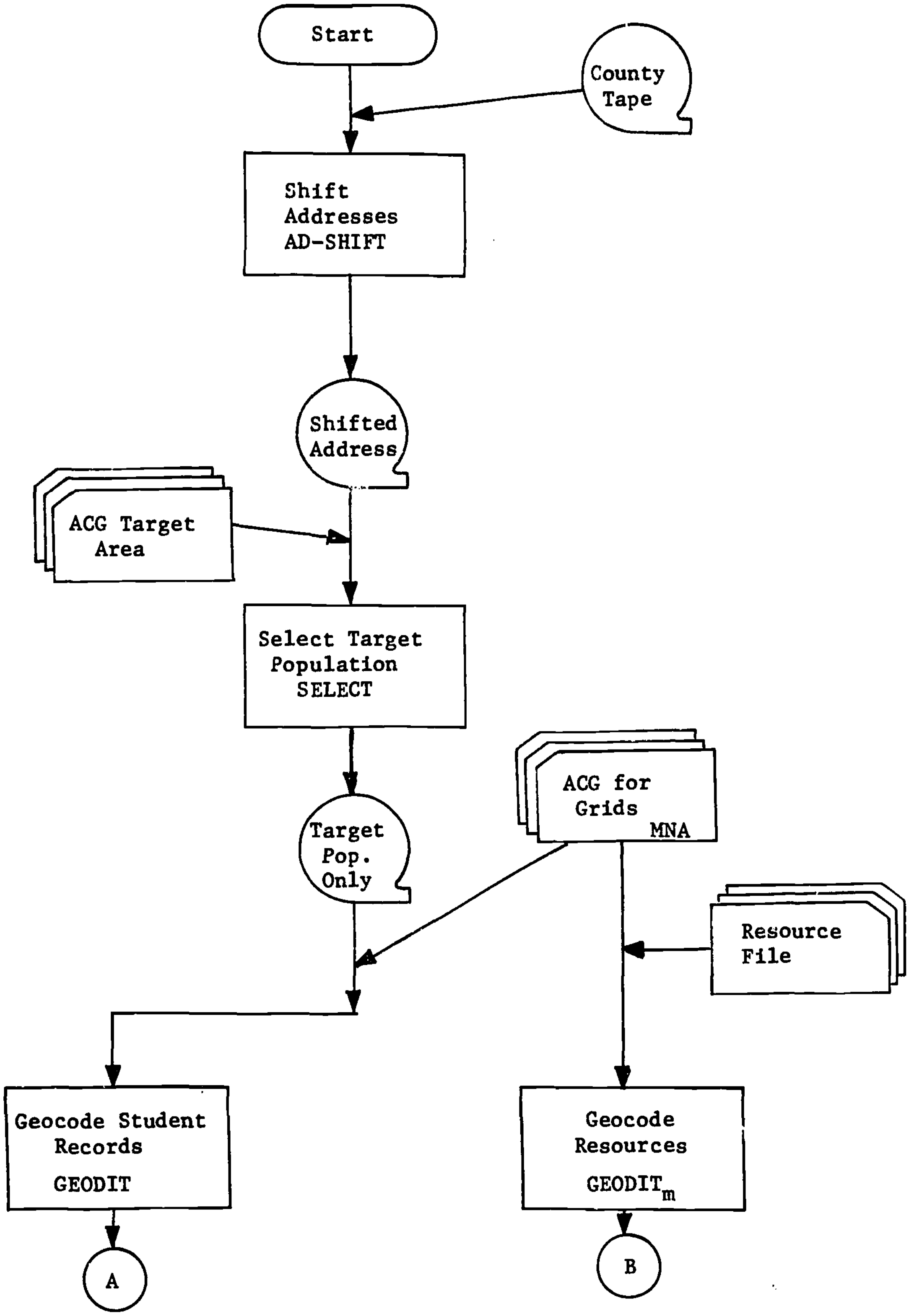

Fig. 1.--Computerized procedure for graphically locating students and resources over a geographic network.

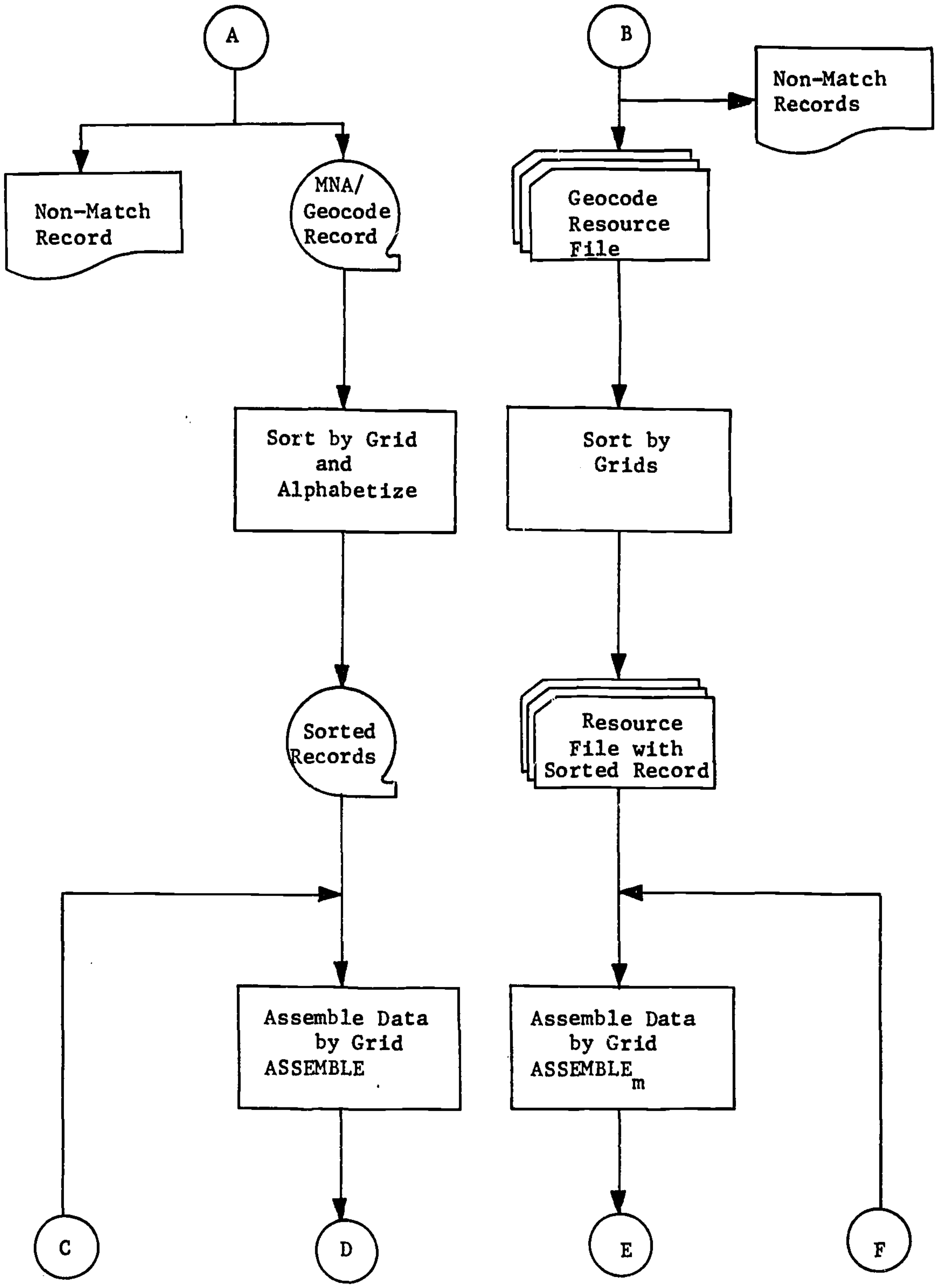

Fig. 1.--Continued.

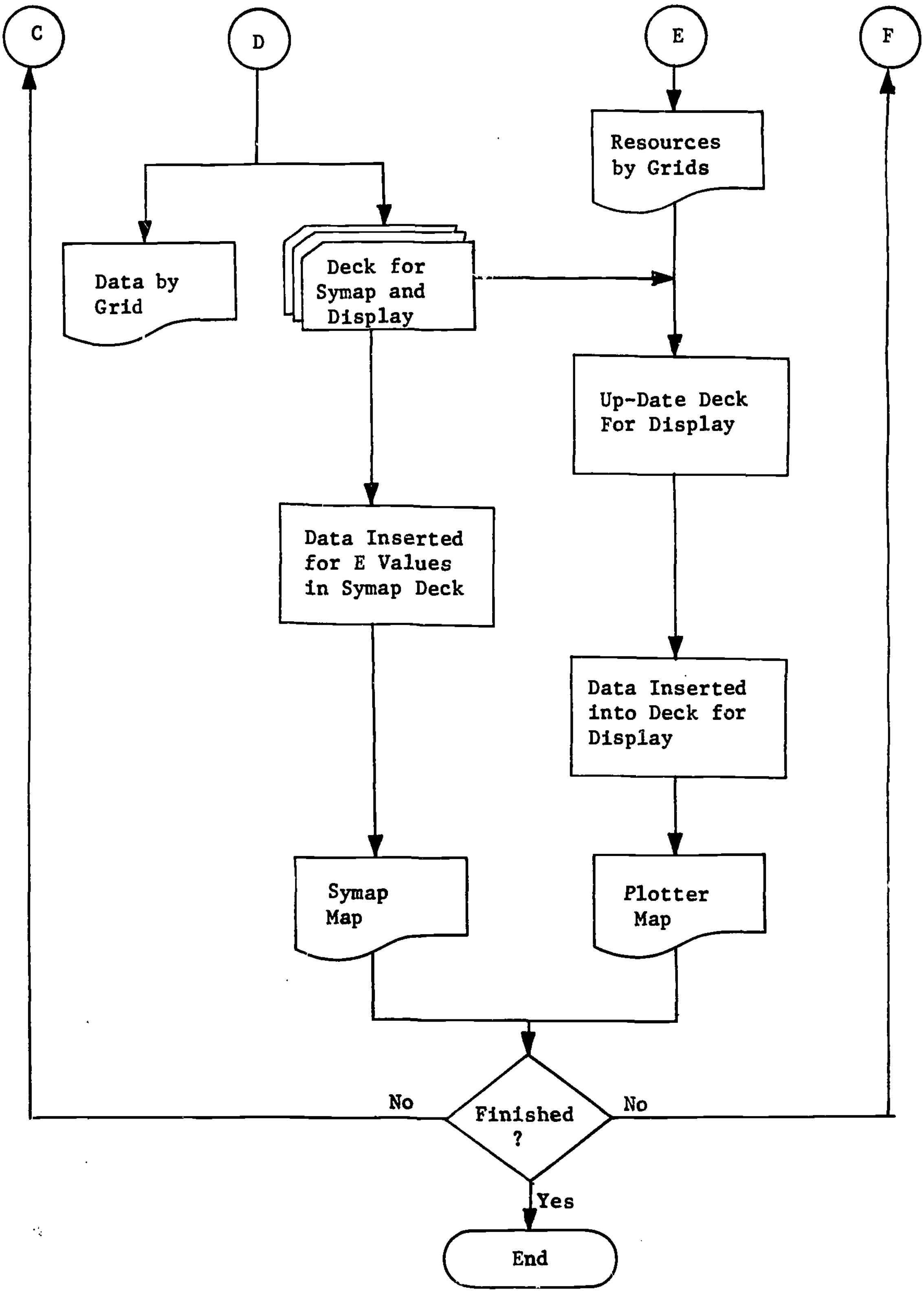

Fig. 1.--Continued.

Phase II

During this phase the students living within the MNA were selected from the edited county student record tape and their records were geocoded.

To accomplish the above it was necessary to obtain the address range contained within the total MNA and construct an overall ACG for the entire MNA.* The computer program SELECT, was used to match the student addresses on the edited county wide tape against the address ranges on the ACG. Those students, with their records, whose addresses fell within the ranges on the ACG were pulled and a new tape was constructed containing only those students residing within the MNA.

Following the above, a land use map of the MNA was secured and subdivided into 170 geographic areas.** The street network, existing physical facilities and boundaries within the MNA were used as variables in considering the size and shape of the geographic areas. An ACG was then developed containing the address ranges within each cell. The ACG, when completed was alphabetized and placed on IBM cards. The computer program GEODIT was then used to geocode the student records of those students living within the MNA.

Phase III

The third phase of this study involved the establishment of a resource file for the MNA and the geocoding of records within the file.

As the Hillsborough Planning Commission in Tampa, Florida had just completed a detailed analysis of the resources within the MNA part of their files were used for this study. Table 1 illustrates that portion of data, gathered by the Planning Commission for each address within the MNA, which was used for the resource file. The records in this file were then geocoded using a modified version of the program GEODIT.

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*This was done to obtain a subset (the students in the MNA) which reduced CPU time in later runs or passes using other programs and a more detailed ACG.

**The cells ranged from one to five city blocks in size.

TABLE 1

FIELD DESCRIPTION FOR RESOURCE FILE

Column	Field Description
1-4	Grid Number
4-10	Street Address
12-31	Street Name
32	Auxiliary Code
34-35	Building Number
37-38	Public/Private
40-43	Acreage
45-48	Activity Code
50-53	School Number
55-58	Student Modules*

Phase IV

During this phase of the study data were prepared for the computer program DISPLAY. This entailed obtaining the x-y coordinates for the centroid of each geographic area and gathering enough x-y coordinates for the plotter program DISPLAY to reproduce the boundaries of each of the 170 geographic areas. An intermediate computer program ASSEMBLE was used to summarize both students and resources located within each grid. DISPLAY used the output of ASSEMBLE as input, and displayed the data over the geographic network.**

Phase V

The final phase of this study involved two analyses: (1) all school children between the ages of six and twelve years of age inclusively along with capacity of each elementary school in the MNA were located and graphically displayed; and (2) an elementary school within the MNA was arbitrarily selected and the students attending this school were located and graphically displayed.

The output and results of these analyses are contained in the following pages.

*A student module is defined as the physical and human resources required to support a student in an activity for a single specified time period.

**See the output for clarification, pp. 20.

OUTPUT

First Analysis

The variable format card for ASSEMBLE was prepared to select for each grid those children located there between the ages of 6 and 12 inclusively. Table 2 shows a listing, by grid, of these students located within each grid. A punched deck of cards containing the totals/grid was also produced. It was this deck which was used as input to the computer mapping programs SYMAP and DISPLAY.

TABLE 2

ALPHABETIZED LISTING OF CHILDREN BY GRID BETWEEN THE AGES OF 6 AND 12 INCLUSIVELY IN THE MNA*

Name			Address	City	Grid No.	Additional Codes
TELLER	MARK	E	706E LARK	TAMPA	2M24010505035932	090969
TOTAL FOR GRID	2		1			
BURGER	MICHAEL	F	709BANKS ST	TAMPA	3M24010211216211	082769
TOTAL FOR GRID	3		1			
DELANY	FONDA		705ERIC ST	TAMPA	4F32410202206211	082969
OWENS	DENNIS		3407NEVADA	TAMPA	4M32410401015911	082769
BRADLEY	RICHARD		3504NEVADA	TAMPA	4M32410110036311	082769
BRADLEY	RICHARD		3504NEVADA	TAMPA	4M32410110036322	110369
BRADLEY	BLANCH		3504NEVADA AVE	TAMPA	4F32410310116111	082769
BRADLEY	BLANCH		3504NEVADA	TAMPA	4F32410310116122	110469
BRADLEY	LYNN		3504NEVADA	TAMPA	4F32410210186122	110469
GRIFFIN	MARTHA		3402TERRACE	TAMPA	4F32410510185911	082769
THOMPSON	DARLA		3415NEVADA	TAMPA	4F32410309016122	121569
THOMPSON	DAVID		3415NEVADA	TAMPA	4M32410306056012	111069
THOMPSON	DAVID		3415NEVADA	TAMPA	4M32410306056022	121569
THOMPSON	DARLA		3415NEVADA	TAMPA	4F32410309016112	111069
TOTAL FOR GRID	4		12			

*Grid totals are recorded only for those areas where students were located. In this analysis 3402 students were located.

Table 3 contains the density shadings generated when SYMAP was used for this analysis.

TABLE 3

INTERVALS FOR DENSITY SHADINGS ON FIGURE 4

DATA VALUE EXTREMES ARE 0.00 453.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
(MAXIMUM INCLUDED IN HIGHEST LEVEL ONLY)

	1	2	3	4	5	6	7	8	9	10	ABOVE
MINIMUM	0.00	7.30	14.60	21.90	29.20	36.50	43.80	51.10	58.40	65.70	73.00
MAXIMUM	7.30	14.60	21.90	29.20	36.50	43.80	51.10	58.40	65.70	73.00	

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL        1          2          3          4          5          6          7          8          9          10         H
         ************************************************************************************************************************
         .........  ''''''''' ---------  =========  +++++++++  XXXXXXXXX  CCCCCCCCO  000000000  @@@@@@@@@  @@@@@@@@@  HHHHHHHHH
         .........  ''''''''' ---------  =========  +++++++++  XXXXXXXXX  CCCCCCCOO  000000000  @@@@@@@@@  @@@@@@@@@  HHHHHHHHH
SYMBOLS  ....1....  ''''2'''' ----3----  ====4====  ++++5++++  XXXX6XXXX  OCCO7CCCO  00008000  @@@@9@@@@  @@@@*@@@@  HHHHHHHHH
         .........  ''''''''' ---------  =========  +++++++++  XXXXXXXXX  CCCCCCCCO  000000000  @@@@@@@@@  @@@@@@@@@  HHHHHHHHH
         .........  ''''''''' ---------  =========  +++++++++  XXXXXXXXX  OOCOOCCOO  000000000  @@@@@@@@@  @@@@@@@@@  HHHHHHHHH
         ************************************************************************************************************************
FREQ.        69         31         20         24         10          6          1          2          1          2          4
    1     I..1..I    I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI    ICO7CCI    I00800I    I@@9@@I    I@@*@@I    IHHHHHI
    2     I..1..I    I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI               I00800I               I@@*@@I    IHHHHHI
    3     I..1..I    I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI                                                 IHHHHHI
    4     I..1..I    I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI                                                 IHHHHHI
    5     I..1..I    I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI
    6     I..1..I    I''2''I    I--3--I    I==4==I    I++5++I    IXX6XXI
    7     I..1..I    I''2''I    I--3--I    I==4==I    I++5++I
    8     I..1..I    I''2''I    I--3--I    I==4==I    I++5++I
    9     I..1..I    I''2''I    I--3--I    I==4==I    I++5++I
   10     I..1..I    I''2''I    I--3--I    I==4==I    I++5++I
   11     I..1..I    I''2''I    I--3--I    I==4==I
   12     I..1..I    I''2''I    I--3--I    I==4==I
   13     I..1..I    I''2''I    I--3--I    I==4==I
   14     I..1..I    I''2''I    I--3--I    I==4==I
   15     I..1..I    I''2''I    I--3--I    I==4==I
   16     I..1..I    I''2''I    I--3--I    I==4==I
```

Table 3 furnishes the code for student density associated with various parts of the Model Cities Area.

Figure 2 contains the actual map which was obtained as output using SYMAP, and shows the density of students between the ages of 6 and 12 inclusive.

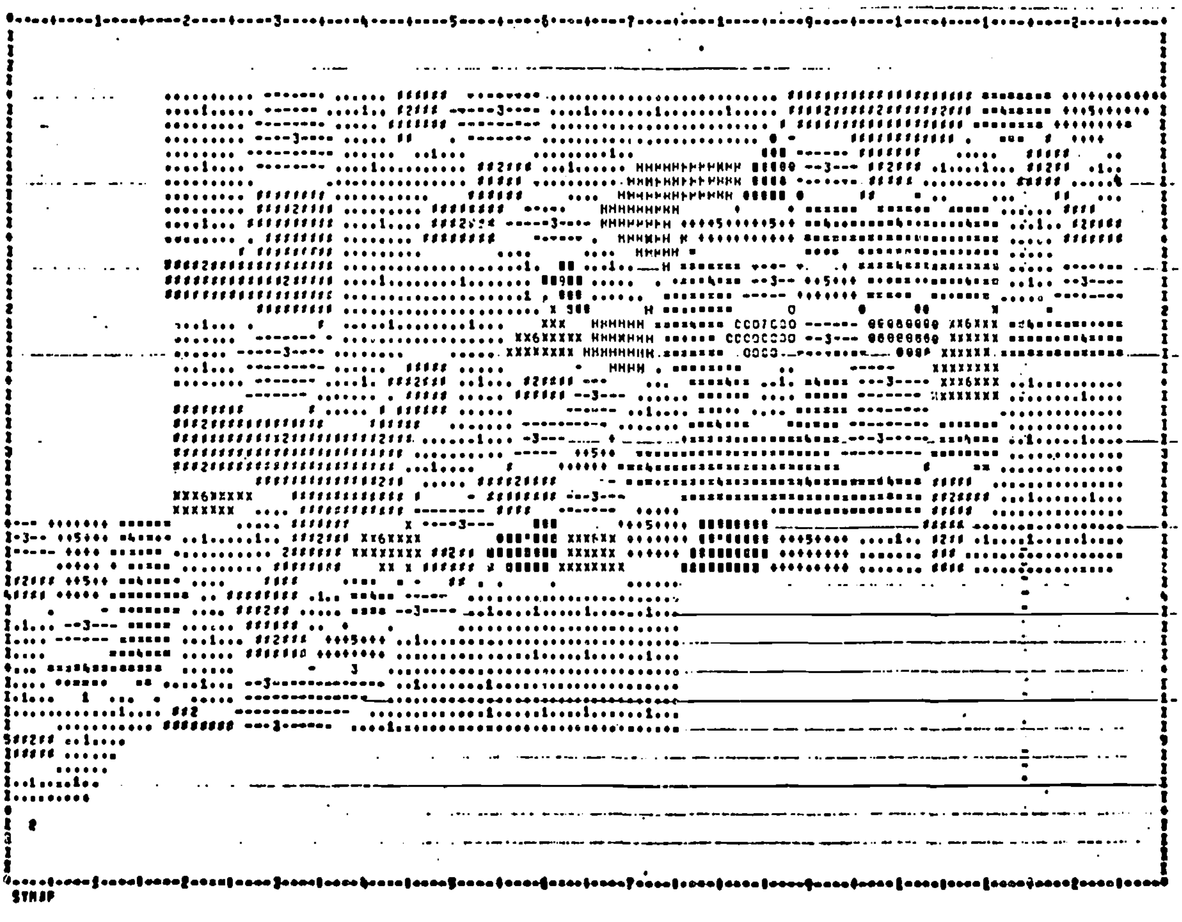

Fig. 2.--SYMAP printout showing density of school children between the ages of 6 and 12 inclusively in the MNA area.

Table 4 furnishes the actual values for each centroid for the printout shown in Figure 2.*

TABLE 4

DATA POINT VALUES FOR FIGURE 2

MAP SCALE = .3714 INCHES CN OUTPUT MAP/UNITS CN SOURCE MAP

MAP SHCULD BE PRINTED AT 6.0 ROWS PER INCH AND 10.0 CCLUMNS PER INCH.

ROW = (DOWN COORDINATE - -1.04) * 2.2286
COLUMN = (ACROSS COORDINATE - .60) * 3.7143

DATA PCINTS FOR MAP

POINT	ROW	COLUMN	DATUM	VALUE	LEVEL
1)	6	22	1	1.00	1
2)	10	22	2	1.00	1
3)	14	22	3	1.00	1
4)	17	22	4	12.00	2
5)	21	22	5	4.00	1
6)	24	22	6	6.00	1
7)	28	22	7	12.00	2
8)	31	22	8	11.00	2
9)	33	22	9	38.00	6
10)	36	2	10	20.00	3
11)	39	2	11	10.00	2
12)	42	2	12	6.00	1
13)	56	3	13	10.00	2
14)	47	2	14	5.00	1
15)	50	3	15	14.00	2
16)	53	3	16	2.00	1
17)	36	8	17	30.00	5
18)	39	9	18	33.00	5
19)	42	9	19	16.00	3
20)	45	9	20	24.00	4
21)	47	9	21	1.00	1
22)	50	9	22	5.00	1
23)	53	8	23	3.00	1
24)	36	14	24	23.00	4
25)	39	15	25	22.00	4
26)	44	15	26	24.00	4
27)	48	13	27	0.00	1
28)	8	32	28	18.00	3
29)	13	32	29	11.00	2
30)	18	31	30	11.00	2
31)	23	31	31	20.00	3
32)	29	31	32	13.00	2
33)	37	31	33	10.00	2

*Due to space constraints, only part of the table showing data point values for Figure 2 is shown in Table 4.

Second Analysis

This analysis was much like that of the first, but more discriminating in nature. The major difference between the two analyses being that this analysis focused on a particular school and only those children attending that school.* In this sense, this analysis involved locating a subset of the first analysis. Table 5 shows a section of a listing containing, by grid, those students presently in attendance at Orange Grove Elementary School. In all, 684 students were located.

TABLE 5

LISTING OF THOSE CHILDREN IN THE MNA ATTENDING ORANGE GROVE ELEMENTARY SCHOOL*

NAME		ADDRESS	CITY	GRID NO. ADDITIONAL CODES	
CROSLEY	DARYL	3415NEVADA	TAMPA	4M32410502055711	082869
DELANY	FONDA	705ERIC ST	TAMPA	4F32410202206211	082969
OWENS	DENNIS	3407NEVADA	TAMPA	4M32410401015911	082769
BRACE	NANCY	3504NEVADA AVE	TAMPA	4F32410610205711	082769
BRADLEY	RICHARD	3504NEVADA	TAMPA	4M32410110036311	082769
BRADLEY	RICHARD	3504NEVADA	TAMPA	4M32410110036322	110369
BRADLEY	BLANCH	3504NEVADA AVE	TAMPA	4F32410310116111	082769
BRADLEY	BLANCH	3504NEVADA	TAMPA	4F32410310116122	110469
BRADLEY	LYNN	3504NEVADA	TAMPA	4F32410210186122	110469
BRACE	NANCY	3504NEVADA AVE	TAMPA	4F32410610205722	110369
GRIFFIN	MARTHA	3402TERRACE	TAMPA	4F32410510185911	082769
THOMPSON	DARLA	3415NEVADA	TAMPA	4F32410309016122	121569
THOMPSON	DAVID	3415NEVADA	TAMPA	4M32410306056012	111069
THOMPSON	DAVID	3415NEVADA	TAMPA	4M32410306056022	121569
THOMPSON	DARLA	3415NEVADA	TAMPA	4F32410309016112	111069
TOTAL FOR GRID	4	15			
MATHEWS	RONALD	920E BARTON	TAMPA	28M32410204096111	082769
MATHEWS	STEVEN	920E BARTON	TAMPA	28M32410409145911	082769
MATHEWS	DENISE	920E BARTON	TAMPA	28F32410609265811	082769
POTTS	MARSHA	101123RD AVE	TAMPA	28F32410112126332	010670
POTTS	MELVIN	101123RD AVE	TAMPA	28M32410310106032	010670
MOODY	LINDA	101122ND AVE	TAMPA	28F32410501295911	082769
MOODY	DANIEL	101122ND AVE	TAMPA	28M32410503195711	082769
POTTS	JEAN	101123RD AVE	TAMPA	28F32410603235732	010670

*The school which was arbitrarily selected for this phase of the second analysis was Orange Grove Elementary School.

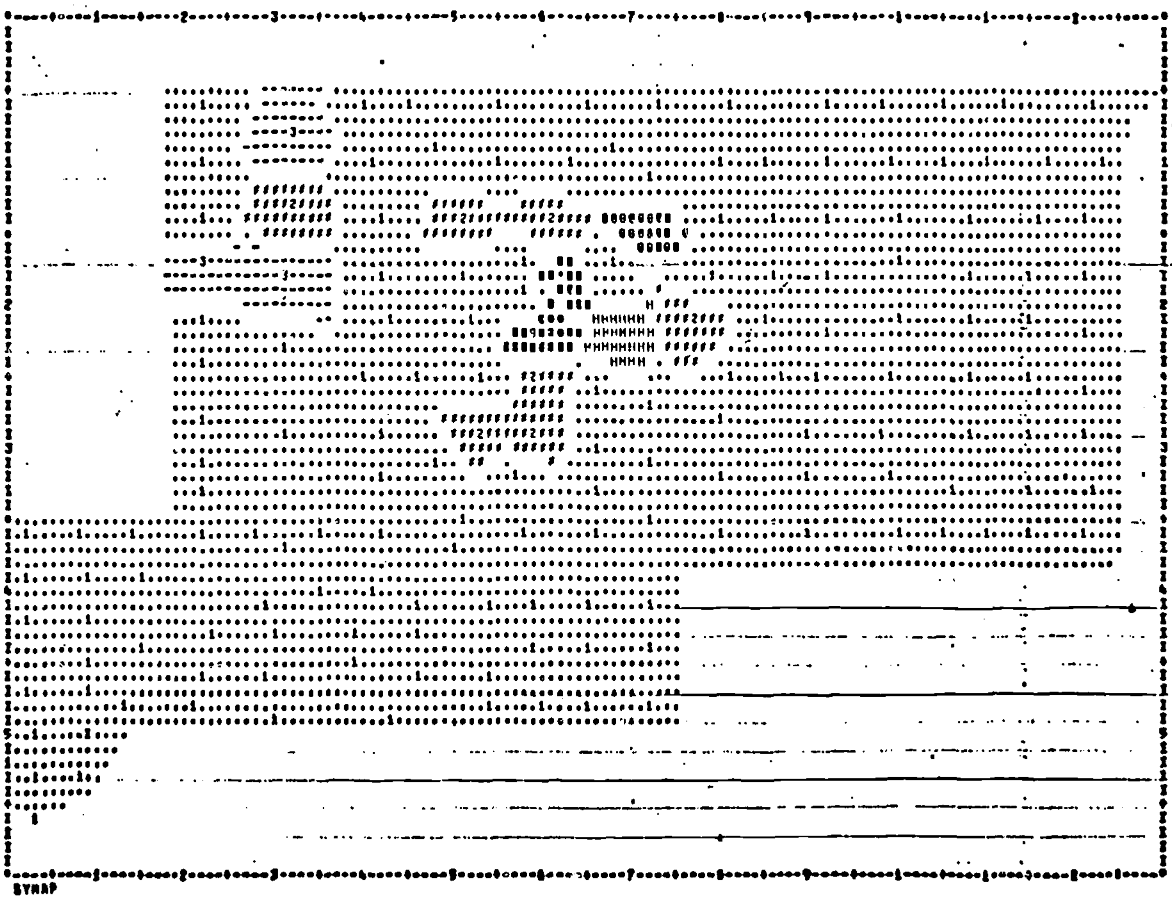

Fig. 3.--SYMAP printout showing density of children attending Orange Grove Elementary School.

Table 6 contains the actual values located at each centroid on Figure 3. Using Table 6 with Figure 3 gains further descriptive data supporting the second analysis, the analysis of those school children attending Orange Grove Elementary School.

TABLE 6

DATA POINTS FOR FIGURE 3

MAP SCALE = .3714 INCHES ON OUTPUT MAP/UNITS ON SOURCE MAP

MAP SHOULD BE PRINTED AT 6.0 ROWS PER INCH AND 10.0 COLUMNS

ROW = (DOWN COORDINATE - -1.04) * 2.2286
COLUMN = (ACROSS COORDINATE - .60) * 3.7143

DATA POINTS FOR MAP

POINT	ROW	COLUMN	DATUM	VALUE	LEVEL
1)	6	22	1	0.00	1
2)	10	22	2	0.00	1
3)	14	22	3	0.00	1
4)	17	22	4	15.00	3
5)	21	22	5	0.00	1
6)	24	22	6	0.00	1
7)	28	22	7	0.00	1
8)	31	22	8	0.00	1
9)	33	22	9	0.00	1
10)	36	2	10	0.00	1
11)	39	2	11	0.00	1
12)	42	2	12	0.00	1
13)	56	3	13	0.00	1
14)	47	2	14	0.00	1
15)	50	3	15	0.00	1
16)	53	3	16	0.00	1
17)	36	8	17	0.00	1
18)	39	9	18	0.00	1
19)	42	9	19	0.00	1
20)	45	9	20	0.00	1
21)	47	9	21	0.00	1
22)	50	9	22	0.00	1
23)	53	8	23	0.00	1
24)	36	14	24	0.00	1
25)	39	15	25	0.00	1
26)	44	15	26	0.00	1
27)	48	13	27	0.00	1
28)	8	32	28	11.00	3
29)	13	32	29	10.00	2
30)	18	31	30	11.00	3
31)	23	31	31	4.00	1
32)	29	31	32	0.00	1

Figure 4 is a graphic output of the student density by grid throughout the Model Cities Area. The map, grids, highways and frequency counts are printed simultaneously by computer plotter. The actual computer output uses color codes to denote specific data associated with each grid.

Only those grids where students are located contain numerical values. The center number in each grid represents the grid number, the top number denotes the students located within each grid and the bottom number the number of student modules available. Since the resource locations available were logged only at schools in the printout in Figure 4, those grids with three numbers denote school locations.

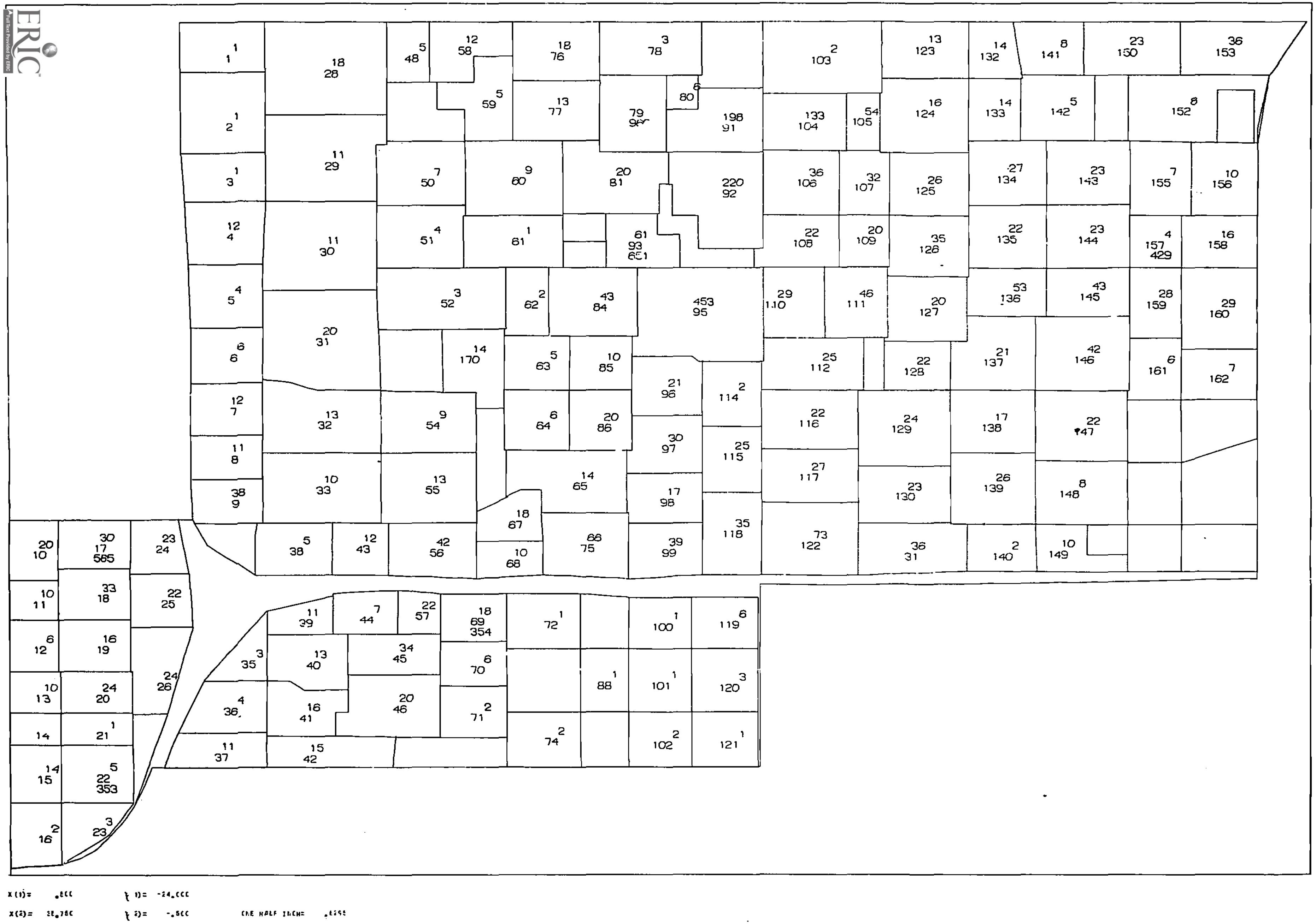

Fig. 4.--Graphic output of student density by grid.

Figure 5 shows the graphic printout showing the locating of each student currently enrolled in the school located in grid #93. The potential use of this program for purposes of locating schools is obvious. By invoking two other programs (a districting program and minimum path transportation program) one can project long range facilities planning according to demographic movement patterns. With emphasis upon moveable or relocatable facilities these programs have considerable potential for solving problems associated with racial mixtures, vocational programs, and population shifts.

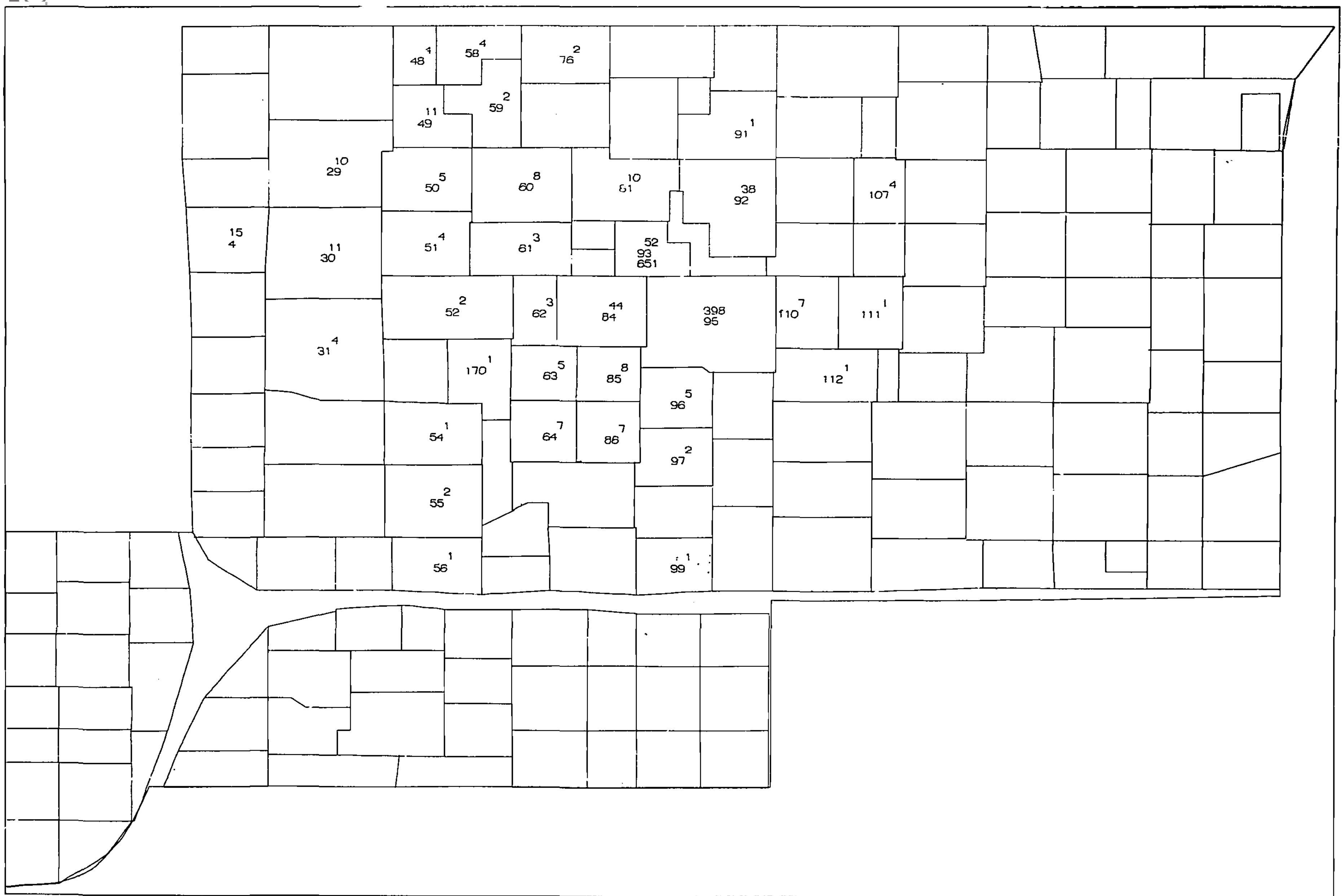

Fig. 5.--Graphic printout showing the locating of each student currently enrolled in the school located in grid #93.

DISCUSSION AND CONCLUSIONS

A computerized system for displaying demographic data over a network was presented. The total system, Figure 1, is generalizable not only to other educational systems, either large or small, but to planning in other disciplines as well. For example, one might use the system described in this document to:

1. Display police data over a geographic network of an urban area.

2. Assist health planners in describing the current "use" status of present facilities and provide information or data relevant to where facilities might be inadequate or additional facilities required.

3. Assist business planners in plant location, transportation problems, or perhaps in establishing the location of small training centers which might be located at various strategic points throughout the community.

4. Provide planners with user-resource location in the development of a system to facilitate proper usage of leisure time or perhaps in the redesigning of a recreational system which would be integrated with other subsystems in the environment.

The above are only a few further possible uses of this system. The system, while it has certain definite advantages over SYMAP, permits the user to utilize the SYMAP program as the input generated for the graphic program. DISPLAY is in the proper format for input to SYMAP. Like SYMAP and other systems or programs, this system has limitations. First, the system does only what it was designed for. It locates both users and resources over a geographic network. As such it does not make planning decisions. Another limiting factor might result from the lack of a sophisticated preprocessor in the early stages of the system. Such an addition to the system would further edit the student and/or resource addresses and possibly allow for a better match when using the ACG. This, however, becomes less a limiting factor if the addresses have all been recorded using the same system. Given that the addresses in the records have been systematized and properly up-dated using the same format, the system outlined in this paper should match most, if not all, of the addresses with the address ranges in the ACG.

While the preceeding pages have only very briefly described what was a very complete and involved stuay it should be evident that the ends justify the means. Further, the ends to this system hold the promise of being used as a means to problem solving and planning in many fields. In the latter sense, this system might better be described as an interdisciplinary planning tool.

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