COMPUTER TECHNIQUES FOR
STUDYING ACTIVITY LOCATIONS
IN A NEW TOWN DESIGN

by

DIMITRIOS LEONIDAS STAMATIADIS
M. Arch. Akademie der Bildenden Kunste in Wien
(1968)

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER OF
ARCHITECTURE

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
June, 1970

Signature of Author

Certificate by

Accepted by

Archives


NOV 16 1970

LIBRARIES
COMPUTER TECHNIQUES FOR STUDYING ACTIVITY LOCATIONS IN A new TOWN DESIGN

by Dimitrios Leonidas Stamatiadis

Submitted to the Department of Architecture and Planning on June 4, 1970 in partial fulfillment of the requirements for the degree of Master of Architecture.

The purpose of this thesis, broadly defined, is to study and explore the use of computer techniques in urban design. Based on a specific design for a new town, a subset of the design process dealing with the behavior of urban activities, is thoroughly described, establishing a set of variables, criteria and rules on which the designer operates.

The generated information and the methods the designer is using in the conventional design process, serve as a subject for the replication of a computer model, using Discourse computer language. The results are used to investigate the comparative performance of the computer technique versus the conventional method, and to draw conclusions that will contribute to further research in Computer aided urban design and especially in the development of the Discourse language.

Thesis supervisors: William L. Porter
Assistant Professor of Architecture

John R. Myer
Associate Professor of Architecture
ACKNOWLEDGEMENTS

I would like to take this opportunity to express my gratitude to my thesis supervisors, Professors John R. Myer and William L. Porter, for their assistance, guidance and most valuable criticism in the development of this thesis. I would also like to thank Mr. Chuck Libby and Mr. Wren McMains for their support and advice in structuring the computer model, and Professor Edward Allen for his criticism and most helpful advice in this thesis. Mrs. Liz Kirby, to whom I am much obliged, contributed to the appearance of this paper through her excellent typing and interest. And last, but not least, I am sincerely grateful to Mr. Tim Lundee and Mr. David Krebs for the computer programing help, and continuous assistance which made the operational part of the model possible.
TO MY FATHER
## TABLE OF CONTENTS

### ABSTRACT

### ACKNOWLEDGEMENTS

#### A. INTRODUCTION

1. The problem and the approach ......................... 6
2. Content of thesis ............................................... 8
3. Purposes and goals ........................................... 10
4. The Discourse language...................................... 11

#### B. NEW TOWN DESIGN

1. A Satellite Town of Athens ................................. 13
2. Description of the Design process ..................... 15
3. Analysis of a subset: activity behavior ............... 19

#### C. THE COMPUTER MODEL

1. Purposes and goals ........................................... 26
2. Translation of the subset .................................. 27
3. Date requirements ........................................... 41
4. Model structure .............................................. 46
5. Model operation .............................................. 59

#### D. TESTS AND CONCLUSIONS

1. Tests of model operation................................. 65
2. Conclusions and future development of model ........ 111
3. Computer techniques in Urban Design .................. 114

#### E. 1. Bibliography

2. List of Figures and Tables
(A) INTRODUCTION:

1. The problem and the approach.
2. Content of thesis.
3. Purposes and goals.
4. The Discourse language.

(1) THE PROBLEM AND THE APPROACH

Until recent years Architecture has been based on the systems of values and techniques nurtured in the first three decades of this century. In the last few years, however, it has become increasingly obvious that a change in attitude has begun to take place as it has in other disciplines and arts.

Recently, architects have begun to concern themselves with the particular place and time of their buildings; with their contexts, and with the psychological effects of their functions and spaces. They find inspiration not in preconceived ideal concepts, but in the particulars of each situation, including the TIME and place of creation, and USE, the permanence or impermanence of the building, all or in part, the fragmentation of forms and spaces, and the entire reaction and counter reaction of the buildings and the environment.

"According to the new Physics, the only reality lies in a particular THING in a particular PLACE and in a particular TIME."

The process of locating this "point" is a simultaneous equation satisfying numerous differentials at a common place in space.
For the urban designer, who is dealing with the environment, the variables time, place, use, and relation of the physical forms, become very important during the design process. He has to analyse them systematically, using different methods and techniques, because of their complexity and change. The buildings are not objects to look at, but parts of the environment that cause things and reactions to happen.

A computer technique can be very useful in this area of design, where the designer is not being replaced, but freed from many detailed operations which presently limit the number of alternatives he can consider. The computer can be used to search mechanically for workable combinations of variables whose nature and range have been precisely defined. The planner can begin to design in direct conjunction with the computer, suggesting solutions whose consequences the machine rapidly develops, or asking for possibilities of a certain kind, which are quickly presented to aim for review and revision. (15)

There is very little done in the development of computer techniques in urban design that would help in producing better step-by-step solutions, than the ones arising from a simultaneous consideration of several objectives by the designer himself.

The intention of this paper is to develop such a computer technique and test it versus a conventional technique. The study will be limited to one specific area of design, considering only a few variables and a simplified process.
There are four major stages in this research:

1st describing
2nd transforming
3rd testing
4th evaluating

(2) CONTENT OF THESIS

This thesis presents a complete approach for studying the behavior and location of Urban Activities in the Design for a new town. The major steps discussed are the following:

1. Description of the Design process based on a specific project, A Satellite Town for Athens.*
2. Analysis of the Activity-Actor relationships and their role during the design process.
3. Translation of a subset of the design process into the Discourse Computer language, and Description of data requirements.
4. Description of the structure of the model, and its operation.
5. Model testing, output, evaluation of "runs", improvements.

*D. Stamatiadis: "A Satellite Town for Athens", student project, Vienna Academy of Arts, 1968. For more information see (20) and (21).
FIGURE 1
6. Conclusions on the use of the Discourse language, and the use of computer techniques in urban design.

Future research.

(3) PURPOSES AND GOALS

The major purpose of this thesis is to draw conclusions on the use of computer techniques in Urban Design, by developing a computer model that will relieve the urban designer from some repetitive operations during certain stages of the design process. The model will replicate the designer's actions and operational behavior in the activity-location stage of the design process, simulating to a certain extent the conventional design method.

A second purpose is to assist the development of the Discourse computer language by describing the author's experiences and difficulties working with the system, through this research.

Another purpose is to re-evaluate, based on the results generated by the model, the product of a conventional design technique, that operated on the same principles and rules.

The following general goals are to be achieved:

1. Simplicity and explicitness in the descriptive parts of this study.
2. Flexibility of the model-structure for use by other designers and for applicability to other places and times.
3. Minimizing cost of the process as compared to conventional processes.

4. The lowest possible ratio of input information to output information of the model.

(4) THE DISCOURSE LANGUAGE

"The Discourse language has been designed as a high level problem oriented language in which the data structure would be transparent to the user and in which there would be the most manipulations existing in any general purpose computer languages."

"The major justification for building higher level languages is to relieve the user of the burden of having to deal with complexities and the communication among different components of the computer system."

"Discourse has to do with assisting the designer in generating and studying alternative configurations of the environment. These configurations may be the design, the implication of a set of policies which is the heart of the design or a representation of the environment which is useful in determining what the design problem is."

"The Discourse statements, whether they be commands or computations are generally interpreted as they are typed, thus giving the user immediate response to his requests or probes into other complex data systems, which are stored and manipulated within the machine."

"The Discourse language is an interactive language used with a terminal interface and oriented toward the analysis of interdependent data. It is especially useful in the
analysis of spatially disposed data systems, and because of its flexibility and ease of manipulation is suited to design applications." (24) Although the language is usually dealing with studies of large scale environments, because of its flexibility, can be used for studying also small scale environments assisting the urban designer in different stages of the design process.

As in the use of other computer systems, it is important to separate the areas of operation between the computer and the designer, avoiding a misuse of the machine that will generate useless or incorrect results. The criteria by which those areas of action are defined are set up according to the specific problem by the designer, who must have a sense of what information he needs, and use a clean vocabulary and pre-defined rules.
NEW TOWN DESIGN

In the case of this study, the design process itself is not as important as the careful description of it, and the analysis of a subset that will serve as a base for the replication into Discourse and the construction of the computer model. Though, in order to make this design process understandable to the reader, it is necessary to go into some depth in describing generally the project and its goals.

1. A Satellite Town for Athens
2. Description of the design process
3. Analysis of a subset: activity behavior

1. A SATELLITE TOWN FOR ATHENS

Athens' need for expansion has caused the formation of small unorganized communities on the periphery of the city that have pushed their way through to become towns or suburbs, demanding urban services and recognition of their being part of the city. To solve this chaotic situation it is proposed to form dense urban centers, on specific locations in and outside the present borders of the city, around nuclei that will attract development more than other areas. Those urban centers can be called "New Towns" or "Satellite Towns" or even "Towns within a Town" and must be based on a very flexible and change-sensitive system, in order to allow incremental growth, according to site conditions, population characteristics, and time-limits.
The kind, size, and rate of the incremental growth of New Town will not only depend on the internal circumstances, but will relate strongly to the other New Towns of the area. Some of them will grow to population sites of 50,000 - 80,000 people, and others will never grow beyond 2,000 - 5,000 people, giving ground for other new TOWNS to develop.

This project deals with the design of an experimental New Town for 25,000 people located 9 miles southeast of the center of Athens surrounded by low hills being open towards the sea, to the southwest. There is little vegetation, but there are sufficient water sources and a very good climate. The town will attract tourism, the major industry, creating job opportunities for at least 6 months of the year. The rest of the year there will be jobs in light (local) industries, like handi-crafts, boat building or textiles.

The town will also contribute to the decentralization of Athens, attracting a population that will mainly commute daily downtown for work and shopping. Only a small percentage of the residents of the town will be occupied locally. Although the density of the town will be close to that of downtown Athens it will offer to the inhabitants the advantages of "country living". The New Town won't be self-supporting, but will be strongly dependent on the mother-town, being a satellite of it.
FIGURE 2: MAP OF THE GREATER ATHENS AREA WITH THE PROPOSED NEW TOWNS
2. DESCRIPTION OF THE DESIGN PROCESS

"Town planning or city design is the general spatial arrangement of activities and objects over an extended area where the client is multiple, the program indeterminate, control partial and there is no state of completion" (14)

The three major steps taken in the design process of the study were the following:

a. 1. The principle of a new Town: general operating rules, criteria, goals.
   2. Setting up site-selection criteria.
   3. Selection of sites, and study of surrounding areas.
   5. Study of a flexible organizational system on which the design was to be based.
   6. Application of the system to the site: town planning (physical) circulation system, residential areas, urban services, industry.

b. 1. Urban activities: characteristics and behavior.
       Study of housing patterns and characteristics.
   2. Criteria, principles and operating rules for locating housing.
   3. Study of Town-facility patterns and characteristics.

5. Tourist industry patterns, characteristics, location.

6. Location of urban activities in the system.

c. 1. Creation of a major plan, for 25,000 people


FIGURE 5
DIAGRAMMATIC PRESENTATION OF THE SUBSET OF THE DESIGN PROCESS OF A NEW TOWN
a. 5. THE ORGANIZATIONAL SYSTEM

The major criteria for the system were the following:

(a) Flexibility to adjust to future changes and directions,
(b) Allowing incremental growth giving the town a complete form at any stage of the development,
(c) Simplicity and clarity of its elements.

FIGURE 6

1. Center area
2. Residential area
3. Service area - light industry
4. Green zone
5. Major artery
6. Service road

The physical form of the system is linear, allowing the town to grow incrementally in both directions, easily adjusting itself to different site conditions and characteristics. The service zone is directly proportional to the center zone, and the center zone to the residential zone, depending upon another.
Economic development has brought specialization to the work of men and also to men's activities like work, home, shopping and recreation which are more separated than they have ever been. Homes specialize by race, income, family, like style, size, ages and tastes of residents. Shops cluster or separate according to price, style, variety and type of goods offered, and according to whether they are reached on foot, by cow or by mass transit. Factories and offices gather and separate in complicated rhythms of their own. The great variety of indoor and outdoor amusements distribute themselves in space, according to the markets they serve.\(^{(23)}\)

For the study of the behavior of the urban activities during the design process, the designer has to specialize and define the major activities involved and their actors, describe their characteristics and understand the relations between one another. Then he is grouping them together, interrelating them in different ways and scales, analysing them, and simplifying them. The understanding of the different actions taking place during the design process, which occur at a specific time and place and in which activities and actors are involved, enables the urban designer to evaluate his work, improve continuously his design, correct his errors and generate new alternatives.

In every activity there are actors involved that are also participants in other activities. This creates relationships between pairs of activities that are affected by the kinds and numbers of the actors
participating in both, by the desirability to be close together, and by the time cost between each other.

\[
\text{time cost: a function of "distance" divided by speed between two activities}\\
\text{closeness desirability: a given "weight" to a pair of activities}\\
\text{relationship: a function of the "weight" divided by the "distance"}
\]

To be able to describe and understand the behavior of the urban activities, we have to simplify things, dealing from now on only with actors, activities and relationships.

The existence of an activity depends on the actors involved, and the location of an activity on its relationships to the other activities. The highest the "value" of a relationship the more is the facility attracted towards one direction. Since the weight in a relationship is constant, only the distance, which is a variable, can influence its value.
In the above example, assuming that activity B is to be located the lines between A and B could be imaginative rubber bands that allow B to move freely till it finds the best location, minimizing the total cost (location $B = \frac{w}{d_1} + \frac{w}{d_2} + \frac{w}{d_3} + \frac{w}{d_4} = \text{minimum}$).

FIGURE 7

The decision making concerning the location and spatial arrangement of urban activities was based on the following list of design goals. *

1) Legibility: Increase the degree of legibility of the urban activities as city forms.

2) Accessibility: Decrease cost (time) of moving or communicating between activity locations and increase the degree of choice of mode.

3) Diversity: Increase the range of variation of urban activities and the spatial mixture of this variation.

4) Adaptability: Decrease the adaptation of urban activities to new functions and increase the degree to which new environmental patterns are generated and evaluated.

* This list is adapted from Kevin Lynch (15)
The following major activities and their specific location are shown in the "Town Center" plan.

1. Existing church
2. Park
3. New church
4. Nursery school
5. Elementary school
6. Secondary school
7. Sports
8. Swimming pool
9. Gymnasium
10. Open space
11. Shopping
12. Offices
13. Supermarket
14. Agora
15. Theater
16. Bus terminal
17. Parking
18. Light industry, services
19. Main road
20. Housing
The community facilities are the prime generator of urban activities and the major contributor to the sensuous form of a town. Therefore, the design and location of these facilities should be coordinated in TIME and SPACE for maximum contribution to an ordering of the form and structure of the urban environment.

The decision making for the number, size and kinds and time of appearance of community facilities required to serve the town population is based on statistical information on population, habits, characteristics and life styles of the Greater Athens area. It won't be necessary to describe the process through which the facilities in the 'Satellite of Athens' project were determined, since the computer model won't be an exact replication of the subset of the design process but will represent a typical situation, based on simplified assumptions.

For the purpose of understanding the transformation of statistical information into design assumptions, one typical table is included on user-facility relations.
<table>
<thead>
<tr>
<th>FACILITY</th>
<th>PEOPLE</th>
<th>MEN</th>
<th>WOMEN</th>
<th>YOUNG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percentage who used the facility once a month</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Church</td>
<td>49.9</td>
<td>38.5</td>
<td>64.3</td>
<td>57.8</td>
</tr>
<tr>
<td>Theater</td>
<td>8.4</td>
<td>10.1</td>
<td>9.6</td>
<td>3.8</td>
</tr>
<tr>
<td>Parks</td>
<td>9.0</td>
<td>6.7</td>
<td>0.2</td>
<td>12.2</td>
</tr>
<tr>
<td>Gymnasium</td>
<td>0.7</td>
<td>0.6</td>
<td>0.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Football</td>
<td>2.7</td>
<td>5.4</td>
<td>0.2</td>
<td>3.0</td>
</tr>
<tr>
<td>Athletic</td>
<td>1.2</td>
<td>1.8</td>
<td>1.9</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Facility</th>
<th>Percentage who used the facility once a week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coffee Shop</td>
<td>11.3</td>
</tr>
<tr>
<td>Confectioners</td>
<td>22.7</td>
</tr>
<tr>
<td>Taverns</td>
<td>8.7</td>
</tr>
<tr>
<td>Restaurants</td>
<td>3.9</td>
</tr>
<tr>
<td>Night Clubs</td>
<td>1.2</td>
</tr>
<tr>
<td>Cinemas</td>
<td>40.6</td>
</tr>
</tbody>
</table>

FIGURE 9

STATISTICAL TABLE OF USERS PARTICIPATION
COMMUNITY FACILITIES OF THE ATHENS' AREA

\(^6\)
A typical example of the conclusions arrived from the previous table is shown by the number of churches required:

1) size: of every church for 250 users
2) town population: 10,000 people
3) percentage maximum: 10% of town population in every mass
4) use: four times monthly (Sundays)
5) first and second mass

Number of churches required: $1,000/250 = 4$

Most of data structure of the simulation model was based on similar mathematical equations but also on other criteria.
(C) THE COMPUTER MODEL

1. Purposes and goals
2. Translation of this subset: activity behavior
3. Data description
4. Model structure

1) PURPOSES AND GOALS

The simulation model of activity behavior serves to study its own practicality as a tool to the Urban Designer during the design process, by indicating the information required to implement it and by testing and evaluating the results, and their usefulness to the design.

The second purpose of the model is to aid the development of the Discourse computer language by describing the author's experience and difficulties, structuring the model and using the language.

The goals and measures of accomplishment of the model are:

a) The ratio of input data required by the model to output data generated by the model.

b) The accuracy and cost of the latter as compared to direct observation of the variables in question.

c) The applicability of the model to other times and places than that for which it was originally constructed.
(2) TRANSLATION OF THE SUBSET: ACTIVITY BEHAVIOR

For the transformation of this part of the design process into the Discourse system and the construction of the model it is necessary to simplify the variables to be considered, and their characteristics.

The activities are divided into 3 major groups, static (existing), developed (housing) and generated (facilities), and there are 5 major actors (users) participating. The relationships between activities are simplified in weights and the decision-making of their behavior and location is based on rules. The variables, relationships and rules are described in the following pages and are used as a base for the data structure of the model.

*(9) "...reducing the apparent complexity of the observed world to the coherent and rigorous language of mathematical relationships"*
ACTIVITIES AND THEIR CHARACTERISTICS

I STATIC ACTIVITIES:

These represent the existing situation, being permanent in their location and characteristics during the operations.

a) Park
   landscape areas in general, forest or groups of trees, existing on the site. Used by people, and especially children for playgrounds. Recreational areas.

b) Water
   Small river or lake used mainly as playground and for recreational purposes. Major actor children.

c) Traffic
   Automobile traffic in general. Local road, serving mainly delivery and shopping. Actor: Households and working men.

II DEVELOPED ACTIVITIES

These are activities, whose existence and location is decided by the designer, who is acting as a developer or agent. The decision making for locating the developed activities is affected by the characteristics and location of the static activities.

a) Lowhous
   Low density housing: Residential area of 1-2 stories. All 5 actors participating.
b) Medhous
   Medium density housing: Residential area of 3-4 stories. All 5 actors participating.

c) Highous
   High density housing: Residential area of 4-6 stories. All 5 actors participating.

III GENERATED ACTIVITIES

Their existence is dependent on their characteristics, location, and number of the developed and generated activities. The time-place arrangement of their location is left totally to the computer according to controls and rules decided previously by the urban designer.

a) Element
   Elementary school and kindergarten for 200 pupils.
   Actor: children 1

b) Second
   Secondary school of 500 students.
   Actor: children 2

c) Religion
   Church for 250 people
   Actor: people
d) Theater
   Entertainment areas and restaurants, theaters, clubs in general.
   Actor: people

e) Sports
   Areas for athletics and playgrounds.
   Actor: children 2

f) Commerce
   Shopping areas, markets or stores. Commercial activities in general.
   Actor: Households

g) Office
   Town offices (public service). Professional offices, office space in general.
   Actor: working men

h) Industry
   Light industry, handi-craft, boat building.
   Actor: working men

i) Busstop
   Bus connections of downtown area (also connections to other surrounding areas)
   Actor: households
ACTORS AND THEIR CHARACTERISTICS:

TOTPEOP is the town population* including men, women and children. The number of the population effects mainly the existence and location of the activities:

a) church
   religion for every 2000 TOTPEOP
b) entertainment
   theater for every 450 TOTPEOP

TOTSHLD is the town households including 1 person families. Their number affects the existence and location of the activities:

a) commercial
   commerc for every 120 TOTSHLD
b) Busstop
   Busstop for every 800 TOTSHLD

TOTMENW represents a percentage of the population employed in the town (10% of TOTPEOP). There are men or women working in, and effecting the activities:

a) office space
   office for every 200 TOTMENW
b) light industry, services
   industry for every 150 TOTMENW

*One social, and income class is assumed for reasons of simplicity.
TOTCLD 1 are children of ages 3-11 affecting the existence and location of the activity (23% of TOTPEOP);

- Nursery and elementary school

Element for every 400 TOTCHLD 1

TOTCHLD 2 are children of ages 12-18 affecting the existence and location of the activities (12% of TOTPEOP):

a) Secondary school

- Second for every 750 TOTCHLD 2

b) Athletics, playgrounds

- Sports for every 300 TOTCHLD 2
DISCLAIMER

Page has been omitted due to a pagination error by the author.
FACTORS CONSIDERED FOR GENERATED - ACTIVITIES BEHAVIOR.

Since static-activities are located according to the site conditions and developed-activities according to the designer's own decisions, it is important to describe only the behavior of the generated-activities.

a) Existence:
   The appearance of a generated-activity is dependent on:
   the number of activities of the same kind already existing,
   and the number of its major actors already existing (in the developed activities). *

b) Priority:
   In most cases more than one generated activity makes its appearance at the same time. A method for deciding which one is to be located first is based on importance, necessity to the town and characteristics.

c) Weighting:
   After the decision is taken that the generated-activity is to be located, 15 weights are assigned, that represent its closeness, desirability to each of the other activities; **A method for assigning those weights to the generated-activities is described separately in this chapter.

* In every generated-activity there are also 5 actors participating, but for simplification reasons, only the major actor has been considered.

** For example: if the activity is an Elementary School, a high value is given to the pair ELEMENT-PARK and a low value to the pair ELEMENT-INDUSTRY.
d) Location:
Through zoning, certain areas are defined for the location of certain activities. The exact location of the activity is found, according to the weights assigned to the generated-activity, the location of all the other activities, and a reduction of cost criterion.

e) Spatial Arrangement:
Around the exact location, different spatial arrangements take place for the different generated-activities, according to their space requirements.

The static-activities are related to the rest of the activities only in terms of weights affecting locational decisions. The developed-activities (with 5 actors each) and the generated-activities (with 1 actor each) relate to each other in terms of participating actors, affecting the existence of the last, and both relate to the rest in terms of weights.
ACTIVITY WEIGHTING

One of the most demanding tasks during the design process is weighting and evaluating various activity-pairs, by attaching particular "values" to those that will affect their behavior and location. The method assign numerical ratings to every generated activities relating each to all others, including itself. The method of assigning weighted values is adapted from a report entitled "American Electric Power System", dealing with industrial plants.

During the operation, every time an activity is to be located on the grid, its "weight", to every other activity is considered influencing strongly its location. The values of the weights of the activity pairs vary between 1 (minimum weight) to 30 (maximum weight). The detailed analysis of the method for assigning weights is described in the following pages taking as an example the activity "COMMERC".

As a result 15 weights were given to the activity COMMERC that are to be considered every time the activity is to be located on the grid. Based on the same method 135 (15 x 9) weights were given to the 9 generated activities which are shown in the activity weights table.
<table>
<thead>
<tr>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Least importance</td>
<td>ACTIVITY PAIR</td>
<td>Most importance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100.0</td>
<td>60.6</td>
<td>2.0</td>
<td>COMMERC - COMMERC</td>
<td>C</td>
<td>1.00</td>
<td>100.0</td>
<td>Aver. 100</td>
</tr>
<tr>
<td>50.0</td>
<td>30.3</td>
<td>1.5</td>
<td>TRAFFIC - &quot;</td>
<td>T</td>
<td>.70</td>
<td>70.0</td>
<td>60.0</td>
</tr>
<tr>
<td>33.3</td>
<td>20.2</td>
<td>1.0</td>
<td>BUS STOP - &quot;</td>
<td>B</td>
<td>.90</td>
<td>63.0</td>
<td>45.5</td>
</tr>
<tr>
<td>22.6</td>
<td>13.5</td>
<td>1.0</td>
<td>INDUSTRY - &quot;</td>
<td>I</td>
<td>.80</td>
<td>50.4</td>
<td>41.5</td>
</tr>
<tr>
<td>22.6</td>
<td>13.5</td>
<td>2.0</td>
<td>OFFICE - &quot;</td>
<td>O</td>
<td>.90</td>
<td>45.4</td>
<td>34.0</td>
</tr>
<tr>
<td>15.1</td>
<td>9.0</td>
<td>1.0</td>
<td>THEATER - &quot;</td>
<td>N</td>
<td>.60</td>
<td>27.3</td>
<td>21.2</td>
</tr>
<tr>
<td>7.6</td>
<td>4.5</td>
<td>1.5</td>
<td>WATER - &quot;</td>
<td>W</td>
<td>.90</td>
<td>24.5</td>
<td>16.0</td>
</tr>
<tr>
<td>7.6</td>
<td>4.5</td>
<td>1.0</td>
<td>PARK - &quot;</td>
<td>P</td>
<td>.70</td>
<td>17.2</td>
<td>12.4</td>
</tr>
<tr>
<td>5.0</td>
<td>3.0</td>
<td>1.0</td>
<td>SECOND - &quot;</td>
<td>S</td>
<td>.60</td>
<td>10.3</td>
<td>7.7</td>
</tr>
<tr>
<td>5.0</td>
<td>3.0</td>
<td>1.0</td>
<td>ELEMENT - &quot;</td>
<td>E</td>
<td>.90</td>
<td>9.3</td>
<td>7.2</td>
</tr>
<tr>
<td>5.0</td>
<td>3.0</td>
<td>2.0</td>
<td>RELIGION - &quot;</td>
<td>R</td>
<td>.80</td>
<td>7.4</td>
<td>6.2</td>
</tr>
<tr>
<td>2.5</td>
<td>1.5</td>
<td>1.0</td>
<td>H. LOW - &quot;</td>
<td>L</td>
<td>.70</td>
<td>5.2</td>
<td>3.9</td>
</tr>
<tr>
<td>2.5</td>
<td>1.5</td>
<td>1.0</td>
<td>H. MEDIUM - &quot;</td>
<td>M</td>
<td>.90</td>
<td>4.7</td>
<td>3.6</td>
</tr>
<tr>
<td>2.5</td>
<td>1.5</td>
<td>1.5</td>
<td>H. HIGH - &quot;</td>
<td>H</td>
<td>.90</td>
<td>4.2</td>
<td>3.3</td>
</tr>
<tr>
<td>1.6</td>
<td>1.0</td>
<td>1.0</td>
<td>SPORTS - &quot;</td>
<td>A</td>
<td>.80</td>
<td>3.4</td>
<td>2.5</td>
</tr>
</tbody>
</table>

TOTAL 365 100%

FIGURE 10

ACTIVITY COMMERC
ASSIGNING WEIGHT TABLE
The preparation of the table follows these steps:

Column 1. List activities in order of importance, with the most important at top.

Column 2. Assign the value of 1.0 to the least important activity, then assign judged relative value to the one above (n times as important as previous one)

Column 3. Determine relative importance, by progressive multiplication of the values in column 2, assigning 1.0 to the least important activity.

Column 4. Establish a ratio, of each activity, to the top activity, (with value 100.0).

Column 5. Assign the value of 1.0 to the most important activity, then assign judged relative value to the next one (n times as important as the one above).

Column 6. Determine relative importance (100.0 the most important) multiplying the column 5 figure by the column 6 figure just above.

Column 7. Average column 4 and 6, find total

Column 8. Calculate percentage of each activity (to the total in column 7) that becomes the assigned weight value of the activity.
(3) DATA REQUIREMENTS

The following tables list all the required data for the structure of the simulation model, including activity characteristics, weighting table and assigning priority weights table. For the operation of the model all the information has to be given in terms of numbers, simplifying real life conditions into mathematical equations.

The data structure is simple and easily accessible to the user for corrections and other changes that he wishes to make for testing the model or affecting the results.
<table>
<thead>
<tr>
<th></th>
<th>HIGHHOUS</th>
<th>MEDHOUS</th>
<th>LOWHOUS</th>
<th>Character</th>
</tr>
</thead>
<tbody>
<tr>
<td>high density</td>
<td>H</td>
<td>M</td>
<td>L</td>
<td>general description</td>
</tr>
<tr>
<td>housing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>medium density</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>housing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>low density</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>housing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>9</td>
<td>6</td>
<td></td>
<td>DWE/loc</td>
</tr>
<tr>
<td>25%</td>
<td>40%</td>
<td>35%</td>
<td></td>
<td>% of loc in residential</td>
</tr>
<tr>
<td>5-6</td>
<td>3-4</td>
<td>1-2</td>
<td></td>
<td>stories high stories high</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>each loc</td>
</tr>
<tr>
<td>30</td>
<td>35</td>
<td>25</td>
<td></td>
<td>people</td>
</tr>
<tr>
<td>14</td>
<td>9</td>
<td>6</td>
<td></td>
<td>households</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>2</td>
<td></td>
<td>men working</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>7</td>
<td></td>
<td>children 3-11</td>
</tr>
<tr>
<td>1</td>
<td>6</td>
<td>4</td>
<td></td>
<td>children 12-18</td>
</tr>
</tbody>
</table>

FIGURE 11
DEVELOPED ACTIVITIES CHARACTERISTICS
<table>
<thead>
<tr>
<th>name of activity</th>
<th>character</th>
<th>general description</th>
<th>name of major actor involved</th>
<th>no. of loc occupied</th>
<th>no. of actors per loc required</th>
<th>no. of actors per activity required</th>
<th>locational priority weight</th>
<th>radius of search in grid in loc (100 ft.)</th>
<th>power (gravity command)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELEMENT</td>
<td>E</td>
<td>learning</td>
<td>children 3-11</td>
<td>4</td>
<td>105</td>
<td>420</td>
<td>20</td>
<td>10</td>
<td>2.0</td>
</tr>
<tr>
<td>SECOND</td>
<td>S</td>
<td>learning</td>
<td>children 12-18</td>
<td>10</td>
<td>75</td>
<td>750</td>
<td>5</td>
<td>20</td>
<td>3.0</td>
</tr>
<tr>
<td>RELIGION</td>
<td>R</td>
<td>religious mass</td>
<td>people</td>
<td>1</td>
<td>2000</td>
<td>2000</td>
<td>7</td>
<td>6</td>
<td>2.5</td>
</tr>
<tr>
<td>THEATER</td>
<td>N</td>
<td>entertainment</td>
<td>people</td>
<td>1</td>
<td>450</td>
<td>450</td>
<td>3</td>
<td>7</td>
<td>2.7</td>
</tr>
<tr>
<td>SPORTS</td>
<td>A</td>
<td>athletics play</td>
<td>children 12-18</td>
<td>6</td>
<td>50</td>
<td>300</td>
<td>4</td>
<td>8</td>
<td>2.2</td>
</tr>
<tr>
<td>COMMERC</td>
<td>C</td>
<td>commercial shopping</td>
<td>households</td>
<td>1</td>
<td>120</td>
<td>120</td>
<td>28</td>
<td>5</td>
<td>1.8</td>
</tr>
<tr>
<td>OFFICE</td>
<td>O</td>
<td>working at office</td>
<td>men working</td>
<td>4</td>
<td>50</td>
<td>200</td>
<td>15</td>
<td>4</td>
<td>1.7</td>
</tr>
<tr>
<td>INDUSTRY</td>
<td>I</td>
<td>working at light industry, services</td>
<td>men working</td>
<td>6</td>
<td>25</td>
<td>150</td>
<td>16</td>
<td>6</td>
<td>2.9</td>
</tr>
<tr>
<td>BUS STOP</td>
<td>B</td>
<td>bus connection</td>
<td>households</td>
<td>1</td>
<td>800</td>
<td>800</td>
<td>2</td>
<td>8</td>
<td>2.7</td>
</tr>
</tbody>
</table>

FIGURE 12: GENERATED ACTIVITIES CHARACTERISTICS
<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>W</th>
<th>P</th>
<th>T</th>
<th>L</th>
<th>M</th>
<th>H</th>
<th>E</th>
<th>S</th>
<th>R</th>
<th>N</th>
<th>A</th>
<th>C</th>
<th>O</th>
<th>I</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELEMENT</td>
<td>8</td>
<td>16</td>
<td>10</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>20</td>
<td>8</td>
<td>2</td>
<td>15</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SECOND</td>
<td>4</td>
<td>7</td>
<td>11</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>21</td>
<td>1</td>
<td>3</td>
<td>12</td>
<td>9</td>
<td>4</td>
<td>11</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>RELIGION</td>
<td>11</td>
<td>20</td>
<td>8</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>21</td>
<td>9</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>THEATER</td>
<td>2</td>
<td>4</td>
<td>14</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>16</td>
<td>3</td>
<td>25</td>
<td>8</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>SPORTS</td>
<td>7</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td>6</td>
<td>4</td>
<td>25</td>
<td>17</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>COMMERCE</td>
<td>5</td>
<td>4</td>
<td>16</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>27</td>
<td>9</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>OFFICE</td>
<td>2</td>
<td>1</td>
<td>14</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>27</td>
<td>23</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>INDUSTRY</td>
<td>3</td>
<td>10</td>
<td>19</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>15</td>
<td>5</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>BUS STOP</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>11</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td>18</td>
<td>9</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

**FIGURE 13:** ACTIVITY WEIGHTS TABLE
<table>
<thead>
<tr>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Least importance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ACTIVITY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100.0</td>
<td>10.0</td>
<td>1.5</td>
<td>COMMERC</td>
<td>1.00</td>
<td>100.0</td>
<td>100</td>
<td>28</td>
</tr>
<tr>
<td>67.0</td>
<td>6.7</td>
<td>1.5</td>
<td>ELEMENT</td>
<td>0.80</td>
<td>80.0</td>
<td>73</td>
<td>20</td>
</tr>
<tr>
<td>45.0</td>
<td>4.5</td>
<td>1.0</td>
<td>INDUSTRY</td>
<td>0.90</td>
<td>72.0</td>
<td>58</td>
<td>16</td>
</tr>
<tr>
<td>45.0</td>
<td>4.5</td>
<td>2.0</td>
<td>OFFICE</td>
<td>0.90</td>
<td>65.0</td>
<td>55</td>
<td>15</td>
</tr>
<tr>
<td>22.0</td>
<td>2.2</td>
<td>1.0</td>
<td>RELIGION</td>
<td>0.40</td>
<td>26.0</td>
<td>24</td>
<td>7</td>
</tr>
<tr>
<td>22.0</td>
<td>2.2</td>
<td>1.5</td>
<td>SECOND</td>
<td>0.60</td>
<td>16.0</td>
<td>19</td>
<td>5</td>
</tr>
<tr>
<td>15.0</td>
<td>1.5</td>
<td>1.0</td>
<td>SPORTS</td>
<td>0.70</td>
<td>11.0</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>15.0</td>
<td>1.5</td>
<td>1.5</td>
<td>THEATER</td>
<td>0.90</td>
<td>10.0</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>10.0</td>
<td>1.0</td>
<td>1.0</td>
<td>BUS STOP</td>
<td>0.80</td>
<td>8.0</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TOTAL</td>
<td>363</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

**FIGURE 14:** LOCATIONAL PRIORITY OF ACTIVITIES
ASSIGNING WEIGHTS TABLE
(4) MODEL STRUCTURE

I. DESCRIPTION:

a) Grid Size: The model operates on a grid size of 25 x 40 grid locations that make a total of 1,000. Each location occupies a square of 100 x 100 feet or 1/4 of an acre. According to the above the area covered by the model is approximately 250 acres of land.

b) Variables: To the 15 main variables considered (Park, Water, Traffic, Lowhous, Medhous, Highous, Element, Second, Religion, Theater, Sports, Office, Commerc, Industry, Busstop) has been assigned characteristics (weights) called "charcons". Each variable has 9 charcons.

II. FUNCTIONS:

a) Definition of area of operation (designer's decision).

b) Application of the variable value* at all locations of the pre-defined area.

c) Linear search for best location considering all the values.

d) Radial search around best location for optimum and free location.

*Value that exists only temporarily all over the area, has 9 varying characteristics (charvars) that are also the 9 charcons of the 15 main variables.
III RULES

a) Quantitative measures:
   1. calculating actor-figures
   2. calculating activity-need

b) Locating rules:
   1. Decision-making of locational priority
   2. locating an activity at optimum loc
   3. spatial arrangements around optimum loc
# A COMPUTER MODEL FOR STUDYING ACTIVITY LOCATIONS IN A NEW TOWN DESIGN

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRO DIMITRI</td>
<td>Information on figures and operation of model.</td>
</tr>
<tr>
<td>DATA DIMITRI</td>
<td>Data requirements for operation of model. Weights of activities, location of static activities, definitions of existing situation.</td>
</tr>
<tr>
<td>DEVELOP DIMITRI</td>
<td>Location of developed activities, divided in 4 stages.</td>
</tr>
<tr>
<td>MAJOR DIMITRI</td>
<td>Information on actors and activity-need decision making what and when to locate. Specifies area of operation.</td>
</tr>
<tr>
<td>RULES DIMITRI</td>
<td>Rules for finding best land (macro activity) and optimum land (macro optimum). Spatial arrangements of different activities.</td>
</tr>
<tr>
<td>INFO DIMITRI</td>
<td>Information on present state of activities, density figures.</td>
</tr>
</tbody>
</table>
FILENAME FILETYPE MODE NO.REC. DATE

DATA DIMITRI P1 6 6/02
INFO DIMITRI P1 3 6/01
INTRO DIMITRI P1 5 6/01
RULES DIMITRI P1 9 6/03
MAJOR DIMITRI P1 9 6/03
DEVELOP DIMITRI P1 5 5/31

data dimitri

SETUP 1 40 1 25 70 60 0
DEFINE WATER 0:* 9: E=8 S=4 R=11 N=2 A=7 C=5 0=2 1=3 B=1
PUT WATER 1,16 2,16 3,16 4,16 5,17 6,17 7,17 8,17 9,17 10,17 11,17 12,
13 17 14 17 15,16 15,17 16,16 16,17 17,16 18,16 19,16 20,16 21,16 22,16 23,16 24,16
25,17 26,17 27,17 28,17 29,17 30,17 31,17 32,17 33,
17 34,17 35,17 36,17 37,17 38,16 39,15 40,14
DEFINE PARK 0:* 9: E=16 S=7 R=20 N=4 A=9 C=4 0=1 1=10 B=2
PUT PARK 1,1 1,3 1,8 1,9 1,10 1,11 1,12 1,13 1,14 1,15 1,17 1,18 1,
22 1,23 1,24 1,25 2,1 2,2 2,6 2,14 2,15 2,17 2,18 2,19 3,1 3,2 3,14 3,
15 3,17 3,18 3,21 4,1 4,2 4,14 4,15 5,1 5,2 5,3 5,15 5,16 6,1 6,2 6,3
6,4 6,16 7,1 8,1 9,1 9,24 9,25 10,1 10,2 10,25 11,1 11,2 11,25 12,1 12,
2 12,3 12,4 12,25 13,1 13,2 13,3 13,24 13,25 14,1 14,2 14,24 14,25 15
1,15 12 15,13 15,14 15,25 16,1 16,12 16,15 16,16 16,14 17,1 17,11 17,12 17,
13 17,14 18,1 18,11 18,12 18,13 18,14 19,1 19,12 19,13 19,14 20,1 20,
12 21,1 22,1 23,1 24,1 25,1 26,1 26,5 27,1 27,3 27,4 28,1 28,2 28,3 28,
5 29,2 30,1 31,1 33,2 35,1 36,1 37,1 38,1 38,9 38,10 38,15 39,2 39,9
39,10 40,2 40,4 40,8 40,40,1 40,10 40,11 40,12 40,13
DEFINE TRAFFIC 0:* 9: E=10 S=11 R=8 N=14 A=10 C=16 0=14 1=19 B=10
PUT TRAFFIC 1,19 2,20 2,21 2,22 2,23 2,24 2,25 3,20 4,20 5,20 6,20 7,
20 8,20 9,20 10,20 11,20 12,20 13,20 14,21 15,21 16,21 17,21 18,21 19,
21 20,21 21,21 22,22 23,22 24,22 25,22 26,22 27,22 28,22 29,22 30,22
31,22 32,22 33,2 34,2 35,2 36,2 35,23 35,24 35,25 36,21 37,20 38,20 39,
20 40,20
DEFINE LOWHOUS 0:* 9: E=6 S=2 R=6 N=1 A=9 C=1 0=1 1=1 B=4
PUT LOWHOUS 6,9 7,7 7,8 8,8 11,12 16,6 22,10 23,11 26,11
33,12 36,8
DEFINE MEDIHOUS 0:* 9: E=6 S=2 R=6 N=2 A=6 C=1 0=1 1=1 B=4
DEFINE HIGHHOUS 0:* 9: E=3 S=1 R=5 N=2 A=4 C=1 0=2 1=1 B=5
DEFINE ELEMENT 0:* 9: E=1 S=21 R=21 N=3 A=25 C=2 0=2 1=1 B=7
DEFINE SECOND 0:* 9: E=20 S=1 R=9 N=6 A=17 C=2 0=5 1=1 B=11
DEFINE RELIGION 0:* 9: E=8 S=3 R=1 N=3 A=2 C=2 O=1 1=1 B=2
DEFINE THEATER 0:* 9: E=2 S=12 R=3 N=16 A=3 C=6 O=10 1=1 B=7
DEFINE SPORTS 0:* 9: E=15 S=9 R=1 N=3 A=3 C=1 0=1 1=3 R=2
DEFINE COMMERC 0: * 9: E=2 S=4 N=25 A=2 C=27 0=27 I=15 B=18
DEFINE OFFICE 0: * 9: E=3 S=11 R=3 N=8 A=2 C=9 0=25 I=5 B=9
DEFINE INDUSTRY 0: * 9: E=1 S=1 R=1 N=1 A=1 C=11 O=2 I=30 B=8
DEFINE BUSSTOP 0: * 9: E=1 S=1 R=1 N=10 A=1 C=12 O=8 I=8 B=10
DEFINE CENTER1 1: 1*
DEFINE CENTER2 1: 1*
DEFINE TEMPOR 1: 1*
DEFINE TEMPOR2 1: 1*
DEFINE EXPANSE 0: *
DEFINE NEED 0: * 9: 1 = 0. 2 = 0. 3 = 0. 4 = 0. 5 = 0. 6 = 0. 7 = 0. 8 = 0. 9 = 0.
TOTPEOP = 275.
TOTCHLD1 = 77.
TOTCHLD2 = 44.
TOTHSHLD = 66.
TOTMENW = 22.
DEFINE INDLAND 0*
PUT INDLAND<1,21>...INDLAND<40,25>
DEFINE CENTLAND 0*
PUT CENTLAND<1,13>...CENTLAND<40,25>
DEFINE CULTLAND 0*
PUT CULTLAND<1,13>...CULTLAND<40,20>
SAY NOW DEVELOP HOUSING -- ACTORS AT PRESENT STATE ARE:
EXPAND +$40**TOTPEOP=$3TOTPEOP** TOTCHLD1=$3TOTCHLD1** +
EXPAND +TOTCHLD2=$3TOTCHLD2** TOTHSHLD=$3TOTHSHLD** +
EXPAND +TOTMENW=$3TOTMENW /+
READ_CONSOLE
SAY PRESENT ACTIVITY STATUS:
SET_CARRIAGE_WIDTH 70
TABSET 17 34
EXPAND +$40*HIGHOUS :$3HIGHOUS* .MEDHOUS :$3MEDHOUS* .+
EXPAND +LOWHOUS :$3LOWHOUS*/ELEMENT :$3ELEMENT* .+
EXPAND +SECOND :$3SECOND* .RELIGION :$3RELIGION* /+
EXPAND +THEATER :$3THEATER* .SPORTS :$3SPORTS* .+
EXPAND +COMMERC :$3COMMERC*/OFFICE :$3OFFICE* .+
EXPAND +INDUSTRY :$3INDUSTRY* .BUSSTOP :$3BUSSTOP* /+
DENSRES=(TOTPEOP/640)*4
SAY
SAY
EXPAND +$40 RESIDENTIAL AREA DENSITY=$3DENSRES* PEOPLE PER ACRE /
TOTHOUS=LOWHOUS+MEDHOUS+HIGHOUS
PLOWHOUS=(LOWHOUS*100)/TOTHOUS
PMEDHOUS=(MEDHOUS*100)/TOTHOUS
PHIGHOUS=(HIGHOUS*100)/TOTHOUS
SAY
EXPAND +$40 TOTAL HOUSING DEVELOPMENT=$1TOTHOUS* LOC /
EXPAND +PERCENTAGE LOWHOUS=$1PLOWHOUS* /+
EXPAND +" MEDHOUS=$1PMEDHOUS* /+
EXPAND +" HIGHOUS=$1PHIGHOUS* /+
READ_CONSOLE
introduction

say information and figures for model
say grid size is 1000 loc or 40x25 loc
say each loc=100x100 feet or 4 loc=approx.1 acre
say grid size is 1000 loc or 40x25 loc
say static activities:
say park exists at: 133 loc
say water: 42 loc
say traffic: 48 loc
say static activities:
say a. residential area(housland):<1,1>..<40,16>: 640 loc
say max density allowed is 57peop/acre
say max housing development is 300 loc
say housing: low hous=105 med hous=120 high hous=75
say percentage: 35 40 25
say b. town cultural area(cultland):<1,13>..<40,20> 320 loc
say (8)element: 5x4
say (9)second: 2x10
say (10)religion: 5x1
say (11)theater: 20x1
say (12)sports: 4x6
say c. town center area(centland):<1,13>..<40,25>: 520 loc
say (13)commerce: 23x1
say (14)office: 5x4
say d. industrial area(indland):<1,21>..<40,25>: 200 loc
say (15)industry: 6x6
say (16)bus stop: 3x1
say actors at max development are:
say total people: (low hous*25)+(med hous*35)+(high hous*30)=9075
say total child1: (low hous*7)+(med hous*9)+(high hous*5)=2190
say total child2: (low hous*4)+(med hous*6)+(high hous*1)=1215
say total child3: (low hous*6)+(med hous*9)+(high hous*14)=2760
say total men: (low hous*2)+(med hous*3)+(high hous*5)=945
say
say operation:
say rd data, value, rules dimitri
say rd develop dimitri
say rd major dimitri( , , ,)
say map*(a b c d e ;v) coord
say rd info dimitri
say end program or rd major again
read console
BEGIN_MACRO ACTIVITY
SUBSTITUTION ON
ATTRNUMB LAND=ARG3
POWR=ARG4
RAD=ARG2
Z1=ARG1
C1=Z1-7
SUM1=0.
SUMJ=0.
SUMT=0.

THROUGH V FOR K=,P= EACH VALUE
SUMI=SUMI+K*VALUE<C1 K,P>
SUMJ=SUMJ+P*VALUE<C1 K,P>
V$SUMT=SUMT+VALUE<C1 K,P>
SUMJ=SUMJ/SUMT
SUMI=SUMI/SUMT
SUMI=SUMI+0.05
SUMJ=SUMJ+0.05

EXPAND +>>>>

OPTIMUM LOC: $3SUMI,$3SUMJ/+ 

IF Z1.EQL.8 GOTO POL
IF Z1.EQL.9 GOTO POL
IF Z1.EQL.10 GOTO UNO
IF Z1.EQL.11 GOTO UNO
IF Z1.EQL.12 GOTO POL
IF Z1.EQL.13 GOTO UNO
IF Z1.EQL.14 GOTO POL
IF Z1.EQL.15 GOTO POL
IF Z1.EQL.16 GOTO BUS

POLS CONTINUE
EX OPTIMUM(C1, Z1, RAD, LAND, POWR)
IF FLAG.EQL.0 GOTO FIN

SPV=9
IF Z1.EQL.8 OR Z1.EQL.14 SPV=3
IF Z1.EQL.12 OR Z1.EQL.15 SPV=5

THROUGH ZAP FOR K=1, 1. SPV
TEMP=*LAND.ANDN. VALUE
NEAREST TEMP POS U= V= DIST=
IF DIST.LEQ.8 GOTO PZ
EXPAND +ACTIVITY PARTIALLY LOCATED; BUILD HIGH RISE/+ 
GOTO FIN

PZ$PUT Z1<> U,V

EXPAND +

PUT VALUE U,V(Z1<1> Z1<2> Z1<3> Z1<4> Z1<5> ,
Z1<6> Z1<7> Z1<8> Z1<9>)
ZAP $ CONTINUE
IF NEED<C1>.GEQ.0.5 GOTO POL
GOTO FIN

UNOS CONTINUE
EX OPTIMUM(C1, Z1, RAD, LAND, POWR)
IF FLAG.EQL.0 GOTO FIN
IF NEED<C1>.GEQ.0.5 GOTO UNO
GOTO FIN

BUS$ CONTINUE
PUT BUSSTOP R,P
EXPAND +LOCATED AT:$40$3R,$3P/+ 
PUT VALUE R,P(Z1<1> Z1<2> Z1<3> Z1<4> Z1<5> ' 
Z1<6> Z1<7> Z1<8> Z1<9>)
NEED<C1>=NEED<C1>-1
IF NEED<C1>.GEQ.0.5 GOTO BUS 
FIN$ CONTINUE
END_MACRO
BEGIN_MACRO OPTIMUM 
FLAG=I
CENTER2*** NULL 
THROUGH LAB FOR I=3, 1, 10.
CIRCLE I CENTER1<SUMI,SUMJ>*
CENTER1 *** CENTER1,ANDN,VALUE .ANDN. CENTER2,ANDN.ARG4
IF CENTER1,EQL.0 GOTO LAB3
GRAVITY CENTER1<1>=VALUE<ARG1> RADIUS=ARG3 POWER=ARG5
FOR POS=EACH RANKED HIGH CENTER1<1> GOTO LAB2
LAB2$ PUT ARG2< POS
CONVERT POS Q1=,Q2=
EXPAND +LOCATED AT:$40$3Q1,$3Q2/+ 
PUT VALUE Q1,Q2(ARG2<1> ARG2<2> ARG2<3> ARG2<4> ARG2<5> ' 
ARG2<6> ARG2<7> ARG2<8> ARG2<9>)
LAB2A$ I=18
GOTO LAB 
LAB3$IF I.EQL.3 EXPAND +RADIAL SEARCH/+ 
IF I.NEQ.3 EXPAND +/>/ 
LAB$ CENTER2===CENTER1 
EXPAND +I = $31/+ 
IF I.EQL.11 GOTO LAB3A
NEED<ARG1>=NEED<ARG1>-1
RETURN
LAB3A$FLAG=0
EXPAND +SEARCH FAILED /+
END_MACRO
Substitution on

\[ \text{TOTPEOP} = (\text{LOWHOUS} \times 25) + (\text{MEDHOUS} \times 35) + (\text{HIGHOUS} \times 30) \]
\[ \text{TOTCHLD} = (\text{LOWHOUS} \times 7) + (\text{MEDHOUS} \times 9) + (\text{HIGHOUS} \times 5) \]
\[ \text{TOTCHLD2} = (\text{LOWHOUS} \times 4) + (\text{MEDHOUS} \times 6) + (\text{MEDHOUS} \times 1) \]
\[ \text{TOTHSHLD} = (\text{LOWHOUS} \times 6) + (\text{MEDHOUS} \times 9) + (\text{HIGHOUS} \times 14) \]
\[ \text{TOTMENW} = (\text{LOWHOUS} \times 2) + (\text{MEDHOUS} \times 3) + (\text{HIGHOUS} \times 5) \]

Expand +$40 \times \text{TOTPEOP} = 3 \times \text{TOTPEOP} \]
\[ \text{TOTCHLD} = 3 \times \text{TOTCHLD} \]
\[ \text{TOTHSHLD} = 3 \times \text{TOTHSHLD} \]

Define \[ \text{VALUE} 9: 1 2 3 4 5 6 7 8 9 \]

Put EXPANSE<ARG1,ARG2>... EXPANSE<ARG3,ARG4> TERR* = HIGHOUS, OR, MEDHOUS, OR, LOWHOUS, OR, PARK, OR, TRAFFIC, OR, WATER
VALUE*=TERN.AND.EXPANSE
FOR T=EACH Q<> IF VALUE<T> PUT VALUE T(Q<1> Q<2> Q<3> ' F T(E Q<4> Q<5> Q<6> Q<7> Q<8> Q<9>)
T TIMES CONTINUE
THROUGH F FOR I=, T1= EACH RANKED HIGH TEMPOR2<<1>>
IF TEMPOR<1 , T1>. EQL.0 GOTO F
EXPAND +<>NOW LOCATE:(S3T1)/+
IF T1.EQL.8 EX ACTIVITY(T1,10,CULTLAND,2.0)
IF T1.EQL.9 EX ACTIVITY(T1,20,CULTLAND,3.0)
IF T1.EQL.10 EX ACTIVITY(T1,6,CULTLAND,2.5)
IF T1.EQL.11 EX ACTIVITY(T1,7,CULTLAND,2.7)
IF T1.EQL.12 EX ACTIVITY(T1,8,CULTLAND,2.2)
IF T1.EQL.13 EX ACTIVITY(T1,5,CENTLAND,1.8)
IF T1.EQL.14 EX ACTIVITY(T1,4,CENTLAND,1.7)
IF T1.EQL.15 EX ACTIVITY(T1,6,INDLAND,2.9)
IF T1.EQL.16 EX ACTIVITY(T1,8,INDLAND,2.7)
F$ CONTINUE
TEMP*=NULL
EXPANSE*=EXPANSE.ANDN.VALUE
A*=WATER.OR.HIGHOUS.OR.THEATER.OR.OFFICE.OR.INDUSTRY.OR.EXPANSE
B*=PARK.OR.HIGHOUS.OR.ELEMENT.OR.SPORTS.OR.COMMERC.OR.EXPANSE
C*=TRAFFIC.OR.ELEMENT.OR.SECOND.OR.THEATER.OR.EXPANSE
D*=LOWHOUS.OR.SECOND.OR.RELIGION.OR.SPORTS.OR.INDUSTRY
E*=MEDHOUS.OR.RELIGION.OR.COMMERC.OR.OFFICE
W*=BUSSTOP
MAPSET STANDARD (1;+)(2;*)(3;X)SMALL (4;L)
(5;M) (9; ) (6;O)SMALL (1 2 3 ;;)ONLY (1 2 ;H)ONLY ' (2 3;E)ONLY (3 4;S)ONLY (4 5;R)ONLY (1 3;N)ONLY (2 4;A)ONLY ' (2 5;C)ONLY (1 5;O)ONLY (1 4;I)ONLY
SAY TO GET MAP TYPE: MAP* (A B C D E;W) ()-() ()-()
READ_CONSOLE_RETURN
EXPANSE*=NULL
DELETE VALUE
OF
READ_CONSOLE
IF ARG1.NEQ.1 GOTO FIRST

PUT HIGHOUS 1,4 1,5 1,6 1,7 2,3 2,8 2,9 3,3 4,3
4,10 4,11 4,12 4,13 5,10 5,14 6,10 7,10 7,3 7,4
8,3 8,9 9,3 9,9 10,3 10,9 11,4

PUT MEDIUM 2,4 2,5 2,7 3,4 3,5 3,6 3,7 3,8
4,4 4,5 4,6 5,4 5,11 5,12 5,13 6,11 6,13 6,14
7,5 7,11 8,4 8,5 8,10 8,11 9,4 9,5 9,6 9,10 9,11
10,4 10,5 10,6 10,7 10,10 11,5 11,6 11,11 11,10 11,11
12,5 12,6 12,9 12,10 12,11 13,10

PUT LOWHOUSE 2,10 3,9 4,7 4,9 4,10 4,11 4,12 4,13 5,10 5,14
6,10 6,11 7,10 7,3 7,4 8,3 8,9 9,3 9,9 10,3 10,9

FIRSTS IF ARG2.NEQ.1 GOTO SECON

PUT HIGHOUS 14,3 14,4 15,2 15,3 16,2 16,9 16,10
17,2 17,3 17,4 18,2 18,8 19,2 19,7 19,8 20,2 20,7 21,2
21,7 22,2 22,3 22,7 23,3 23,7 24,8 24,9

PUT MEDIUM 14,5 14,6 15,4 15,5 15,10
15,11 16,3 16,4 17,3 17,4 17,9 17,10 18,3 18,4 18,9 17,10
19,3 19,9 19,10 20,3 20,4 20,8 20,9 21,3 21,4 21,8
21,9 22,4 22,8 22,9 23,4 23,5 23,8 23,9 24,3 24,4 25,4

PUT LOWHOUSE 15,6 15,7 16,5 17,5 18,5 19,5 19,9 19,11
20,5 20,10 20,11 20,13 21,5 21,10 21,11 21,12
22,5 22,11 22,12 22,10 22,12 23,4 24,5 24,10 24,11
24,12 24,13 25,5 25,6 25,12 26,6 27,5

SECON$ IF ARG3.NEQ.1 GOTO THIRD

PUT HIGHOUS 28,9 28,10 28,11 28,12 29,9 30,9 31,9 32,9
33,9 34,10 36,11 36,12 36,13 37,11 37,12 38,11 39,11

PUT MEDIUM 27,13 28,13 29,13 29,12 29,11 29,10
30,10 30,11 30,12 31,10 31,11 31,12 32,10 32,11 33,11 34,11
36 14 37,14 27,13 37,12 38,12 38,13 39,12

PUT LOWHOUSE 28,14 29,14 30,13 30,14 30,15
31,12 31,13 31,14 32,12 32,13 33,13 34,12 34,13
37,15 38,14 39,14 39,13

THIRDS IF ARG4.NEQ.1 GOTO FORTH

PUT HIGHOUS 30,5 31,3 31,4 32,3 33,3 34,2 35,2 36,2

PUT MEDIUM 30,6 31,5 31,6 32,4 32,5 33,4 34,3 35,3 36,3
36,4 36,5 37,3 37,4 38,3

PUT LOWHOUSE 32,6 32,7 33,5 33,6 34,4 34,5 34,6 35,4 35,5
36,5 36,6 37,6 37,7 38,5 38,6 39,5

READ_CONSOLE
LIST OF ATTRIBUTES

ATTR 0 -- NULL
ATTR 1 -- UNIVERSE
ATTR 2 -- WATER
ATTR 3 -- PARK
ATTR 4 -- TRAFFIC
ATTR 5 -- LOWHOUS
ATTR 6 -- MEDHOUS
ATTR 7 -- HIGHOUS
ATTR 8 -- ELEMENT
ATTR 9 -- SECOND
ATTR 10 -- RELIGION
ATTR 11 -- THEATER
ATTR 12 -- SPORTS
ATTR 13 -- COMMERCE
ATTR 14 -- OFFICE
ATTR 15 -- INDUSTRY
ATTR 16 -- BUSSTOP
ATTR 17 -- CENTER1
ATTR 18 -- CENTER2
ATTR 19 -- TEMPOR
ATTR 20 -- TEMPOR2
ATTR 21 -- EXPANSE
ATTR 22 -- NEED
ATTR 23 -- INDLAND
ATTR 24 -- CENTLAND
ATTR 25 -- CULTLAND
ATTR 26 -- VALUE
(5) OPERATION OF MODEL

a) rd file data:  1) compute and file the data
                2) define attributes with charcons or charvons
                3) put static attributes (park, water, traffic) on existing locations
                4) define "zoning" that specifies limitation for the different activities

b) rd file develop:
   1) put developed-activities in the grid according to housing patterns

c) rd file rules:
   1) read macros "activity" and "optimum" that contain rules for locating the generated activities.

d) rd file major:
   1) through arguments, define the grid area in which operation will take place, ignoring the rest
   2) calculate actors participating in the developed activities
   3) show figures of actors
   4) calculate generated-activity need
   5) show numbers of activity need
   6) figure out which activity is to be located first, second, third...etc. Locational priorities (ranked command)
   7) put value with charvar wherever static or generated activities exist

e) ex macro activity:
   1) find best location through linear search, considering the location and charvar of value

f) ex macro optimum:
   1) find optimum and empty location in area specified by zoning. Circular search around best location (gravity command).
   2) locate activity in this location
   3) put value on this location
   4) go back to macro-activity
g) macro-activity:  1) search for more locations around optimum location (nearest command)
                 2) locate activity in new locations
                 3) put values in new locations
                 4) substructuring located activity, from need for this activity, go back to optimum if necessary
                 5) when all activities of the same kind are located go back to major

h) file major:     1) if other activities are to be located find next one on activity priority list (ranked command)
                 2) if all generated-activities are located and total need is zero, go back to console

i) from console:   1) decide about map site and variables to appear on the grid (map command)

j) rd file info:   1) get figures about present state
FIGURE 15: MODEL STRUCTURE
FIGURE 16  DECISION RULES FOR LOCATING AN ACTIVITY IN THE GRID (files: Major and Rules)
1. Put value in grid
2. Find center of gravity
   ideal loc
3. Fail to locate activity
   no empty land available
4. radial search around
   ideal loc for empty land
5. find n locs of empty land
6. increase radial search
7. for each n test if optimum loc
8. loc not optimum
9. repeat with next loc
10. loc optimum, put activity
    test if activity requires
    additional locs
11. radial search for empty
    land
12. if empty put activity
13. increase radial search
14. put value at loc
MODEL CONTROLS

Changes in the data structure of the model influence strongly the generated results, allowing in this way for the user to control to a certain extent the operation. The following controls are easily accessible to the user during the design process.

1) Scale (size of each loc)
2) grid size (number of locs)
3) weighting of activity-pairs
4) actors participation in activities
5) actors supporting activity existence
6) weighting of locational priority
7) definition of area of operation
8) definition of area of activity location (zoning)
9) radius of circular search (gravity)
10) rules for locating an activity
11) Power used in gravity command
12) map size, and variables to be shown
(D) **TESTS AND CONCLUSIONS**

(1) Tests of model operation  
(2) Conclusions and Future development of model  
(3) Computer techniques in Urban Design

(1) **TESTS OF MODEL OPERATION**

The main purpose of the model "runs" will be to test its capability and accuracy in locating activities on a grid. The grid represents a part of the site of the Satellite for Athens and is based on the organizational system described in Chapter 2.

The user develops housing (in stages) according to the "housing patterns", rules, and the computer responses with the generation and location of activities.

Three of the most typical tests are included in this chapter. They operate on different bases and sequences, and give the reader a complete idea of the present development of the model.

Before the testing a series of examples was necessary, examining different situations, and functions of the model.
EXAMPLES ON OPERATION OF THE MODEL

In order to understand the operation of the model the following simplified examples are demonstrated:

Example: a) Effectiveness of weighting in location of activities.

Example: b) Influence of location of static activities to generated activities location.

Example: c) Function of defined area in which operation takes place, in affecting the activity location.

Example: d) Demonstration of pointing best location (SUMI, SUMJ) through linear search and locating in optimum location of activity.

Example: e) Complete operation in locating in optimum arrangement 5 activities, generated by Medium density houses (in two stages).
put medhous 9,15 10,15 11,15
R 0.02/4.94
rd major dimitri(9,14,11,21)
TOTPEOP=380 TOTCHLD1=104 TOTCHLD2=65 TOTHSHLD=93 TOTMENW=31
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:
(8)ELEMENT=0   (9)SECOND=0   (10)RELIGION=0
(11)THEATER=1   (12)SPORTS=0   (13)COMMERC=1
(14)OFFICE=0    (15)INDUSTRY=0   (16)BUSSTOP=0
<>NOW LOCATE:(13)
OPTIMUM LOC:10,19
LOCATED AT:10,19
GET OUT
<>NOW LOCATE:(11)
OPTIMUM LOC:10,19
LOCATED AT:11,19
GET OUT
I IS NOW 16.00
TO GET MAP TYPE: MAP* (A B C D E;W) ()-() ()-()
READ_CONSOLE_RETURN
R 4.92/9.86
map* (a b c d e;w) 7-13 12-23

Example a)

Weighting: MEDHOUS (M) - COMMERC (C) = 1
MEDHOUS (M) - THEATER (N) = 2
put medhous 9,15 10,15 11,15
R 0.03/4.96
rd major dimitri(9,14,11,21)
TOTPEOP=380 TOTCHLD1=104 TOTCHLD2=65 TOTHSDL=93 TOTMENW=31
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:
(8)ELEMENT=0 (9)SECOND=0 (10)RELIGION=0
(11)THEATER=1 (12)SPORTS=0 (13)COMMERC=1
(14)OFFICE=0 (15)INDUSTRY=0 (16)BUSSTOP=0
<>NOW LOCATE:(13)
OPTIMUM LOC:10,17
LOCATED AT:10,16
GET OUT
I IS NOW 16.00
<>NOW LOCATE:(11)
OPTIMUM LOC:10,17
LOCATED AT:11,16
GET OUT
I IS NOW 16.00
TO GET MAP TYPE: MAP* (A B C D E;W) (-) (-) (-) (-)
READ_CONSOLE RETURN
R 5.15/10.11
map* (a b c d e ;w) 7-13 12-23

Example a)

New Weighting:  MEDHOUS (M) - COMMERC (C) = 30
              MEDHOUS (M) - THEATER (N) = 15
### Example b)

#### LEGEND:

**PRIMARY ATTRIBUTE ASSIGNMENTS** - - '＋' = A(27); '＊' = B(28); 'x' = C(29); 'L' = D(30); 'M' = E(31)
Example c)
Example d)

\begin{align*}
\text{SUMI} &= 8.09 \\
\text{SUMJ} &= 18.54 \\
Q_1 &= 7. \\
Q_2 &= 19. \\
(1,3,12,15,21) \\
\end{align*}
rd data dimitri
*R 0.78/8.10
rd data2 dimitri
**ALL NON-MACRO LABELS REMOVED
R 3.64/11.74
dr rule dimitri
ERROR 1001
rd rule dimitri
END OF FILE ON DISK
R 0.15/11.89
rd major dimitri(18,9,27,24)
NOW DEVELOP HOUSING -- ACTORS AT PRESENT STATE ARE:
TOTPEOP=0 TOTCHLD1=0 TOTCHLD2=0 TOTHSHLD=0 TOTMENW=0
READ_CONSOLE_RETURN
R 0.07/11.96
block 1.0 medhous<23,13>
R 0.04/12.00
returnsk
TOTPEOP=450 TOTCHLD1=135 TOTCHLD2=99 TOTHSHLD=108 TOTMENW=36
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:
(8)ELEMENT=1 (9)SECOND=0 (10)RELIGION=0
(11)THEATER=1 (12)SPORTS=0 (13)COMMERC=1
(14)OFFICE=1 (15)INDUSTRY=0 (16)BUSSTOP=0
<>NOW LOCATE:(13)
OPTIMUM LOC:22,19
LOCATED AT:20,20
<>NOW LOCATE:(8)
OPTIMUM LOC:21,16
*LOCATED AT:19,15
  18,15
  20,15
  20,14
<>NOW LOCATE:(14)
OPTIMUM LOC:22,20
LOCATED AT:19,20
<>NOW LOCATE:(11)
OPTIMUM LOC:22,20
LOCATED AT:21,20
  21,19
  22,20
  20,19
TO GET MAP TYPE: MAP* (A B C D E;W) ()-() ()-()
READ_CONSOLE_RETURN
R 14.40/26.40

Example e)
Example e)
1. locating office, commerce, theater and elementary
map* (a b c d e;w) 14-32 7-25

1
7 8 9 0 1 2 3 4 5
2
7 8 9 0 1 2 3 4 5

14 * * * + + x * * 14
15 * * * + + x * 15
16 * * * + + x 16
17 * * * + + . x . 17
18 * * * E + + . x . 18
19 * * * E + + . O x . 19
20 * R E E + . . N C x . 20
21 . . . + . . N N x . 21
22 M M M + . . N . x . 22
23 M M M + . . . x . 23
24 M M M + . . . x . 24
25 + M M + . . . x 25
26 + . . . . + . . . x 26
27 + x x 27
28 + x x 28
29 + x x 29
30 + x x 30
31 + x x 31
32 + x x 32

LEGEND:
PRIMAR Y ATTRIBUTE ASSIGNMENTS - - ' + ' = A(25); ' * ' = B(26); ' x ' = C(27)
' L ' = D(28); ' M ' = E(29)

' N ' = + , x ' E ' = * , x ' O ' = + , M ' C ' = * , M
' R ' = L , M ' ' = NON EMPTY LAND
REFERENCE ATTRIBUTE ASSIGNMENTS - - ' o ' = W(30); ' ' = NO REF ATTS
R 0.52/32.20

Example e)
2) locating a church
TEST 1

grid size: 1-12, 1-25
operation area: 3, 10 ... 11, 22
number of developed activities: 25

1) part: developed activities  HIGHOUS
2) part: developed activities  MEDHOUS
3) part: developed activities  LOWHOUS

The generated activities differ in kind, number and location in each of the 3 parts of the test.
block 2.0 highous<8,13>  
TEST 1, a) part  
R 0.02/4.98  
r1 major dimitri(3,10,11,22)  
TOTPEOP=1025  TOTCHLD1=202  TOTCHLD2=44  TOTHSHLD=416  TOTMENW=147  
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:  
(8)ELEMENT=0  (9)SECOND=0  (10)RELIGION=1  
(11)THEATER=2  (12)SPORTS=0  (13)COMMERC=3  
(14)OFFICE=1  (15)INDUSTRY=1  (16)BUSSTOP=1  
<>NOW LOCATE:(13)  
*OPTIMUM LOC:7,18  
LOCATED AT:7,19  
GET OUT  
I IS NOW 16.00  
LOCATED AT:6,19  
GET OUT  
I IS NOW 16.00  
LOCATED AT:8,19  
GET OUT  
I IS NOW 16.00  
<>NOW LOCATE:(15)  
*OPTIMUM LOC:6,18  
LOCATED AT:6,21  
GET OUT  
I IS NOW 16.00  
5,21  
6,22  
7,21  
5,22  
7,22  
<>NOW LOCATE:(14)  
*OPTIMUM LOC:7,18  
LOCATED AT:7,18  
GET OUT  
I IS NOW 16.00  
6,18  
8,18  
5,18  
<>NOW LOCATE:(11)  
OPTIMUM LOC:7,18  
LOCATED AT:5,19  
GET OUT  
I IS NOW 16.00  
LOCATED AT:4,19  
GET OUT  
I IS NOW 16.00  
<>NOW LOCATE:(10)  
OPTIMUM LOC:6,16  
LOCATED AT:4,17  
GET OUT  
I IS NOW 16.00  
<>NOW LOCATE:(16)
OPTIMUM LOC: 7,17
RADIAL SEARCH
RADIAL SEARCH
GET OUT
I IS NOW 16.00
LOCATED AT: 8,20
TO GET MAP TYPE: MAP* (A B C D E;W) ()-() ()-()
READ_CONSOLE_RETURN
R 23.41/28.39
map* (a b c d e;w) 1-12 1-25

```
1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
1 * * * * * * * * * * * * * * * x * * * 1
2 * * * * * * * * * * * * * * * x x x x x 2
3 * * * * * * * * * * * * * * * x * 3
4 * * * * * * * * * * * * * * * x * 4
5 * * * * * * * * * * * * * * * x * 5
6 * * * * * * * * * * * * * * * x * 6
7 * * * * * * * * * * * * * * * x * 7
8 * * * * * * * * * * * * * * * x * 8
9 * * * * * * * * * * * * * * * x * 9
10 * * * * * * * * * * * * * * * x * 10
11 * * * * * * * * * * * * * * * x * 11
12 * * * * * * * * * * * * * * * x * 12
```
block 2.0 medhous<8,13> Test 1. b) part
R 0.03/4.97
rd major dimitri(3,10,11,22)
TOTPEOP=1150 TOTCHLD1=302 TOTCHLD2=219 TOTHSHLD=291 TOTMENW=97
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:
(8)ELEMENT=1 (9)SECOND=0 (10)RELIGION=1
(11)THEATER=3 (12)SPORTS=1 (13)COMMERC=2
(14)OFFICE=0 (15)INDUSTRY=1 (16)BUSSTOP=0
<>NOW LOCATE:(13)
OPTIMUM LOC:7,18
LOCATED AT:7,19
GET OUT
I IS NOW 16.00
LOCATED AT:6,19
GET OUT
I IS NOW 16.00
<>NOW LOCATE:(15)
OPTIMUM LOC:6,18
LOCATED AT:6,21
GET OUT
I IS NOW 16.00
5,21
6,22
7,21
5,22
7,22
<>NOW LOCATE:(8)
*OPTIMUM LOC:6,16
LOCATED AT:4,17
GET OUT
I IS NOW 16.00
4,18
5,18
2,17
<>NOW LOCATE:(12)
*OPTIMUM LOC:6,16
LOCATED AT:6,18
GET OUT
I IS NOW 16.00
7,18
5,19
8,18
4,19
7,16
<>NOW LOCATE:(11)
*OPTIMUM LOC:7,18
LOCATED AT:8,19
GET OUT
I IS NOW 16.00
LOCATED AT:8,16
GET OUT
I IS NOW 16.00
RADIAL SEARCH
LOCATED AT:9,19
GE
I IS NOW 16.00
<>NOW LOCATE:(10)
*OPTIMUM LOC:6,16
LOCATED AT:5,14
GET OUT
I IS NOW 16.00
*TO GET MAP TYPE: MAP* (A B C D E;W) ( ) ( ) ( ) ( )
READ_CONSOLE_RETURN
R 23.84/28.81
map* (a b c d e ;w) 1-12 1-25
block 2.0 lowhous<8,13>
R 0.05/5.01
rd major dimitri(3,10,11,22)
TOTPEOP=900 TOTCHLD1=252 TOTCHLD2=144 TOTHSHLD=216 TOTMENW=72
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:
(8)ELEMENT=1 (9)SECOND=0 (10)RELIGION=0
(11)THEATER=2 (12)SPORTS=0 (13)COMMER=2
(14)OFFICE=0 (15)INDUSTRY=0 (16)BUSSTOP=0
<>NOW LOCATE:(13)
*OPTIMUM LOC:7,18
LOCATED AT:7,19
GET OUT
I IS NOW 16.00
LOCATED AT:6,19
GET OUT
I IS NOW 16.00
<>NOW LOCATE:(8)
*OPTIMUM LOC:6,16
LOCATED AT:5,14
GET OUT
I IS NOW 16.00
5,13
4,13
3,13
<>NOW LOCATE:(11)
OPTIMUM LOC:6,18
LOCATED AT:5,19
GET OUT
I IS NOW 16.00
LOCATED AT:8,19
GET OUT
I IS NOW 16.00
TO GET MAP TYPE: MAP* (A B C D E;W) (-() (-)
READ_CONSOLE_RETURN
R 13.42/18.43
map* (a b c d e ;w) 1-12 1-25
TEST 2

grid size: 1-25  8-25
operation area: 1, 10 . . . 23, 23

Part 1: incremental development in 3 stages

1) stage: develop 9 HIGHOUS
   6 MEDHOUS
   6 LOWHOUS

2) stage: develop 7 HIGHOUS
   10 MEDHOUS
   13 LOWHOUS

3) stage: develop 6 HIGHOUS
   (final)
   4 MEDHOUS
   9 LOWHOUS

Part 2: same development in one stage

develop 22 HIGHOUS
20 MEDHOUS
28 LOWHOUS
rd hous 1
END OF FILE ON DISK
R 0.04/1.88
rd major dimitri(1,10,23,23)
TOTPEOP=930  TOTCHLD1=225  TOTCHLD2=114  TOTHSHLD=288  TOTMENW=99
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:
(8) ELEMENT=1  (9) SECOND=0  (10) RELIGION=0
(11) THEATER=2  (12) SPORTS=0  (13) COMMERC=2
(14) OFFICE=0  (15) INDUSTRY=1  (16) BUSSTOP=0

<>NOW LOCATE:(13)
* >>>> OPTIMUM LOC:10,18
LOCATED AT:8,19
I = 19
LOCATED AT:9,19
I = 19
<>NOW LOCATE:(15)
* >>>> OPTIMUM LOC:10,18
RADIAL SEARCH
LOCATED AT:9,21
I = 19
8,21
9,22
10,21
8,22
10,22
<>NOW LOCATE:(8)
* >>>> OPTIMUM LOC:10,16
LOCATED AT:6,15
I = 19
7,15
7,14
7,16
<>NOW LOCATE:(11)
* >>>> OPTIMUM LOC:10,18
LOCATED AT:7,19
I = 19
*LOCATED AT:10,19
I = 19
TO GET MAP TYPE: MAP* (A B C D E; W) ()()()()()
READ_CONSOLE RETURN
R 29.62/31.50
map*(a b c d e;w) 1-25 8-25

LEGEND

PRESENT ACTIVITY STATUS:
HIGHOUS:9 MEDHOUS:6 LOWHOUS:18
ELEMENT:4 SECOND:0 RELIGION:0
THEATER:2 SPORTS:0 COMMERC:2
OFFICE:0 INDUSTRY:6 BUSSTOP:0

RESIDENTIAL AREA DENSITY=6 PEOPLE PER ACRE

TOTAL HOUSING DEVELOPMENT=33.00 LOC
PERCENTAGE LOWHOUS=54.55
" MEDHOUS=18.18
" HIGHOUS=27.27
rd hous 3
END OF FILE ON DISK
R 0.05/32.57
rd major dimitri(1,10,23,23)
TOTPEOP=1815 TOTCHLD1=441 TOTCHLD2=236 TOTHSHLD=554 TOTMENV=190
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:
(8)ELEMENT=0 (9)SECOND=0 (10)RELIGION=1
(11)THEATER=2 (12)SPORTS=1 (13)COMMERC=5
(14)OFFICE=1 (15)INDUSTRY=0 (16)BUSSTOP=1

*<>NOW LOCATE:(13)
*>>> OPTIMUM LOC:10,18
LOCATED AT:8,19
I = 19
LOCATED AT:9,19
I = 19
LOCATED AT:10,19
I = 19
<>NOW LOCATE:(14)
*>>> OPTIMUM LOC:10,19
LOCATED AT:9,18
I = 19
8,18
10,18
7,18
<>NOW LOCATE:(12)
*>>> OPTIMUM LOC:10,16
LOCATED AT:6,15
I = 19
7,15
7,16
8,15
8,16
4,17
<>NOW LOCATE:(10)
*>>> OPTIMUM LOC:9,15
LOCATED AT:9,16
I = 19
<>NOW LOCATE:(11)
*>>> OPTIMUM LOC:10,18
LOCATED AT:7,19
I = 19
*LOCATED AT:11,19
I = 19
<>NOW LOCATE:(16)
*>>> OPTIMUM LOC:9,17
LOCATED AT:9,20
TO GET MAP TYPE: MAP* (A B C D E;W) ()-( )-() READ_CONSOLE_RETURN
R 41.37/73.94
map*(a b c d e;w) 1-25 8-25

LEGEND:

PRESENT ACTIVITY STATUS:
HIGHOUS :16  MEDHOUSS :16  LOWHOUSS :31
ELEMENT :4  SECOND :0  RELIGION :1
THEATER :3  SPORTS :6  COMMERC :3
OFFICE :4  INDUSTRY :6  BUSSTOP :1

RESIDENTIAL AREA DENSITY=11 PEOPLE PER ACRE

TOTAL HOUSING DEVELOPMENT=63.00 LOC
PERCENTAGE LOWHOUSS=49.21
"  MEDHOUSS=25.40
"  HIGHOUS=25.40
Test 2, 3rd Stage, part 1

rd hous 2
R 0.07/75.21
rd major dimitri(1,10,23,23)
TOTPEOP=2360  TOTCHLD1=570  TOTCHLD2=300  TOTHSHLD=728  TOTMENW=250
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:
(8)ELEMENT=0  (9)SECOND=0  (10)RELIGION=0
(11)THEATER=2  (12)SPORTS=0  (13)COMMERC=3
(14)OFFICE=0  (15)INDUSTRY=0  (16)BUSSTOPO=0

**<>NOW LOCATE:(13)
**>>> OPTIMUM LOC:11,18
LOCATED AT:11,19
I = 19
LOCATED AT:12,19
I = 19
LOCATED AT:10,19
I = 19
<>NOW LOCATE:(11)
**>>> OPTIMUM LOC:10,18
LOCATED AT:9,19
I = 19
*LOCATED AT:11,18
I = 19
TO GET MAP TYPE: MAP* (A B C D E;W) ()-() ()-()
READ_CONSOLE_RETURN
R 25.33/100.54
map* (a b c d e;w) 1-25 8-25

LEGEND:

PRESENT ACTIVITY STATUS:
HIGHOUS :22  MEDHOUW :20  LOWHOUW :40
ELEMENT :4    SECOND :0    RELIGION :1
THEATER :5    SPORTS :6     COMMERC :5
OFFICE :4     INDUSTRY :6   BUSSTOP :1

RESIDENTIAL AREA DENSITY=15 PEOPLE PER ACRE

TOTAL HOUSING DEVELOPMENT=82.00 LOC
PERCENTAGE LOWHOUW=48.78
   " MEDHOUW=24.39
   " HIGHOUS=26.83
rd data dimitri
*NOW DEVELOP HOUSING -- ACTORS AT PRESENT STATE ARE:
TOTPEOP=275 TOTCHLD1=77 TOTCHLD2=44 TOTHSHLD=66 TOTMENW=22
R 1.10/6.56
rd hous 1
END OF FILE ON DISK
R 0.05/6.61
rd hous 2
R 0.04/6.65
rd hous 3
END OF FILE ON DISK
R 0.05/6.70
d#rd ru es dimitri
END OF FILE ON DISK
R 0.16/6.86
rd major dimitri(1,10,23,23)
TOTPEOP=2360 TOTCHLD1=570 TOTCHLD2=300 TOTHSHLD=728 TOTMENW=250
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:
(8)ELEMENT=1 (9)SECOND=0 (10)RELIGION=1 (11)THEATER=5 (12)SPORTS=1
(13)COMMERC=6 (14)OFFICE=1 (15)INDUSTRY=2 (16)BUSSTOP=1
**<>NOW LOCATE:(13)
*>>> OPTIMUM LOC:11,18
LOCATED AT:8,19
I = 19
LOCATED AT:9,19
I = 19
LOCATED AT:10,19
I = 19
*LOCATED AT:9,18
I = 19
LOCATED AT:8,18
I = 19
LOCATED AT:10,18
I = 19
<>NOW LOCATE:(15)
**>>> OPTIMUM LOC:10,17
RADIAL SEARCH
LOCATED AT:10,21
I = 19
9,21
10,22
11,21
9,22
11,22
RADIAL SEARCH
<>LOCATED AT:8,21
I = 19
7,21
8,22
7,22
6,21
8,23
<>NOW LOCATE:(8)
>>> OPTIMUM LOC: 10,16
LOCATED AT: 7,15
I = 19
6,15
7,16
8,15

NOW LOCATE: (14)

>>> OPTIMUM LOC: 10,18
LOCATED AT: 11,19
I = 19
11,18
12,19
12,18

NOW LOCATE: (12)

>>> OPTIMUM LOC: 10,15
LOCATED AT: 8,16
I = 19
9,16
7,18
6,18
11,16
7,19

NOW LOCATE: (11)

>>> OPTIMUM LOC: 10,18
LOCATED AT: 12,16
I = 19
LOCATED AT: 12,15
I = 19
LOCATED AT: 11,15
I = 19
RADIAL SEARCH
LOCATED AT: 13,19
I = 19
RADIAL SEARCH
LOCATED AT: 13,18
I = 19
NOW LOCATE: (10)

>>> OPTIMUM LOC: 10,15
RADIAL SEARCH
LOCATED AT: 12,14
I = 19
NOW LOCATE: (16)

>>> OPTIMUM LOC: 10,17
LOCATED AT: 10,20

*TO GET MAP TYPE: MAP* (A B C D E;W) ()-() ()-()
READ_CONSOLE RETURN
R 70.01/76.87
map*(a b c d e;w) 1-25 8-25

LEGEND:

PRESENT ACTIVITY STATUS:
HIGHOUS:22 MEDIHOUS:20 LOWHOUS:40
ELEMENT:4 SECOND:0 RELIGION:1
THEATER:5 SPORTS:6 COMMERC:6
OFFICE:4 INDUSTRY:12 BUSSTOP:1

RESIDENTIAL AREA DENSITY=15 PEOPLE PER ACRE

TOTAL HOUSING DEVELOPMENT=82.00 LOC
PERCENTAGE LOWHOUS=48.78
" MEDHOUS=24.39
" HIGHOUS=26.83
DESCRIPTIVE INFORMATION:

The 3 maps of the following pages give information on the existing conditions of the site.

map 1. grid size 40 x 25
static activities and their location in the grid
+ : water
x : traffic
* : park

map 2. zoning, defined are 4 areas for 12 different activities

Housland: LOWHOUS
MEDHOUS
MEDHOUS
MEDHOUS
HIGHOUS
HIGHOUS
HIGHOUS

Centland: COMMERCE
OFFICE

Cultland: ELEMENT
SECOND
RELIGION
THEATER
SPORTS

Indland: INDUSTRY
BUSSTOP

map 3. Shows in dots the available empty locations for the developed and generated activities. (There are some locations occupied by existing LOWHOUS)
MAP 2
MAP 3
TEST 3

Incremental development in 4 stages

grid size: 1-40    1-25

operation area: varies

1 stage develop housing: Group A
2 stage develop housing: Group B
3 stage develop housing: Group C
4 stage develop housing: Group D

(final)
INFORMATION AND FIGURES FOR MODEL

GRID SIZE IS 1000 LOC OR 40X25 LOC
EACH LOC=100X100 FEET OR 4LOC=APPROX.1 ACRE

STATIC ACTIVITIES:
PARK EXISTS AT: 133 LOC
WATER : 42 LOC
TRAFFIC : 48 LOC

A. RESIDENTIAL AREA (HOUSLAND): <1,1>...<40,16>: 640 LOC
MAX DENSITY ALLOWED IS 56PEOP/ACRE
MAX HOUSING DEVELOPMENT IS 300 LOC
HOUSING: LOWHOUS=105 MEDHOUS=120 HIGHOUS=75
PERCENTAGE: 35 45 25

B. TOWN CULTURAL AREA (CULTLAND): <1,13>...<40,20> 320 LOC
(8) ELEMENT: 5X4
(9) SECOND : 2X10
(10) RELIGION: 5X1
(11) THEATER: 20X1
(12) SPORTS: 4X6

C. TOWN CENTER AREA (CENTLAND): <1,13>...<40,25> 520 LOC
(13) COMMERC: 23X1
(14) OFFICE: 5X4

D. INDUSTRIAL AREA (INDLAND): <1,21>...<40,25> 200 LOC
(15) INDUSTRY: 6X6
(16) BUSSTOP: 3X1

ACTORS AT MAX DEVELOPMENT ARE:
TOTPEOP: (LOWHOUS*25)+(MEDHOUS*35)+(HIGHOUS*30)=9075
TOTCHLD1: (LOWHOUS*7)+(MEDHOUS*9)+(HIGHOUS*5)=2190
TOTCHLD2: (LOWHOUS*4)+(MEDHOUS*6)+(MEDHOUS*1)=1215
TOTMENW: (LOWHOUS*6)+(MEDHOUS*9)+(HIGHOUS*14)=2760
TOTMENW: (LOWHOUS*2)+(MEDHOUS*3)+(HIGHOUS*5)=945

OPERATION:
RD DATA VALUE RULES DIMITRI
RD DEVELOP DIMITRI
RD MAJOR DIMITRI( , , , )
MAP*(A B C D E ;W) COORD
RD INFO DIMITRI
END PROGRAM OR RD MAJOR AGAIN
PRESENT ACTIVITY STATUS:
HIghHOUS :0  MEDHOUS :0  LOWHOUS :11
ELEMENT :0  SECOND :0  RELIGION:0
THEATER :0  SPORTS :0  COMMERC :0
OFFICE :0  INDUSTRY:0  BUSSTOP :0

RESIDENTIAL AREA DENSITY=2 PEOPLE PER ACRE

TOTAL HOUSING DEVELOPMENT=11.00 LOC
PERCENTAGE LOWHOUS=100.00
    MEDHOUS=0.00
    HIghHOUS=0.00
Staging of development

Housing groups (M, H, L) and patterns
rd develop dimitri(0,1,0,0)
END OF FILE ON DISK
ALL NON-MACRO LABELS REMOVED
R 0.19/2.61
rd major dimitri(14,1,26,25)
TOTPEOP=3035 TOTCHLD1=736 TOTCHLD2=416 TOTHSHLD=920 TOTMENW=315
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:

(8) ELEMENT=2 (9) SECOND=1 (10) RELIGION=2
(11) THEATER=7 (12) SPORTS=1 (13) COMMERC=8
(14) OFFICE=2 (15) INDUSTRY=2 (16) BUSSTOP=1

**<>NOW LOCATE:(13)
**>>>< OPTIMUM LOC:19,15
LOCATED AT:17,15
I = 16
LOCATED AT:18,15
I = 16
*LOCATED AT:19,15
I = 16
LOCATED AT:20,15
I = 16
LOCATED AT:20,14
I = 16
LOCATED AT:21,15
I = 16
LOCATED AT:21,14
I = 16
LOCATED AT:21,13
I = 16
<>NOW LOCATE:(15)
**>>>< OPTIMUM LOC:19,13
RADIAL SEARCH
<<<<
<<
<<
<<
<<
LOCATED AT:22,21
I = 16
23,21
21,22
22,23
24,21
20,22
RADIAL SEARCH
<<
<<
<<
<<
<<
LOCATED AT:19,22
18, 22
19, 23
18, 23
20, 23
17, 22

<> NOW LOCATE: (8)

**>>>** OPTIMUM LOC: 19, 11

RADIAL SEARCH

<<
LOCATED AT: 23, 13
I = 16
23, 14
22, 14
24, 14

RADIAL SEARCH

<<

LOCATED AT: 16, 15
I = 16
15, 15
14, 15
14, 14

<> NOW LOCATE: (14)

**>>>** OPTIMUM LOC: 20, 15

LOCATED AT: 22, 15
I = 16
23, 15
22, 17
24, 15

LOCATED AT: 21, 17
I = 16
20, 17
21, 18
20, 18

<> NOW LOCATE: (12)

**>>>** OPTIMUM LOC: 19, 11

RADIAL SEARCH

<<

LOCATED AT: 14, 13
I = 16
13, 13
13, 14
12, 13
12, 14
13, 15

<> NOW LOCATE: (9)

**>>>** OPTIMUM LOC: 19, 13

RADIAL SEARCH

LOCATED AT: 19, 17
I = 16
18, 17
18,18
17,17
19,19
17,18
18,19
20,19
17,19

<>NOW LOCATE:(11)
>>>>
OPTIMUM LOC: 19,14
RADIAL SEARCH
<<
LOCATED AT: 22,18
I = 16
RADIAL SEARCH
<<
LOCATED AT: 23,17
I = 16
RADIAL SEARCH
<<
LOCATED AT: 16,18
I = 16
RADIAL SEARCH
<<
LOCATED AT: 19,20
I = 16
RADIAL SEARCH
<<
LOCATED AT: 23,18
I = 16
RADIAL SEARCH
<<
LOCATED AT: 21,19
I = 16
RADIAL SEARCH
<<
LOCATED AT: 22,19
I = 16
<>NOW LOCATE:(10)
>>>>
OPTIMUM LOC: 19,11
RADIAL SEARCH
<<
<<
LOCATED AT: 25,14
I = 16
RADIAL SEARCH
<<
<<
LOCATED AT: 25,13
<>NOW LOCATE:(16)
*>>>>
OPTIMUM LOC:20,14
LOCATED AT:19,21
TO GET MAP TYPE: MAP* (A B C D E;W) ()-() ()-()
READ_CONSOLE RETURN
R 92.95/95.56
map* (a b c d e ;w) 1-40 1-25
ERROR 1000
ALL NON-MACRO LABELS REMOVED
R 0.03/95.59
map
map *(a b c d e;w) 1-40 1-25
Test 3, 2 stage

```
rd develop dimitri(0,0,1,0)
END OF FILE ON DISK
ALL NON-MACRO LABELS REMOVED
R 0.16/97.17
rd major dimitri(27,1,40,25)
TOTPEOP=4710) TOTCHLD1=1133 TOTCHLD2=638 TOTHSHLD=1444 TOTMENW=495
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:
(8) ELEMENT=0 (9) SECOND=0 (10) RELIGION=0
(11) THEATER=3 (12) SPORTS=0 (13) COMMERC=4
(14) OFFICE=0 (15) INDUSTRY=0 (16) BUSSTOP=1

**<>NOW LOCATE:(13)
>>>>
OPTIMUM LOC:34,16
LOCATED AT:35,18
I = 16
LOCATED AT:34,18
I = 16
*LOCATED AT:33,18
I = 16
LOCATED AT:33,19
I = 16
<>NOW LOCATE:(11)
>>>>
OPTIMUM LOC:34,16
LOCATED AT:34,16
I = 16
*LOCATED AT:35,16
I = 16
LOCATED AT:33,16
I = 16
<>NOW LOCATE:(16)
>>>>
OPTIMUM LOC:33,15
LOCATED AT:37,20
TO GET MAP TYPE: MAP* (A B C D E;W) ()-(()) ()-()
READ_CONSOLE_RETURN
R 28.25/125.92
map* (a b c d e;w) 26-1#40 1-25
```

```
<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5</td>
</tr>
<tr>
<td>26</td>
<td>*</td>
</tr>
<tr>
<td>27</td>
<td>*</td>
</tr>
<tr>
<td>28</td>
<td>*</td>
</tr>
<tr>
<td>29</td>
<td>*</td>
</tr>
<tr>
<td>30</td>
<td>*</td>
</tr>
<tr>
<td>31</td>
<td>*</td>
</tr>
<tr>
<td>32</td>
<td>..</td>
</tr>
<tr>
<td>33</td>
<td>*</td>
</tr>
<tr>
<td>34</td>
<td>..</td>
</tr>
<tr>
<td>35</td>
<td>*</td>
</tr>
<tr>
<td>36</td>
<td>*</td>
</tr>
<tr>
<td>37</td>
<td>*</td>
</tr>
<tr>
<td>38</td>
<td>*</td>
</tr>
<tr>
<td>39</td>
<td>*</td>
</tr>
<tr>
<td>40</td>
<td>*</td>
</tr>
</tbody>
</table>
```
rd info dimitri

PRESENT ACTIVITY STATUS:
HIGHOUS: 41  MEDHOUS: 58  LOWHOUS: 58
ELEMENT: 8  SECOND: 10  RELIGION: 2
THEATER: 10  SPORTS: 6  COMMERC: 12
OFFICE: 8  INDUSTRY: 12  BUSSTOP: 2

RESIDENTIAL AREA DENSITY = 29 PEOPLE PER ACRE

TOTAL HOUSING DEVELOPMENT = 157.00 LOC
PERCENTAGE LOWHOUS = 36.94
" MEDHOUS = 36.94
" HIGHOUS = 26.11
R 0.28/126.57
rd develop dimitri(0,0,0,1)  
ALL NON-MACRO LABELS REMOVED  
R 0.13/126.70  
rd major dimitri(27,1,40,25)  
TOTPEOP=5865  TOTCHLD1=1418  TOTCHLD2=804  TOTHSHLD=1784  TOTMENW=611  
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:  

(8) ELEMENT=0  
(9) SECOND=0  
(10) RELIGION=1  
(11) THEATER=3  
(12) SPORTS=0  
(13) COMMERC=3  
(14) OFFICE=0  
(15) INDUSTRY=0  
(16) BUSSTOP=0  

**<>NOW LOCATE:(13)**  
**>>> OPTIMUM LOC:34,15**  
LOCATED AT:33,18  
| I |  16  |
---|-----|
LOCATED AT:33,16  
| I |  16  |
LOCATED AT:34,16  
| I |  16  |

**<>NOW LOCATE:(11)**  
**>>> OPTIMUM LOC:34,15**  
LOCATED AT:34,15  
| I |  16  |
---|-----|
LOCATED AT:33,15  
| I |  16  |
LOCATED AT:32,15  
| I |  16  |

**<>NOW LOCATE:(10)**  
**>>> OPTIMUM LOC:34,15**  
RADIAL SEARCH  
<<  
LOCATED AT:37,13  
| I |  16  |
---|-----|
TO GET MAP TYPE: MAP* (A B C D E;W) ()-() ()-()  
READ_CONSOLE_RETURN  
R 30.52/157.22  
map* (a b c d e;w) 26-40 1-25  

```
1 2 3 4 5)6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
26  *  *  L  L  *  +  x 26  
27  *  *  *  *  *  M  *  +  *  *  x 27  
28  *  *  *  *  *  H  H  H  M  L  *  +  *  x 28  
29  .  *  .  *  *  H  M  M  M  L  L  *  +  x 29  
30  *  *  *  *  *  H  M  M  M  L  L  *  +  x 30  
31  *  *  H  H  M  M  M  M  L  L  *  +  *  x 31  
32  .  *  *  M  M  M  M  L  L  H  M  M  M  L  L  +  N  x 32  
33  .  *  H  H  M  M  M  M  L  L  N  M  +  C  M  .  x 33  
34  .  *  *  H  H  M  M  M  M  L  L  N  M  +  M  x 34  
35  *  H  M  M  L  L  .  .  .  .  M  .  x  x  x  x 35  
36  *  H  M  M  R  L  L  .  .  .  .  .  .  H  H  M  .  +  x 36  
37  *  .  M  M  M  M  L  L  .  .  .  .  .  .  H  M  R  M  L  *  +  .  x 37  
38  .  *  M  L  L  .  *  *  H  M  M  L  *  +  .  x  .  x 38  
39  .  *  .  L  .  .  *  *  H  M  L  L  *  +  .  x  39  
40  .  *  .  *  .  .  .  *  *  *  *  *  *  +  .  x  40  
```
rd info dimitri

PRESENT ACTIVITY STATUS:
HIGHOUS: 75    MEDHOUS: 117    LOWHOUS: 111
ELEMENT: 8     SECOND: 9      RELIGION: 5
THEATER: 20    SPORTS: 6      COMMERC: 22
OFFICE: 8      INDUSTRY: 11   BUSSTOP: 3

RESIDENTIAL AREA DENSITY = 57 PEOPLE PER ACRE

TOTAL HOUSING DEVELOPMENT = 303.00 LOC
PERCENTAGE LOWHOUS = 36.63
"    MEDHOUS = 38.61
"    HIGHOUS = 24.75

R 0.28/19.32
rd develop dimitri(1,0,0,0)
END OF FILE ON DISK
ALL NON-MACRO LABELS REMOVED
R 0.19/158.00
rd major dimitri(1,1,13,25)

TOTPEOP=9120  TOTCHLD1=12205  TOTCHLD2=1263  TOTHSHLD=2769  TOTMENW=948
THE ACTORS INCREASE GENERATES THE FOLLOWING ACTIVITIES:
(8) ELEMENT=0  (9) SECOND=0  (10) RELIGION=2
(11) THEATER=7  (12) SPORTS=0  (13) COMMERC=9
(14) OFFICE=0  (15) INDUSTRY=0  (16) BUSSTOP=1
***<>NOW LOCATE:(13)
**>>>
OPTIMUM LOC:6,15
LOCATED AT:7,16
I = 16
LOCATED AT:3,13
I = 16
RADIAL SEARCH
LOCATED AT:4,17
I = 16
RADIAL SEARCH
LOCATED AT:5,18
I = 16
RADIAL SEARCH
LOCATED AT:8,16
I = 16
RADIAL SEARCH
LOCATED AT:8,15
I = 16
RADIAL SEARCH
LOCATED AT:2,13
I = 16
RADIAL SEARCH
<>LOCATED AT:4,18
I = 16
RADIAL SEARCH
<<
LOCATED AT:5,19
I = 16
<>NOW LOCATE:(11)
**>>>
OPTIMUM LOC:6,14
RADIAL SEARCH
<<
LOCATED AT:6,18
I = 16
RADIAL SEARCH
<<
LOCATED AT:9,16
I = 16
RADIAL SEARCH
<<
LOCATED AT:9,15
I = 16
RADIAL SEARCH
LOCATED AT:7,18
I = 16
RADIAL SEARCH
<> LOCATED AT:8,18
I = 16
RADIAL SEARCH
<<
<<
<<
*LOCATED AT:6,19
I = 16
<> NOW LOCATE:(10)
<<<>>> OPTIMUM LOC:6,11
RADIAL SEARCH
<<
<<
LOCATED AT:10,15
I = 16
RADIAL SEARCH
<<
<<
LOCATED AT:11,14
I = 16
<> NOW LOCATE:(16)
<<<>>> OPTIMUM LOC:6,13
LOCATED AT:6,20
TO GET MAP TYPE: MAP* (A B C D E;W) ())--() ()--()
READ_CONSOLE_RETURN
map* (a b c d e: k) 1-40 1-25

FIGURE 17. FINAL PLAN OF TEST 3
(2) CONCLUSIONS AND FUTURE DEVELOPMENT OF MODEL

The three previous tests allow through direct observation and some calculations to evaluate the performance of the model and to determine the areas where further development is necessary. Although operating on a small grid size the accuracy and spatial arrangements of the activity was very satisfactory, on the large grid size (40 x 25) it was difficult to control the results. This is because the model was developed through testing on a relatively small grid size (9 x 15).

By using the "controls" that are available (chapter C5) through experimentation, it is possible to apply the model successfully on a larger grid size. This will demand a large amount of computer time and effort, but can be very useful for demonstrating the maximum performance of the model. Questioning the measures of accomplishment (set up in chapter C1) of the model, we arrive at the following conclusions:

1) the ratio of input data required at the present state of the model is approximately equal to the ratio of output data generated by the model. In a later version of the model it is possible that the output ratio will be much larger than the input.

2) Direct observation and decision making by the urban designer is at the present development of the model much more accurate than that of the model, that in addition operates on a higher cost.
3) The flexible structure of the model allows applicability to other times and places and operation by different users, than that for which it was originally constructed. This may effect a great reduction of cost in the use of the model, once it has been developed, that might compete with conventional techniques.

Future versions of the model should take into account more variables and characteristics that will operate on more complicated rules, producing results closer to reality. Also based on the incremental growth principle, where staging occurs in a continuous form in time (cycles), the model should develop continuously changing its data and structure according to the new information and changes that occurred in the Town.
FIGURE 18: DIAGRAMMATIC PRESENTATION OF THE INCREMENTAL GROWTH PRINCIPLE.
(3) COMPUTER TECHNIQUES IN URBAN DESIGN

The author's intention was not to develop a complete computer model for locating urban activities, but to study the strategy and the requirements of using a computer technique in an urban design problem by specifying the area of operation and simplifying the development process.

The experience of working with the Discourse language was new to the author but the simplicity and clarity of the structure of the language helped in the understanding and proper use of it. The Discourse system, not being fully developed, is a very flexible system that gives a complete set of operational rules to the user for handling urban problems. To further development of the Discourse system, the following factors should be considered:

1) Simplification of language used for greater accessibility by different types of users. More proximity of language to English. Vocabulary of words used.
2) Construction of more complicated equations into simple single commands (like gravity, nearest)
3) More clear explanation of some types of error messages. Error information should be included in the system (eg. show error..)
4) Use of other devices than the console, like TV sets or better 3 dimensional models, that the user can "feel" and "touch" which enable a better men-machine communication.
5) A Discourse complete manual with vocabulary, commands, error messages and examples, in a handy form to facilitate the use of the system (also all this information could be included in the system, i.e. show gravity command)
At its present state, the Discourse system requires continuous use and programing or assistance by trained programmers. Discourse improvements based on the 5 factors described above should allow easy accessibility to any designer with little preparation and practice on the system.

The use of computer techniques in urban planning will influence the design-process generating a new kind of design based on a more systematical search and producing more accurate results. The present computer techniques used in urban planning which are derived from conventional technique observations and conclusions, are not able to compete with the latter. Therefore, through experimental projects and tests, new concepts, principles and methods should be set up and used as a base for the computer aided urban design techniques.
BIBLIOGRAPHY:

4. "Comparative Housing Study", Harvard University Graduate School of Design
9. Ira S. Lowry, "A Short Course in Model Design", 1965
12. J. W. Forrester, "Urban Dynamics"
   MIT Press, 1969
   ICMA, 1968
15. K. Lynch, "Quality in City Design, PAM, pp. 38-40, pp. 51-64
17. K. Lynch, "The Image of the City"
   MIT Press, 1960
   Town Planning Review, April, 1966, pp. 5-20
19. "A Plant Location Survey"
   American Electric Power System Report 1969
20. D. Stamatiadis, Architectoniki, Vol. 74
    pp. 45-51, 1969, July
    A Satellite Town for Athens
21. D. Stamatiadis, L'Architecture D'aujourd'hui "Villes Nouvelles" - October, 1969, p. 76
22. Lionel March and Michael Trace, "The Land Use Performances of Selected Arrays of Built Forms"
    University of Cambridge, School of Architecture
24. "The Discourse manual and command descriptions",
    April 1970
LIST OF FIGURES:

1. Approach Strategy 9
2. Map of Greater Athens Area 13
3. Aerial Photograph of Site 14
4. Master Plan 16
5. Subset of Design Process 17
6. Organizational System 18
7. Activity Relations 21
8. Town Center Plan 22
9. Table of Users Participation 24
10. Assigning Weights Table 39
11. Developed Activity Characteristics 42
12. Generated Activity Characteristics 43
13. Activity Weights Table 44
14. Locational Priorities Table 45
15. Model Structure 61
16. Rules for Locating Activity 62
17. Final Plan of Computer Model 110
18. Incremental Growth Principle 113