THE SUBAREA PLANNING MACRO

preliminary release

DEVELOPMENT OF A METHOD FOR SUBAREA PLANNING IN THE EMME/2 SOFTWARE ENVIRONMENT

Data Management Group
Joint Program in Transportation
University of Toronto

November 1995

Introduction.

The following report is intended for EMME/2 system users. It assumes the reader is familiar with the EMME/2 software and has experience in transportation analysis techniques. This knowledge is necessary to implement many of the options in the macro procedure and for the user to make adjustment to fit the specific needs of any specific project. Given this constraint, one of the purposes of the techniques presented in this report was to allow the transportation analyst or planner to avoid time consuming manual adjustments and calibration procedures when undertaking system or network aggregation. As much as possible, the techniques attempt to save the analyst from the task of learning all the technical features in EMME/2.

This report was prepared by Dr.Vladimir Livshits and methodologically supervised by Professor Gerald N. Steuart.

I. Problem definition.

A regional transportation planning framework is well established in the Toronto area with a well-established zone system and a comprehensive representation of the regional road and transit system. However, there is considerable interest in adjusting this framework to better suit the needs of subarea analysis and planning. This adjustment poses some method and technical problems. How to extract information from the regional data base? How to provide the feed back to the regional data base? How to represent the links that are outside as opposed to inside the subarea? What will be the rational level of aggregation for the subarea? Whether there is a need in some cases for special subarea forecasting models? All these and many other related questions will face the transportation analyst during subarea analysis and planning. Obviously the answers will depend on the software environment and the specific questions for which the subarea analysis is conducted. The goal of this report is to provide a general method and technical framework for users who are going to implement different subarea planning tasks in the Great Toronto Area (GTA) using the shared EMME/2 environment.

EMME/2 subarea planning limitations.

There are a number of practical limitations to the size and complexity of a transportation network, and corresponding size of the data bank, when using EMME/2. These limitations are not only related to rigid constraints, but also to the performance of EMME/2. The main types of limitation and the general reason for limiting the size of a data bank are given in Table 1.1.

Table 1.1. Limitations associated with the size of an EMME/2 bank.

PERFORMANCE TASK	LIMITATIONS AND INCONVENIENCES
	(In order of practical importance)
creation and storing the EMME/2 bank	disk space backup convenience data transfers convenience
network presentations and calculations, presentation of assignment results, plotting, storing external network data files	performance time computer terminal display of networks data transfers convenience disk space
matrix presentations and calculations, storing external matrix data files	performance time display of matrix contents data transfers convenience disk space
assignments	performance time
implementing macros	processing time

If a network and data bank are common to a variety of users, and even the same user performing a different task, requires detail on different parts of the network or matrix data. It is common for an EMME/2 data system to be created and calibrated for a large region, which may be some metropolitan or large regional district, or even for a whole country. This is particularly true when the system is licensed to some government, education or public non-profit organizations for access by a variety of users. In most of these cases, EMME/2 is operated in the multi-user environment with a wide range of users with their own financial, temporal and technical restrictions. In such an environment, it is important to be able to customize the network and data base to the task at hand and eliminate the parts of the EMME/2 data bank that are not related explicitly to the problem to be solved. The procedures described in this report attempt to assist in this process of customizing the data bank to the task at hand.

Main approaches to subarea planning.

There are two main approaches that have been used for subarea analysis and planning (See Table 1.2.), the isolation approach and the focusing approach. The isolation approach is partly implemented in the EMME/2. EMME/2 has the build-in capability to isolate part of the network and to compute the resulting link-to-link matrix. However, this procedure (known as the Computation of Traversal Matrices) has three important restrictions. First, the resulting link-to-link matrix may be considered a satisfactory solution for local traffic impact analysis in the short-term or assessments of a very local transportation project. Applications are restricted to the condition where users of the gates in the sub-area and their destinations in the sub-area are known. The basic assumption is that any changes in development or in network capacity will not influence the pattern of traffic into or through the sub-area. Second, the computation of a traversal matrix is time consuming and must be performed by an experienced EMME/2 user. All procedures must be repeated from the beginning if the user decides to change the definition of a subarea or to change an initial demand matrix. Third, the number of 'gates' that can be created is limited, which affects the size of subarea that can be analyzed.

The common way to implement a focusing approach is to create a separated data base with larger traffic zones and higher capacity links in areas remote from the subarea of interest. The number of traffic zones may be reduced by a factor of three or four and the road network may include mostly freeways, expressways and some major arterial roads. The reality is that such an approach requires the creation, validation and calibration of the another network and corresponding data bank. This process is time consuming and requires considerable care in the selection of appropriate detail and in the calibration to be certain it represents reality. The practical result is that when an aggregated system is once prepared and calibrated it is applied to a variety of subarea projects in spite of their differences size and spatial configuration. Usually it is necessary to develop and calibrate special travel forecasting models for the aggregated network and selected subarea as distinct from those developed on the full network. Solutions of these problems are highly

depended from the context of the subarea projects and spatial characteristics of the network and the travel demand. The other technical problem that may arise is compatibility of the different data bases with different levels of aggregation. This compatibility is important to facilitate the exchange of data that is necessary to ensure that all projects are using the most recent update. If the data bases are created in EMME/2 with different numbers of traffic zones, it is better to keep them in separate data banks for operational reasons.

Table 1.2. General approaches to the subarea planning.

	ISOLATION APPROACH	**FOCUSING APPROACH**
PREREQUISITES	• growth and change outside the subarea do not influence the pattern of traffic entering and passing through the subarea • short-term analysis • obvious and clear definition of the subarea where boundaries are not likely the subject of subsequent revisions	• pattern of traffic in the subarea is influenced by growth and network change outside • short-term and middle-term analysis and planning • the subarea definition may be revised in subsequent analysis and forecasting
METHODOLOGY	• complete isolation of the subarea • the travel on each severed link is represented as an "external station"	• aggregation of the computer representation of outside transportation supply and demand • development of subarea forecasting models
ADVANTAGES	• simple method with little need for complex modeling • existing technical tools and procedures	• flexibility of method (aggregation and modeling may be adjusted to the analysis purposes) • flexibility in application and may be adjusted for a wide range of projects, analysis and planning tasks
DISADVANTAGES	• restricted range of possible analysis tasks and projects • rigid conditions placed on the method	• complexity of method which usually requires the development of special models • absence of the state-of-art technical tools and well-defined recommendations on method

Main principles of the Macro development.

The potential solution to the aggregation problem proposed by the Data Management Group is to attempt to develop a macro operating in the EMME/2 environment that allows the user to select and implement the appropriate procedure. The task is to develop a flexible automated procedure (hereinafter referred to as "The Macro") that allows the user to define subsystems of network and matrix data according to his particular definitions and demands. Several principles guided the construction of this macro:

1. Technical effectiveness:
    *   minimal use of disk space and execution time:
        -   minimum number of information exchanges between an EMME/2 environment and the operating system environment (punches and batch outputs-inputs)
        -   minimum number of extra attributes required in the Macro
        -   minimum number of reports needed during the Macro execution
        -   minimum number of scenarios and matrices needed during the Macro execution
    *   simplicity in customising the procedure:
        -   avoid the use of software external to EMME/2
        -   simple interactive dialogues with direct questions or "EMME/2 like" user's choice questions
        -   avoid unnecessary dialogue by including automatic procedures based on logical selections (to define previous user's choices for example)
    *   utilisation of the specific network characteristics:
        -   unused parameters in the GTA network code
        -   specific spatial configuration and network type
    *   minimum execution time:
        -   effective algorithms
        -   minimum switching between different modules of EMME/2
        -   eliminating unnecessary reports and screen outputs.

2. Flexibility of Methods:
    *   ability to trace changes in traffic flow outside a selected subarea which may significantly affect traffic flow inside that selected subarea and vice versa;
    *   flexibility in subarea definition that can be specifically designed to reflect the type of project to be implemented
        -   use of graphic and numeric options in an EMME/2 environment to assist in the choice of subarea
        -   automatic adjustment of the all procedures and criteria to the size and configuration of the selected subarea
        -   include all the main approaches to subarea planning
    *   independence of the subarea size and configuration
        -   acceptable working time of the Macro, independent of the subarea size.

3. Theoretical validity.
   - use accepted in transportation planning and traffic engineering concepts
   - use accepted methods in subarea planning
   - use, wherever possible, established state-of-the-art algorithms from the theory of graphs.

It is desirable to implement the full process in the framework of the EMME/2 macro language. This is done to avoid any difficulties that may arise because of different qualifications and preferences of EMME/2 users. In addition, operating entirely within the EMME/2 system should reduce the total time taken to complete an aggregation task.

II. Initial information.

Implementation of the Macro procedure obviously depends on the specific network code. The size and characteristics of the network and matrix data on which the procedure will operate will affect the decisions as well. Therefore, a brief description of these factors is important to understand the choices that are implemented in the algorithm. The current version of the Macro is based on the report *GTA Network Coding Standards, Report 47 Joint Program in Transportation, February 1995.*

The GTA Road Network Code

The road network code includes the following main elements:

Table 2.1. Main elements of the GTA road network code.

EMME/2 ATTRIBUTE	CONTEST OF THE ATTRIBUTE
centroid number	centroids are numbered according to the Regional Districts
node numbers	nodes are numbered according to the Regional Districts
node user data items	not in use
node label	node number
link type	first digit - functional class second and third digit - planning zone number
link length	link length
number of lanes	number of lanes
volume-delay function index	volume-delay function index
first link user data item	not in use
second link user data item	free flow speed
third link user data item	link capacity

Intersection coding has not been developed in the GTA network. Turn penalty functions are only used to reflect turn prohibitions. The set of volume-delay does not contain any specification for turn penalties. These circumstance simplifies the Macro structure, in particular, the availability of user data fields allow them to be used in the Macro. This opportunity is important as the addition of external attributes to the bank significantly increases its size. Even if the user data items must be reserved for the future needs, it is preferably to organise data exchange and to store unused data temporary outside the bank rather than increase its size for the external attributes. The Macro may be rewritten easily

to store data items in a different fashion if necessary. A second important characteristic of the current coding procedure is that the road network code already contains some elements of spatial definition and functional classification. This classification may be used as a base for the network aggregation procedures.

Spatial Characteristics of The Network

The GTA transportation network has a clearly defined grid pattern for the most part, although the orientation of the grid changes where jurisdictions come together. Apart from some differences in orientation, the network has an orientation of the axis in a north-south and east-west direction. It is possible to establish a rather clear classification of the roads from the point of their main functional purposes. However, this functional roads and street classification can not been described unambiguously in the terms of the GTA network code, which includes land use characteristics of the specific road environment and is too aggregated to be used explicitly as it is , see Table 2.2. To distinguish major and minor street categories and to resolve movement and access functions of the roads and streets in the network, one must consider not only the designated road type but also the spacing of the network elements their location and directions. Subarea planning demands a precise division of the road facilities according to their function to achieve the proper level of aggregation for the subarea and outside network. The issues become more complicated as the base network becomes larger.

Table 2.2. Road functional classification in the GTA network code.

LINK TYPE	FUNCTIONAL CLASSIFICATION
100 - 199	Freeways
200 - 299	Freeways ramps
300 - 399	Controlled/restricted access highway/arterial roads
400 - 499	Rural highways/arterial roads
500 - 599	High capacity urban arterial roads
600 - 699	Medium capacity urban arterial roads
700 - 799	CBD arterial roads
800 - 899	Collector roads and local streets
900 - 999	Centroid connectors

Different functional classifications on the actual road system have different levels of detail in the coded GTA network. As in any other model, the GTA network model represents a certain degree of aggregation of the real network. It can be seen from the Table 2.3, the GTA network represents mainly those road facilities that cater to through

traffic and major traffic circulation.. The category of minor streets is implemented mostly
by centroid connectors.

Table 2.3. Road facilities presentation in GTA network.

LINK TYPE	NUMBER OF LINKS	LINK LENGTH (km)	AVERAGE LENGTH (km)
100 - 199	472	783	1.65
200 - 299	320	82	0.26
300 - 399	1675	2784	1.66
400 - 499	1946	2820	1.44
500 - 599	4215	3583	0.85
600 - 699	3381	2777	0.82
700 - 799	1854	1154	0.62
800 - 899	542	365	0.67
900 - 999	6063	4555	0.75

III. Algorithm.

The Macro algorithm consists of three main steps , see Figure 3.1:
- subarea definition
- aggregation of transportation supply and demand
- presentation and testing of results.

In accordance with this logical definition of the tasks, the macro procedure is structured into three main modules. The module structure, interactive mode dialogues and graphic representations are carried out completely within EMME/2 and are implemented in the EMME/2 macro language. This makes it easy for the user to operate completely within EMME/2 and allows the Macro to be changed or customised easily by any EMME/2 user, see Chapter IV, Customising the Macro.

Figure 3.1. Main steps of The Macro algorithm.
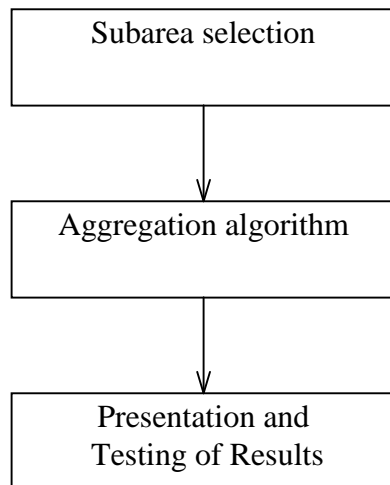
During the subarea selection, the user is offered different ways to specify the subarea. The Macro marks the appropriate network elements of the selected area for future use in the aggregation procedure. Outside network aggregation is performed on the basis of different classifications of network elements. The aggregation results are further transferred to a matrix modification module.

Subarea selection procedure

Definition of the subnetwork is based on the classification of the network elements; centroids, nodes and links. There are three main ways to classify network elements in EMME/2:

- by network code
    - using explicit code parameters (type, lanes, vdf, etc.)
    - using network characteristic implicitly implemented in the code or connected with it (it may be a functional road classification as in the GTA code, capacity if it is calculated on the basis of information contained any of the user fields, etc.)
- by some spatial attribute that can be established on the basis of the network code (co-ordinate location, shortest distance between elements according to the node co-ordinates, link length, etc.)
- by attributes taken from an assignment (time, volume, speed, etc.) usually related to volume-capacity ratios, levels of service, accessibility of this or that location and so on.

Classification of links according to their network code in a practical sense means classification according to link capacity. The network might be seen as aggregate of different layers: a layer of freeways, a layer of local roads and etc. On the basis of a spatial location of a network element, it is convenient to define three aggregation levels that are currently present in the road network code; regional districts, planning zones and traffic zones. From the point of view of defining a subarea, network elements need to be classified according to their importance and influence on the selected region.

After choosing the subarea selection module from the main macro menu, users are prompted to organise their selection according to one of the available aggregation levels: by regional districts, by planning zones or by traffic zones. The most appropriate level of aggregation on the GTA network is likely to be the planning zone. The traffic zones level may be useful for some unusual spatial arrangements at the borders of the subarea, for traffic corridors or for very small subareas. If a user is going to work with detail at the level of regional district, especially bordering on other regional districts, the effect of network aggregation will be limited but may be still significant.

The Macro classifies network nodes such that each node will related to one and only one group according to the classification level selected by user (to one region, planning zone or traffic zone). The subarea selection can be performed in either graphic or numeric mode. Graphic mode is much more flexible, visual and simple for user, but more complicated from the point of its implementation and takes a little bit more time to identify all the selected nodes. The Macro will display colour according to the selected level of aggregation (zones, regions, etc.) on a graphic representation of the road network. Selection is possible by a simple mouse click inside the desired areas or by surrounding them with polygon. Annotation will provide some support help if necessary. If the numeric mode is selected, selection demands from the user the knowledge of the

numbering convention used to identify nodes. The Macro marks each node which is related to the current user selection and returns to the main macro menu ready for continuing the aggregation process. No special designations are necessary in making a selection. All information will be recalled automatically in the subsequent macro modules. A brief outline of the subarea selection module is provided on Figure 3.2. Figure 3.3 presents examples of the selection windows (if the selection is performed in the graphic mode).

Figure 3.2. Main blocks in the subarea selection module algorithm.

| Users choice of the selection modes | selection according to regional districts
selection according to planning zones
selection according to traffic zones

graphic or numeric selection mode
selection by surrounding with polygon or by pointing inside the selected area |

| Network elements classification | Classification of the road network nodes and links by the regional districts
on the basis of the nodes and centroids numbers

Classification of the road network nodes and links by the traffic zones on the basis of the "expanding ripples" algorithm

Classification of the road network nodes and links by the planning zones on the basis of the link type |

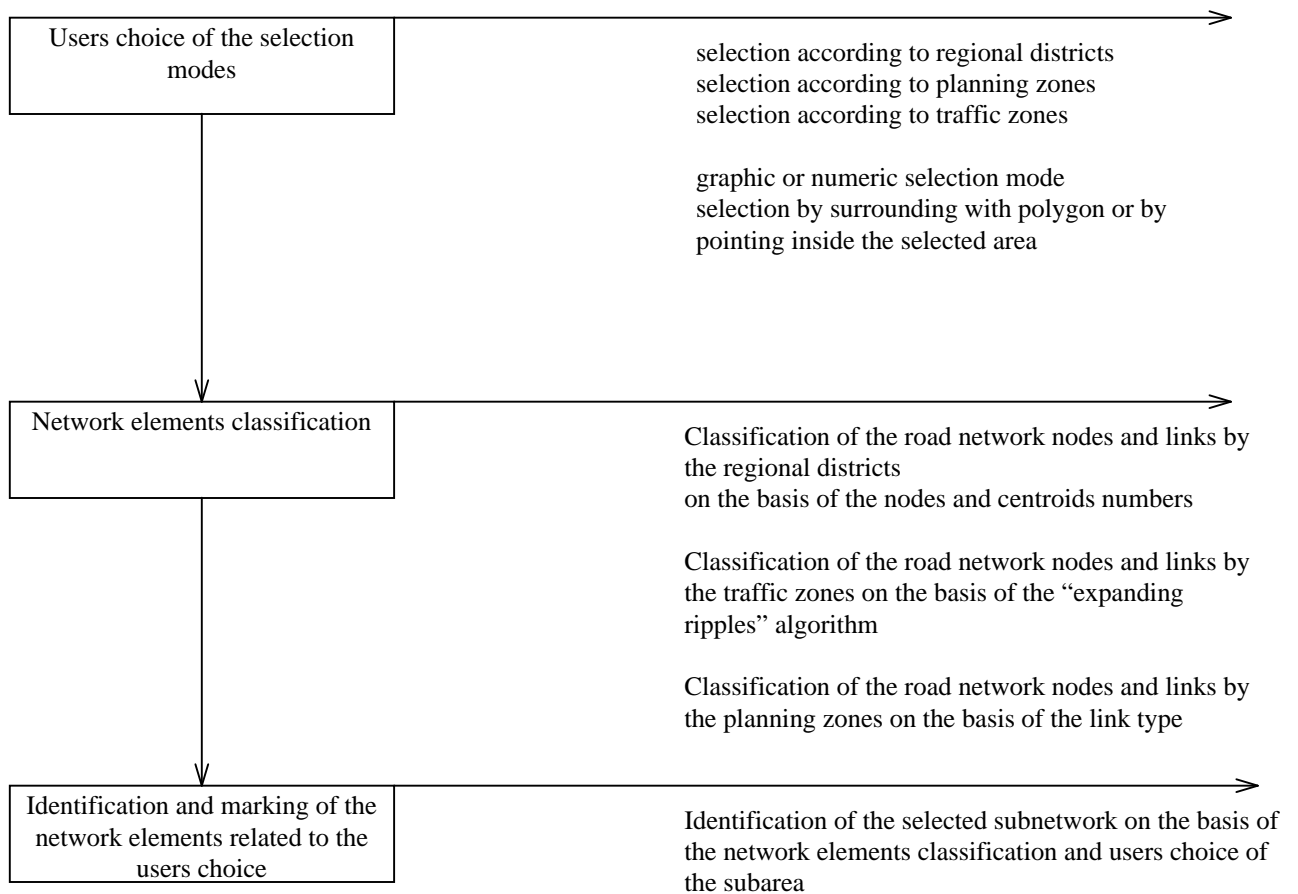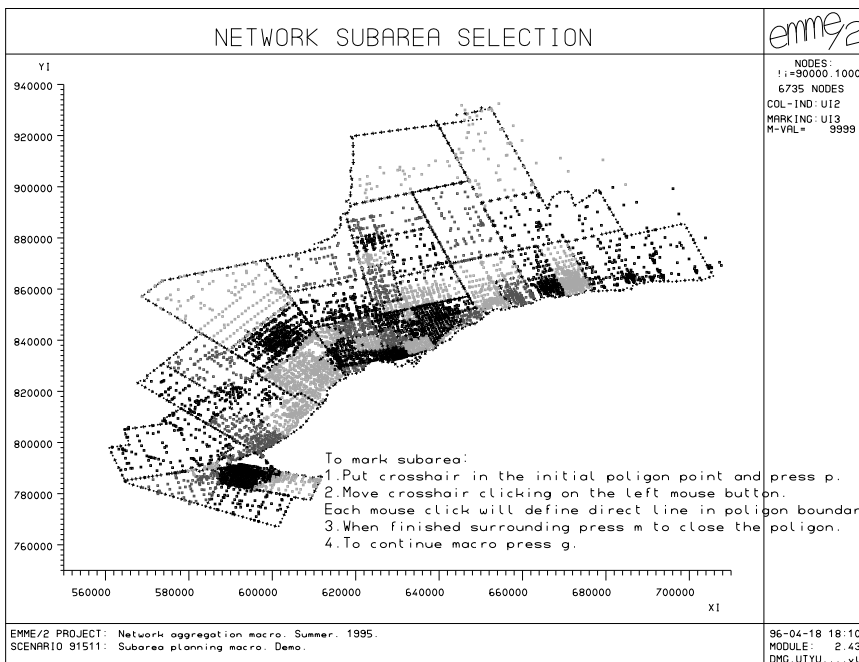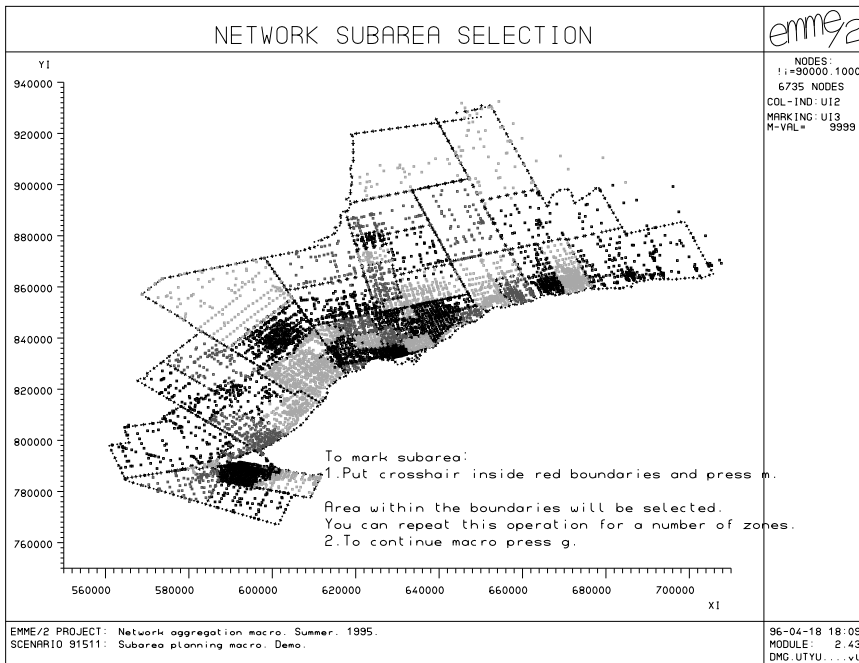| Identification and marking of the network elements related to the users choice | Identification of the selected subnetwork on the basis of the network elements classification and users choice of the subarea |

Figure 3.3. Windows for subarea selection in graphic mode.

Network aggregation procedure

As was mentioned earlier in this report, there are two main approaches to subarea planning: isolation and focusing. Each has its own set of advantages and disadvantages as described in Table 1.2. A third, intermediate approach was developed in the Macro. It combines different elements of the isolation and focusing approaches and is aimed at being flexible enough to allow the major changes in the outside network and demand to be traced and simple enough to allow the aggregation to be automated. Network and demand aggregation is adjusted to the subarea definition from the point of view of the zones and facilities to be aggregated. An isolation approach simply includes automation of the process of creating a traversal matrix. A focusing approach is based on the aggregated network and demand matrix created previously.

The network aggregation module includes three main branches:
- an isolation approach
- a focusing approach
- a compound approach

that apply independent methods, although they use some common procedures , as shown in Figure 3.8. The first step in each branch is to recognise the choices that were made in the previous module of subarea selection. This procedure allows the user to begin the process at the second module if using previously defined aggregations.

The isolation approach implemented in the Macro actually represents automation of the standard traversal matrix building process in EMME/2. It is a rather simple method but requires some special technical knowledge if implemented manually.

The focusing approach is a procedure that places organization and structure to the process of simplifying the supply and demand detail in a computer simulation of a complex urban transportation network in areas where detail is not required. To the transportation planner, the principal benefits are in conserving computer resources and improving response time. Aggregated network and aggregated demand matrices are prepared at a compatible level of detail in accordance with the goals of the planning project at hand.

The compound approach as implemented in the Macro is the most flexible procedure in terms of its ability to adjust to the specific subarea of interest and to adjust to the specific detail of an initial network and demand matrices. It is an entirely automated process with a number of options and module parameters that allow the user to adjust to the specific needs of a subarea project. Automation in full means that the process is based on previously defined methods and technical requirements, or accept the default parameters. Some of the technical requirements are related to the isolation approach and others to the focusing approach. This creates a method, or allows the user to establish a method, that combines the best attributes of the two approaches, isolation and focusing.

The focusing and compound procedures are built in a similar way and include three main step:
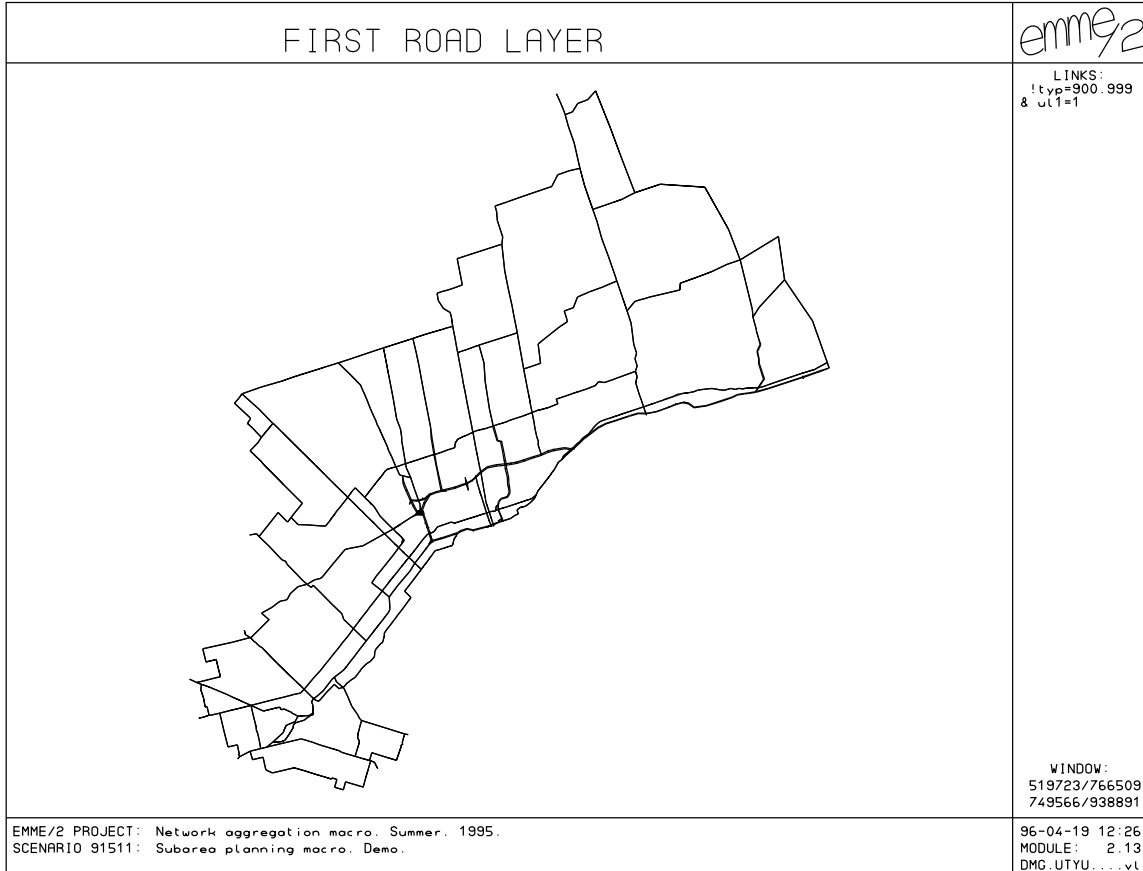
- classification of the network elements by their function in the network
- classification of the elements by their relation to the selected subarea
- choice of the network elements to be represented in the aggregated network on the basis of a functional classification and their relation to the subarea.

The same functional classification procedure is used for both approaches. The purpose of the procedure is to split the road network into different functional layers by associating each road network element with an appropriate layer. Each layer represents facilities with a similar relationship between moving and access functions. There are different ways to define these layers. Since information on traffic function is not explicitly expressed in the current GTA road network, special procedures to allocate links to layers were developed. These procedures are based mainly on the actual network configuration, not just on the codes associated with each link.

The initial step of the procedure is to define the first layer as one containing links that serve almost exclusively a moving function. Different facilities can be included in the first layer. It might include freeways, highway with restricted access, and some of the major arterials. The choice depends mostly on the initial network configuration, its detail and coding standards. It can be based on different facility's attributes such as defined type, number of lanes or capacity if implemented explicitly in the code, etc. Choice of links to place in the initial layer will not affect the algorithmic part of the classification procedure which provides great flexibility to the user in layer definition. Freeways, divided multilane highways with controlled or restricted access and some of the provincial roads are optional definitions to place in the first road layer to begin a macro implementation, see Figure 3.4.

Second and subsequent steps of the procedure are based on the spatial arrangement of the network and network codes (mainly type). A second layer is defined as a layer that contains the set of major arterials. This is usually the only type of facility that has direct access to freeways and are defined as roads serving primarily a moving function. Even if the facility is not defined in the network code as a major arterial, direct access to a freeway indicates that this road is functioning as a major arterial. In most of the cases, if the road is continuing in the same direction in a grid network and its characteristics (as capacity and free flow speed) remains the same, its function is the same as well. Therefore, all the links that are connected directly to the first layer and create an axis in the grid network and contain mostly the same parameters are defined as a second layer. Layers that contain minor arterials and another containing more local roads (residential streets and collectors) are defined in a similar manner, see Figures 3.5 and 3.6.

Figure 3.4. Definition of the first road layer for the GTA road network.


```
┌─────────────────────────────────────────────────────────────┬──────────────┐
│             FIRST ROAD LAYER                                  │   emme/2     │
│                                                               ├──────────────┤
│                                                               │ LINKS:       │
│                                                               │ !typ=900.999 │
│                                                               │ & ul1=1      │
│                                                               │              │
│                                                               │              │
│                                                               │              │
│                                                               │              │
│                                                               │              │
│                                                               │ WINDOW:      │
│                                                               │ 519723/766509│
│                                                               │ 749566/938891│
├─────────────────────────────────────────────────────────────┼──────────────┤
│ EMME/2 PROJECT:  Network aggregation macro. Summer. 1995.     │ 96-04-19 12:26│
│ SCENARIO 91511:  Subarea planning macro. Demo.                │ MODULE:  2.13 │
│                                                               │ DMG.UTYU....vt│
└─────────────────────────────────────────────────────────────┴──────────────┘
```

The functional classification of the road network is mainly a characteristic of the network and should remain unchanged by whatever level of detail is needed in a subarea study. That is why this procedure is the same for both the focusing and compound approaches. The user is asked to define a series of belts radiating out from the subarea and establish what will be the criteria or the principle for the placing links into a belt and how these criteria will be measured. The system of the prompts offer a number of choices for criteria definition in the framework of the compound approach. There are two main ideas that form basis for the approach. First, if the system of existing roads is well established and large enough to prevent serious congestion, the existing use of roads in the system should be a good measure of their function. Consequently, the results of present assignments can be used in a meaningful way for projects of middle and short range. In this manner, the approach combines elements of an isolation method, which is based on the assignment results and a focusing method, which uses exclusively information about the function of elements on the road network. Second, the compound approach combines elements of transportation planning and economics in the definition of criteria. Economic assessments and evaluation are usually conducted in the final stage of transportation projects. In some instances, transportation impacts on the aggregated portion of the network is not as important as assurance that impact is independent of the level of aggregation used in the analysis. The smaller that vehicle operation costs are on the

Figure 3.5. Definition of the freeways, major highways and arterials layers for the GTA road network.


```
 FIRST and SECOND ROAD LAYERS                    emme/2

                                                 LINKS:
                                                 !typ=900.999
                                                 & ul1=1.2

                                                 WINDOW:
                                                 519723/766509
                                                 749566/938891

EMME/2 PROJECT:  Network aggregation macro. Summer, 1995.    96-04-19 12:37
SCENARIO 91511:  Subarea planning macro. Demo.              MODULE:   2.13
                                                            DMG.UTYU....vl
```
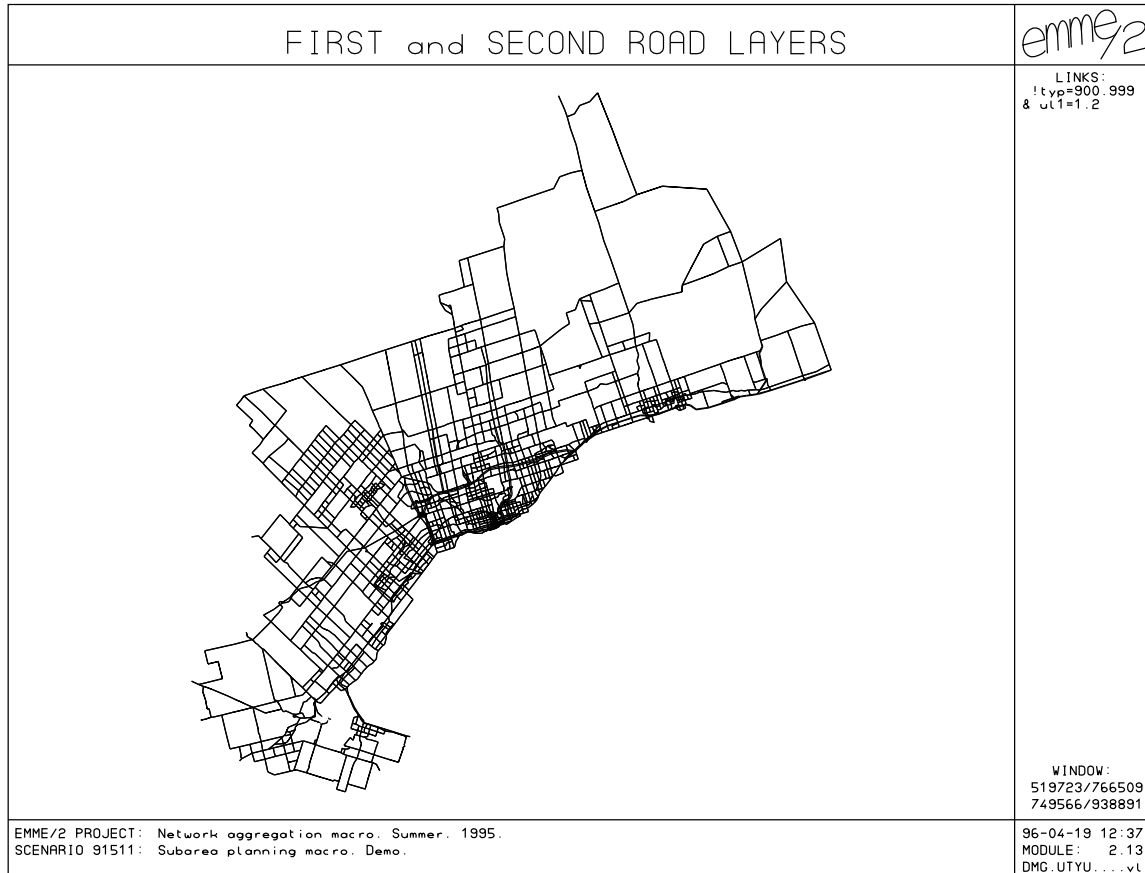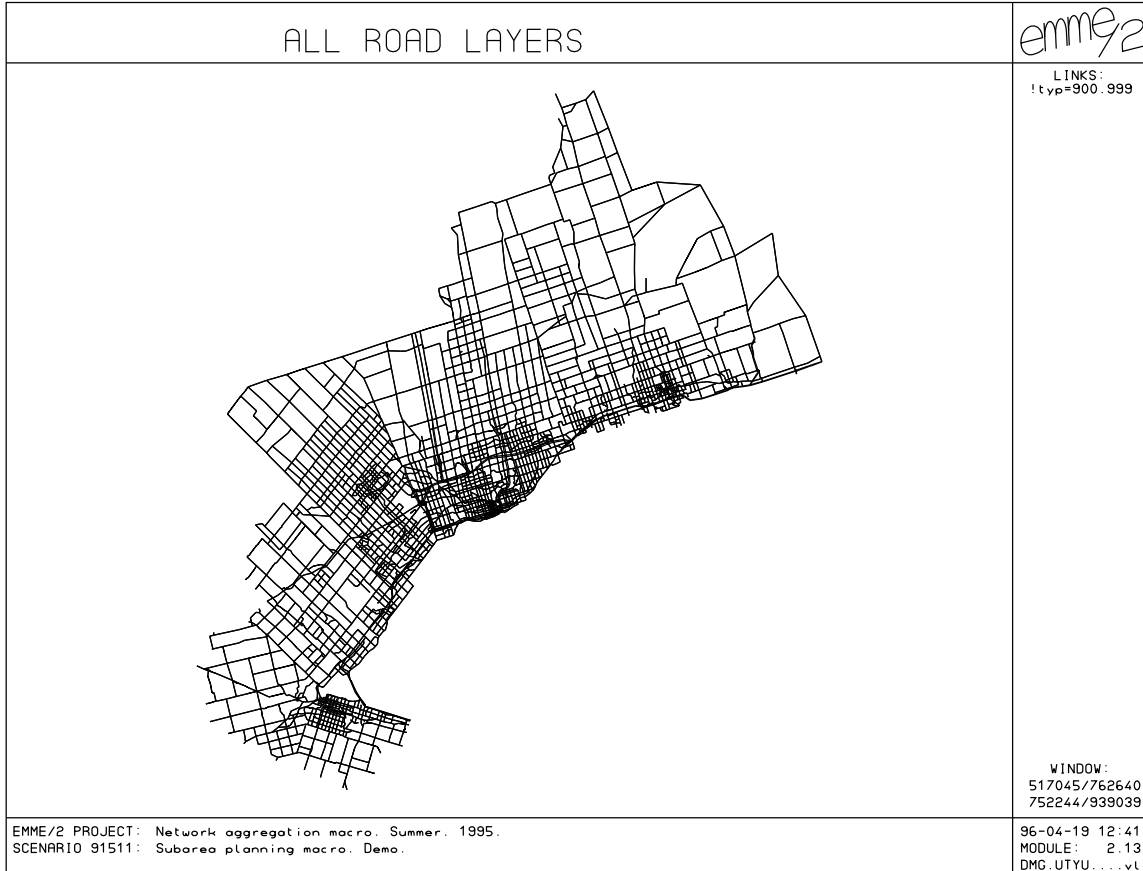
specific part of the network of interest to the project, the smaller the explicit importance this subnetwork has for the project under consideration. As long as vehicle operation costs are defined on the basis of vehicle-hours and vehicle-km these parameters can be used as a measure to define the 'belts' used to aid in selection of an appropriate aggregation.

There are numerous ways of building such a measure. Currently, a user of the Macro must choose one of the parameters mentioned above as a measure in establishing the criteria. The network will then be divided by belts in such a way that the total number of vehicle hours or vehicle km will be the same for each belt, see Figure 3.7. Special procedures are available to adjust the number of belts to subarea size and configuration. The adjustment also can be done manually.

The definition of belts for a focusing approach are based on distance from the subarea. Distance can be defined by the user explicitly in km or calculated and adjusted to suit the subarea size and configuration. In the last case, spacing and average trip length will be calculated for each layer. If the layer has poor representation in the GTA network (local streets, for example) the macro uses default data. The definition of belts can also be

Figure 3.6. Combination of the all road layers for the GTA road network (without centroid connectors).


```
ALL  ROAD  LAYERS                                          emme/2
                                                        LINKS:
                                                        !typ=900.999








                                                        WINDOW:
                                                        517045/762640
                                                        752244/939039
EMME/2 PROJECT:  Network aggregation macro. Summer. 1995.   96-04-19 12:41
SCENARIO 91511:  Subarea planning macro. Demo.              MODULE:   2.13
                                                            DMG.UTYU....vl
```

based on the trip length distribution data obtained after an assignment, but this option is not implemented at this time.

The next step after the classification of the network elements into appropriate layers and belts (Figure 3.8) is to mark regular links and nodes as to whether they will be represented in the aggregated network or not. The further a belt is from the subarea the fewer layers it will contain and the fewer access function these layers will represent. Development of centroid connectors can be done in a number of different ways. The user may choose to perform this task manually since this procedure is highly dependent on the specific network situation. Trip paths to and from subarea can be used to assist in this task.

The current release of the macro procedure uses existing centroid connectors. There are a number of reasons for this decision. First, existing centroid connectors in the GTA network have received considerable attention in the past and provide satisfactory access to links on each layer, including the very first one. It can be shown that there is a strong correlation between road density and trip generation in any area. The existing centroids that are connected to this or that specific layer are roughly in proportion to the density of trip on a layer. The second reason to use existing centroid connectors is the information

contained in these connections. Once centroid connectors are established, they are subject to considerable scrutiny and validation and reflect practical experience with information about the physical possibility to connect this or that specific place in the network. This sort of information is difficult to incorporate into the macro procedure.

Figure 3.7. Definition of the belts surrounding the Hamilton subarea.

BELTS FOR HAMILTON SUBAREA

LINKS:
@pres=1
&!typ=900.999

HAMILTON SUBAREA

Only links with uneven belt's number are shown.

WINDOW:
521433/768979
747856/938796

EMME/2 PROJECT: Network aggregation macro. Summer. 1995.
SCENARIO 91401: Subarea planning macro. Demo.

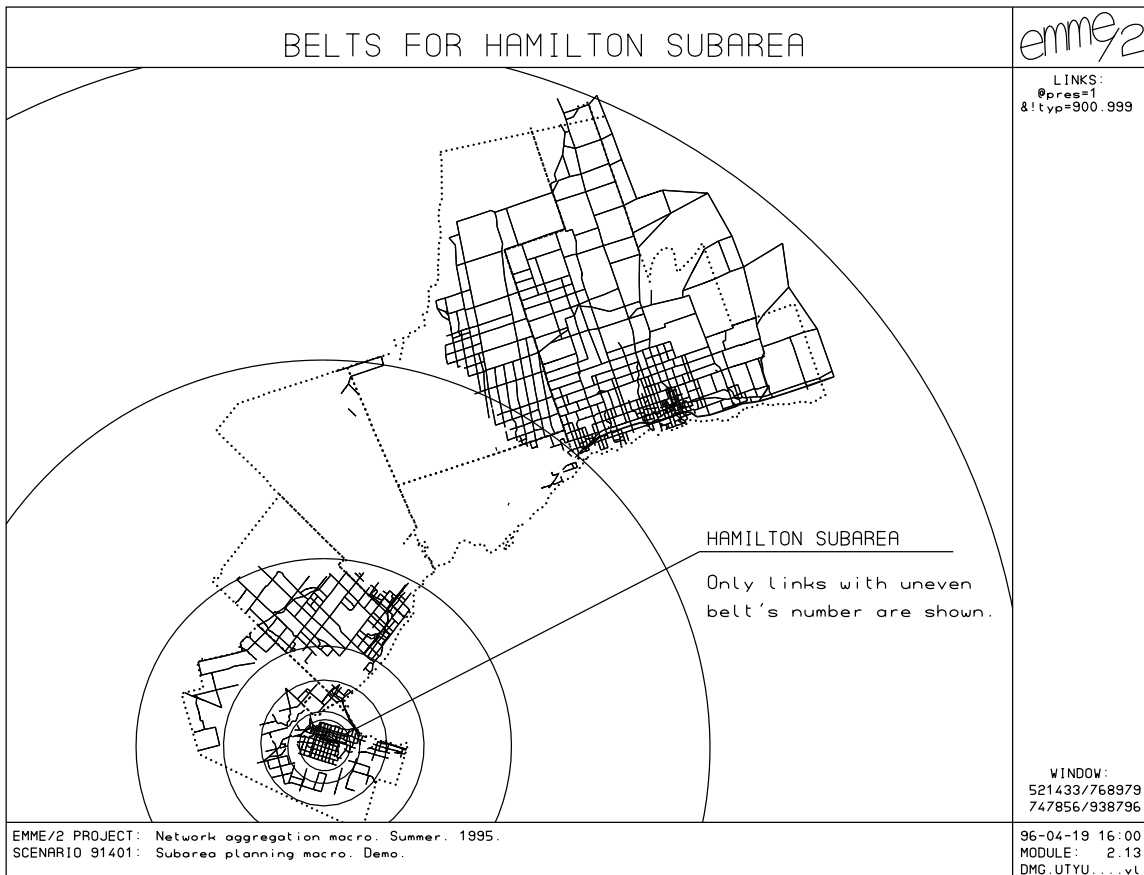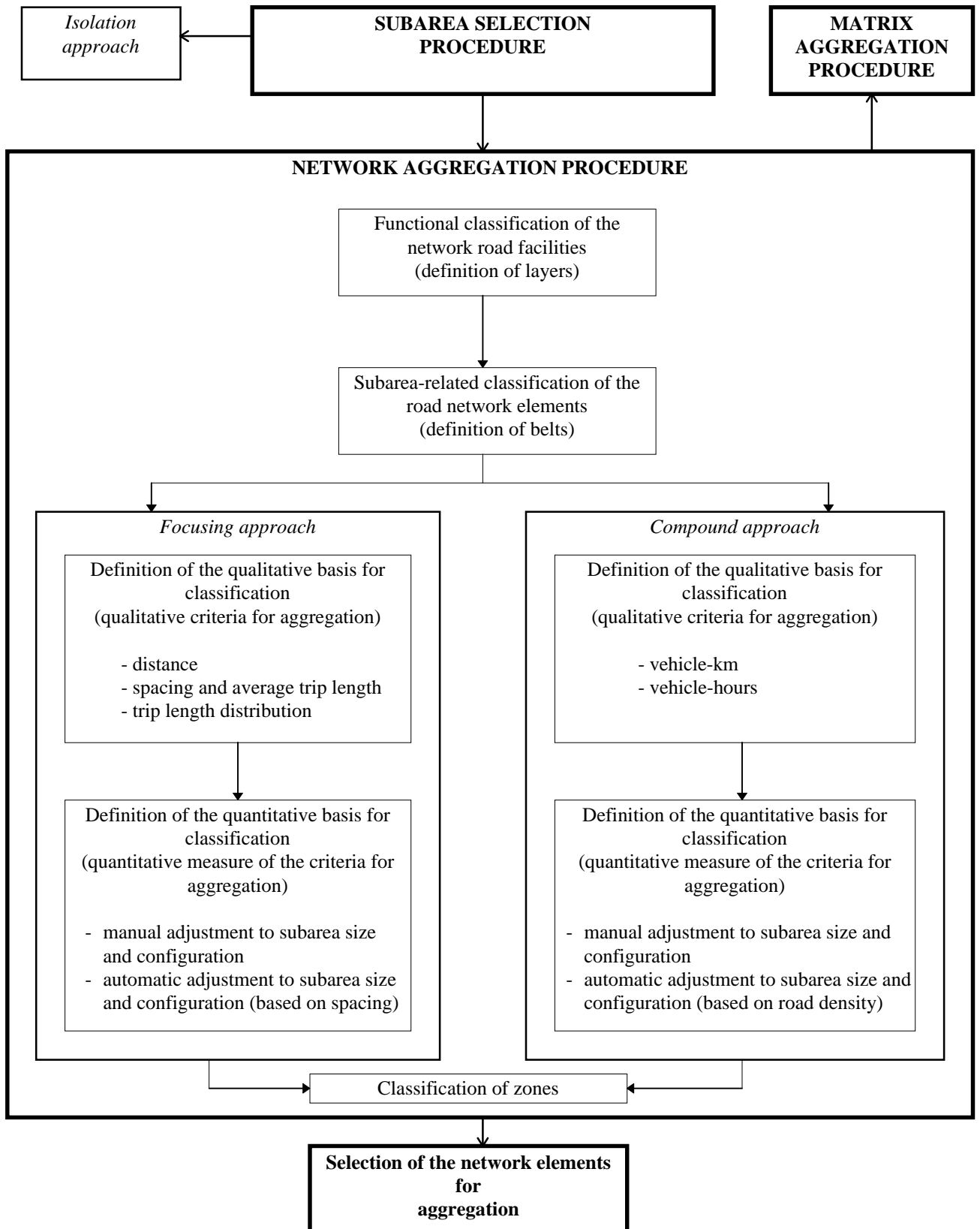96-04-19 16:00
MODULE: 2.13
DMG.UTYU....vt

Figure 3.8. Main steps in the aggregation procedure.

IV. Customizing the Macro.

Files to run the Macro **

The following is the complete set of files to run the Macro procedures:

- macro files with source code to run the Macro procedures, including

  - main_menu.mac:
    root procedure to initialize the process and to allow macro menu choices;

  - numeric_mode.mac:
    procedure for numeric selection of a subarea;

  - graphic_mode.mac:
    procedure for the graphical selection of a subarea;

  - isolation_approach.mac:
    main procedure for the isolation approach;

  - focusing_approach.mac:
    main procedure for the focusing approach;

  - compound_approach.mac:
    main procedure of the compound approach;

  - layers_exp.mac and layers.mac:
    procedures for classification of the network links according to the functional
    criteria;

  - belts.mac:
    procedure for classification of the network elements according to the auto-time or
    auto-volumes criteria;

  - number_of_belts.mac:
    procedure for automatic adjustment of number of belts to subarea size and
    configuration;

---

*) This set represents the current situation and current macro release. Some of the
described below options are not implemented yet neither they have related macro
procedures. If the option is not implemented related message will appear.

- belts_f.mac:
  procedure for the classification of network elements according to the distance
  criteria;

- average_spacing.mac:
  procedure for the definition of distance belts on the basis of average spacing;

- centroid_aggr.mac:
  procedure for aggregation of centroid connectors and zones aggregation;

- netw_aggr.mac:
  procedure for choosing aggregation level of network elements on the basis of their
  previous classifications;

- matrix.mac:
  procedure for matrix aggregation;

- matrix_batch.mac:
  procedure for matrix aggregation to run in batch mode (UNIX);

- netw_pres.mac:
  procedure for aggregated network presentation;

- matrix_pres.mac:
  procedure for aggregated matrix presentation.

- punch.mac:
  procedure for aggregated network and matrix punching;

- annotation files, including

- graphic_mode.ann:
  provides help during subarea selection in graphic mode (point option);

- graphic_mode_1.ann:
  provides help during subarea selection in graphic mode (polygon option);

- title_graphic_mode.ann:
  plot title in graphic mode selection of the subarea;

- type.ann:
  annotations for aggregated network presentation;

- matrixpres1.ann:
  annotations for aggregated matrix presentation.

- demarcation lines files, including

  - demarcation lines which were developed previously by the Joint Program in Transportation to provide demarcation lines for traffic zones, regional districts and planning districts boundaries.

- batch files (optional, to avoid processing some of the procedures by using previously prepared results)

  - layers_rn.batchout:
    definitions of the GTA road layers;

  - road_num_last.batchout:
    definitions and numbers of the provincial roads.

Starting the process

To start the Macro process enter EMME/2 and type at the prompt **~<main_menu.mac**.
The main macro menu will appear on the screen (Figure 4.1). You can start or continue
the macro from any point in the main macro menu. Press the selected number at the
prompt in same manner as other EMME/2 selections. (Do not press period after the
number.) The macro will identify, whenever necessary, to start again from the subarea
selection modules or possibility to continue from the user-selected module and will
display the related prompt. In case of an incorrect selection ,the warning error message
will appear:

```
Sorry you have typed the wrong number.
To get the main macro's menu again press m.
To quit now press q.

Select m or q:
```

The same error message will appear until the user makes the appropriate choice or presses
the escape button, interrupting the Macro.

Figure 4.1. Main macro menu prompt.

```
I.    Subarea selection:

1.1  Selection according to regional districts
1.2  Selection according to the planning zones
1.3  Selection according to the traffic zones

II.   Aggregation procedure selection:

2.1  Isolation approach
2.2  Focusing approach
2.3  Compound approach

III.  Results presentation:

3.1  Aggregated network presentation
3.2  Aggregated matrix presentation
3.3  Punch and test results of aggregation procedure

9.   Exit

Enter selected item number:
```

Subarea selection

Users will be prompted to chose the mode for subarea specification after choosing the aggregation level in the subarea selection process. The mode can be either graphical or numeric. The following menu will appear:

```
Select the mode for marking:

1.  Numeric mode (according to the network code numbers)
2.  Graphic mode (on the map)
3.  Return to the main macros menu
4.  Exit from the macro

Select the number:
```

In the case of an incorrect choice, the error message described above will appear, prompting the user to repeat his main menu choice or to exit. Numeric mode is recommended in cases where the user is going to choose a subarea according to traffic zones. Graphic mode is convenient for planning zones or regional districts. Numeric mode procedures takes less time. The procedure in graphical mode makes the choice visible and helps to avoid mistakes in the subarea selection procedure.

If the user chooses numeric mode, he is asked to enter the numbers of the selected regional districts, planning zones or traffic zones according to the GTA network code standard (Joint Program in Transportation February 1995):

```
Enter the planning zones numbers:
==>
```

The prompt list of planning zones or regional districts for the GTA with related numbers appears during the selection. If the user selects according to traffic zones numbers, it is a recommended that a review of a zone map precedes selection.
The numbers may be entered with the comma and in a number of rows (in the same manner as selection of ensembles in EMME/2). It is necessary to press "enter" after the selection is completed.

Example:

```
==> 20,24
==> 26
```

In the example, planning zones 20,21,22,23,24,26 will be considered as the selected subarea.

If the graphical mode is chosen the following message will appear:

```
You have two options to mark subarea you want to work with:
                        - surrounding it with the closed polygon or
                        - just pointing inside the areas to be
selected.
Type "polygon" if you want to surround with line or "point"
if you want to point and press "Enter".
==>
```

If the user makes a mistake typing the answer, the following message will appear:

```
Please, repeat the choice.   There is some mistake in typing.
Type "polygon" if you want to surround with polygon line or "point"
if you want just to point inside the selected area.   If you want to
exit to the main macro's menu type "exit".
==>
```

A graphical presentation of the network nodes will appear after "point" or "polygon" is entered. The picture has three different kinds of prompt to simplify the user's choice:
  - colour according to the regional districts, planning zones or traffic zones (depending on selection in main macro menu;
  - regional districts, planning zones or traffic zones boundaries (depending on selection in main macro menu);
  - help annotation with step-by-step instructions.

In case of point selection, the only item the user needs to select a zone is to click with the mouse cursor inside it. This method is convenient if the number of zones to be selected is relatively small. If the "polygon" option was selected, the user must surround the area desired with a linear polygon.

Aggregation procedure selection

As was mentioned above, there are three network aggregation procedures in the Macro that represent respectively three approaches to network aggregation; isolation, focusing and compound. The procedure in the isolation approach implements an automatic computation of the of traversal matrix. The focusing approach implements classical ideas of subarea planning and the compound approach combines elements of the isolation and focusing approaches to data aggregation.

If the focusing approach is selected (option 2.2 in main menu, procedure focusing_approach.mac) the following submenu will appear:

```
Select object for aggregation:

1. Network (must be performed to carry out matrix aggregation)
2. Matrix

==>
```

The Macro will indicate if the subarea selection is correct. If it is not, a warning message will be displayed and the user will be returned to the main macro menu. If the subarea definition is correct, the macro will begin the process of functional classification of the network elements (macro layers_exp.mac). It is possible to store the classification marks in a separate file outside the bank once the classification has been performed. As long as these marks are independent of subarea selection, batch input of them can eliminate the time consuming classification procedure. The user will be asked for a batch input file name before the start of the procedure. He can use a pre-prepared file name or specify his own:

```
Specify batch input file name if you have layer's marks ready
or press enter otherwise (optional file is layers_rn.batchout):

==>
```

Once this step is completed, the Macro begins to calculate network layers. This step is crucial as all subconsequent macro procedures work on the definition of functional layers which in turn affect the selection of the network elements to be aggregated. By replacing the batch input file with one of their own specification, the user can provide flexibility to this important step, adjusting it to different types of networks and different degrees of network detail.

The next step in the focusing_approach.mac procedure stratifies the network elements into 'belts' at increasing distance from the subarea using a distance-from-subarea criteria (subprocedure belts_f.mac). Each network element will be associated with one of the distance belts surrounding the subarea. A distance from the subarea to each link in the network is an intermediate result of this procedure. These distances may be input as a batch file if they were previously prepared:

```
Specify batch input file name for length from and to subarea
if you have length marks ready or press enter otherwise:

==>
```

As an example of the file structure, the user can refer to a sample file for a subarea definition containing planning zones 20,21,22,23,24 in the file **file short_len_path_20-24.batchout**. The criteria for belt selection can be based on different concepts (See algorithm description.). These different concepts are reflected in the menu that follows the distance calculations:

```
Select criteria for belt's setup:

1. Distance from subarea
2. Spacing and average trip length on layer
3. Trip length distribution

==>
```

If the user selects the first option, he will be asked to specify the specific manner in which distance will be incorporated into the selection using the following submenu:

```
Select mode for distance definition for each layer:

1. Explicit distance definition for each layer
2. Constant default distances
3. Automatic adjustment to subarea size and configuration
4. Back to primary seletion

==>
```

Explicit distance definition means that the user will be asked to enter distances in km from the subarea boundary to the beginning of each belt. If the second option is selected, the Macro will use a constant distance that is built-in as a default. If the third option is selected, special procedure will be activated.

If spacing criteria was selected to define the belts, the Macro will display a submenu for spacing and average trip length definition:

```
Select mode for average spacing and trip length definition for each
layer:

1. Use default average spacing and trip length
2. Manual adjustment of spacing and trip length
3. Automatic adjustment of spacing and trip length
4. Help
5. Back to primary choice

==>
```

As in the case of distance criteria, the first option means that build-in data is to be used. The second option means that user will be asked to enter his own data. The third option will activate a special procedure; average_spacing.mac. Help will display some general information about the choice and recommend some usual responses.

The focusing approach only network data as the basis for defining the belts. Whereas the compound approach can use some results from an assignment. Consequently, the Macro will check if the current scenario contains the results of an assignment. If results of an assignment exist, the user will be asked to confirm that the assignment was performed for the Macro. If the current assignment results sere not prepared for subarea definition, the scenario will be prepared for the assignment. Assignment might take up to 5-7 hours on the existing SPARC station and the existing GTA network. The user will be asked whether to perform an assignment immediately or to delay it. Functional classification of the network elements is carried out right after an assignment (macro layers_exp.mac). It is possible to use previously prepared classification marks (layer marks) if they are stored in a text file. A prompt for an optional batch input file will appear at the beginning of the procedure. If the user chooses to perform a classification into layers again, it may take up to five minutes to perform this task. The belts.mac procedure runs immediatly after a classification into layers. There are two options to perform it. One of them is based on vehicle-km criteria and the other on vehicle-hours criteria. The user chooses the appropriate criteria in the following menu:

```
Select criteria for aggregation:

1. Length from subarea boundary
2. Morning peak hour time from subarea boundary

==>
```

Shortest paths from the subarea boundary to each network element will be calculated based on a distance or time measure. If first option is choosen, the vehicle-km criteria will be activated. Otherwise the vehicle-hours criteria will be used. In the next step the user must specify how he wishes to define the number of belts. In reality, this choice will determinate the number of aggregation levels.

```
Select mode for belt's number definition:

1. Use default constant number of the aggregation levels
2. Manual adjustment of the aggregation levels number
3. Automatic adjustment of the aggregation levels number
4. Help

==>
```

The final step in the network aggregation procedure is to combine the results of classification of network element by belts and by layers. This step is the same for both the focusing and compound approaches and does not require interactive input from the user.

Before switching to matrix calculations the Macro will ask the user to confirm this step:

```
Time consuming matrix calculations will be performed on the next
step.

Select mode for matrix calculations:

1. Continue in the interactive mode
2. Run matrix calculations in batch mode
3. Return to main macro menu
4. Continue without matrix calculations

==>
```

The first option is acceptable if the size of the data bank is small. Otherwise, the implementation of the matrix procedure in interastive mode will be time consuming when the data bank is large. If the second option is choosen, the name of the macro file to run in batch mode will be displayed. If the last option is chosen, the user will be asked if he want to prepare punch files for the aggregated network and aggregated matrix. The same question about the punch files will be asked after matrix calculations.

The flow-chart of the Macro is displayed on Figure 4.3. Direct questions that are included in the Macro procedure or questions about input-output files are not represented in the flow-chart.

Results presentation and testing

The third module group of the Macro presents the result of the aggregation procedures. There are three modules in the group. The first one will present a plot of the aggregated network with colour and annotation according to the road's type as it appears in the network code. The second module will graphically represent zone aggregation. There are two options to display the zone aggregations:

```
Select presentation mode:

1.  Zone aggregation (all the zones that are related to the same
zone aggregate will be connected on the plot)
2.  Aggregate context (each of the aggregates will be connected to
the zones it includes within)

==>
```

Annotations containing help and demarcation lines are provided on the network and matrix presentation plots. Windowing and node numbering is possible during the plot presentation. The user should consider that, if the matrix presentation module is chosen, he will be asked to provide sufficient space for a number of temporary matrices for presentation purposes.

Module 3.3 of the Macro will prepare aggregated network and punch out the matrix for the user.

If the user selects module 9, he will be returned to the main EMME/2 menu.

Figure 4.3. Flow-chart of the Macro menu selections.

---

main_menu.mac

Select mode for marking:

1. Numeric mode
2. Graphic mode
3. Return to the main menu
4. Exit from the macro

---

main_menu.mac

I. Subarea selection

1.1 Selection according to regional districts
1.2 Selection according to planning zones
1.3 Selection according to traffic zones

II. Aggregation procedure selection:

2.1 Isolation approach
2.2 Focusing approach
2.3 Compound approach

III. results presentation and testing:

3.1 Aggregated network presentation
3.2 Aggregated matrix presentation
3.3 Punch and test results of aggregation procedure

9. Exit

---

matr_pres.mac

Select presentation mode:

1. Zone aggregation
2. Aggregate context

---

focusing_approach.mac
compound_approach.mac

Select mode for matrix calculations:

1. Continue in the iterative mode
2. Run matrix calculations in batch mode
3. Return to main macro menu
4. Continue without matrix calculations

---

graphic_mode.mac
Two options to mark subarea in graphic mode:
- "polygon" option
- "point" option

---

focusing_approach.mac
compound_approach.mac

Select object for aggregation:
1. Network
2. Matrix

---

belts_f.mac

Select mode for distance definition:

1. Explicit distance definition
2. Constant default distances
3. Automatic adjuctment to subarea size and configuration
4. Back to primary selection

---

belts_f.mac

Select criteria for belts setup:

1. Distance from subarea
2. Spacing and average trip length on layer
3. Trip length distribution

---

belts.mac

Select criteria for aggregation:

1. Length from subarea boundary
2. Morning peak hour time from subarea boundary

---

belts_f.mac

Select mode for average spacing and trip length definition:

1. Use default average spacing and trip length
1. Manual adjustment of spacing and trip length
3. Automatic adjustment of spacing and trip length
4. Help
5. Back to primary choice

---

belts.mac

Select mode for number of belts definition:

1. Use default constant number of the aggregation levels
2. Manual adjustment of the aggregation levels number
3. Automatic adjustment of the aggregation levels number
4. Help