

INTEGRATING LAND USE AND TRANSPORTATION PLANNING: A STRATEGIC APPROACH

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RESUME

À L'AIDE D'UN ENSEMBLE DE MODÈLES DE SIMULATION INTERRELIÉS, LES AUTEURS EXPLIQUENT COMMENT UNE APPROCHE INTÉGRANT L'AMÉNAGEMENT DU TERRITOIRE ET LA PLANIFICATION DES TRANSPORTS PEUT AMÉLIORER LES DÉCISIONS EN MATIÈRE D'URBANISME. SELON EUX, IL SUFFIT DE CONSTATER LES PROBLÈMES CRÉÉS PAR L'ÉTALEMENT URBAIN — LES AMÉNAGEMENTS RÉSIDENTIEL ET COMMERCIAL À FAIBLE DENSITÉ, LA CONGESTION ROUTIÈRE ET LES COÛTS ÉLEVÉS DU TRANSPORT EN COMMUN — POUR RECONNAÎTRE LES EFFETS CUMULATIFS À LONG TERME QU'UN PROCESSUS DE PLANIFICATION FRAGMENTÉ PEUT AVOIR SUR LE TISSU URBAIN.

The problems of urban sprawl-low-density residential and commercial development, road traffic congestion and high cost public transit systems are the result of the cumulative, long-term effect of disjointed planning decisions on the urban fabric. What is needed to offset the planning mistakes of the last 30 years is an integrated approach to land use and transportation planning.

Existing planning approaches, for the most part, do not work. They are fragmented. The more or less independent plans for transportation, parks, water and sewage, land use and zoning that are prepared focus mainly on short-term capital and operating budgets. Much of the analysis is concerned with identifying and setting priorities for improvement projects or projects intended to expand the capacity of existing systems. These plans are based on official forecasts for such things as population growth, new land required for development and service levels. Each component is treated individually, assumptions for each are made independently, and only one or two scenarios are developed.

Such a disjointed approach to planning results in a lack of consistency among components and assumptions, an inability to test alternative assumptions, an inadequate understanding of interactions among components that are part and parcel of any complex system and little or no vision of the longer-term consequences of the actions being proposed.

Today's planning environment is in a constant state of flux, and changes in the population, the economy, social systems, political institutions and individual values are coming more and more rapidly. No longer is the planning process confined to the planning department and its political masters. Many interest groups, each capable of delaying action, must be allowed to participate in the process. And along with budgetary concerns must be considered aesthetic and environmental matters.

Experience indicates that the official forecasts upon which planning is based seldom prove true. Consequently, plans are overtaken by events often before the ink is dry.

What is needed is an integrated planning process supported by powerful tools for "what if" analysis that will permit the exploration of strategic alternatives - and their implications. An integrated planning process must be flexible and accommodate stakeholder participation and buyin. Most importantly, the planning process should support and facilitate - not impede - action that achieves individual and community values.

THE USE OF SIMULATION TECHNIQUES

The integrated approach, or framework, described here involves the development and use of a linked set of open simulation models that support the planning process. Using these models, planners can explore the consequences of proposed planning decisions through the creation of alternative scenarios. The models, which ensure that scenarios are internally consistent, provide the means for integrating the various aspects of potential plans within an overall framework. The process of using the framework to explore the full consequences of potential decisions and assumptions enhances understanding of the system and of the real trade-offs among different alternatives. The models do not prescribe "best" solutions as such a determination involves trade-offs among interest groups, and as such is inherently political.

To be effective in supporting the planning function, the simulation framework must be understandable, credible and accessible to its users: planners and interest groups. In order to achieve these characteristics, a structured process for designing, documenting and using the framework is needed. The process consists of the following elements:

- **Modular Design:** A framework is designed as a series of interrelated components such as demographics; land use; demand and availability of services, including water, waste water treatment, solid waste disposal, schools, and health and social services; environmental constraints; and

capital and operating costs. Each component can be simplified, making use of natural concepts that are intuitive. Complex behaviour arises in the dynamic interaction among the components, not in the design of individual components. The modular design enables new components to be added at any time and existing components to be elaborated.

- **Participation in the Design Process:** As much as possible, users should be involved in the design of the simulation framework. This participation will assure the relevance of the framework to those issues that concern the stakeholders. Participation can be accomplished through design workshops that bring together people with expertise in particular areas, people knowledgeable about data sources and data reliability, and stakeholder groups. The workshops are effective in that they focus on the structure of the problem, not on solutions advocated by the different interest groups.
- **Full Documentation:** The design process should result in complete and understandable documentation so that the detailed design of the framework can be agreed upon before resources are committed. The framework is a sort of "white" box: anyone can examine and understand the calculations performed within it.
- **Public Participation in Simulation Analysis:** An important feature of a simulation framework is that scenario analysis may be performed in public forums. Assumptions may be varied, and the consequences of these actions may be seen immediately in graphic or cartographic form. This provides greater understanding of the issues involved and provides a platform for the discussion of trade-offs among the various parties.

A simulation framework based on these principles has been designed for the Regional Municipality of Waterloo. Intended primarily as an analytic tool to be used to support the preparation of a Regional Official Policy Plan for the Regional Municipality of Waterloo, it may also be used to support the strategic planning process in the region.

STRUCTURE OF THE WATERLOO REGION PLANNING FRAMEWORK

The focus of the Waterloo Region Planning Framework (WRPF) is on the relationship between population growth, the requirements for developed land and the provision of transportation and other infrastructure. The relationship is complicated in that the population may grow more or less quickly, development may be geographically distributed in many different ways throughout the region and the amount of new land to be developed depends upon the extent to

The Waterloo Region Planning Framework is being implemented using the *whatIf?* software environment developed and distributed by ROBBERT Associates. *whatIf?* provides full facilities for designing, documenting, implementing and operating largescale simulation frameworks consisting of linked sub-component models.

which existing developed land is redeveloped to higher densities and on the densities planned for land to be developed. Different scales and patterns of development may require more or less conversion of agricultural land, may disrupt natural areas to different degrees and may involve differential costs for the needed infrastructure (roads, transit systems, water supply facilities, sewage treatment facilities and land development costs).

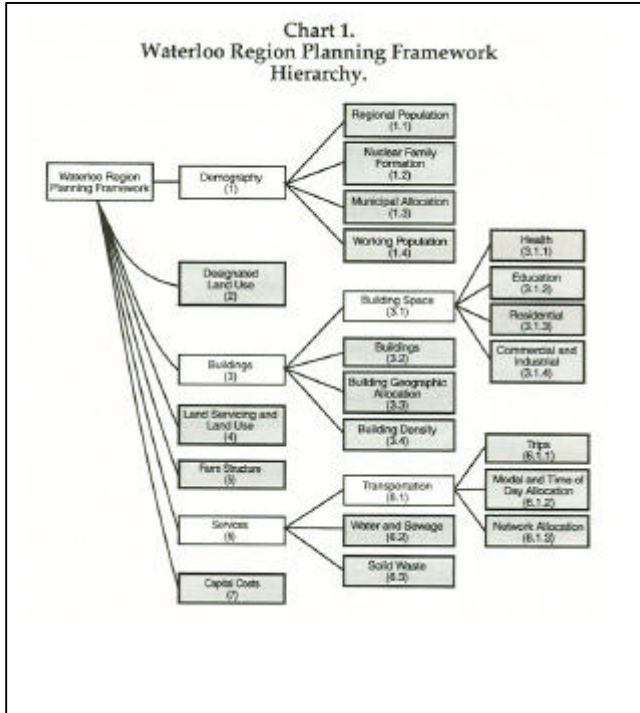
The WRPF is modular in structure in order to facilitate the independent elaboration of its seven components:

- **Demography** - represents the evolution of the regional population by age and sex over time, the formation of families, the municipal population distribution and the working population;
- **Designated Land Use**-represents land use in approximately 200 geographical zones and the designation of undeveloped land for possible development;
- **Buildings** - keeps track of the building space required by the population and the building stock by type and zone such that the stock is commensurate with the space required;
- **Land Servicing and Land Use** - determines the servicing requirements for new developed land and maintains land use accounts for the region;
- **Farm Structure** - keeps track of the number and size of farms throughout the region;
- **Services** - keeps track of transportation services (measured in trips), water requirements, sewage to be treated, and solid waste produced; it represents the transportation network and the additions that may be required, the additional water supply and new sewage treatment capacity; and
- **Capital Costs** - keeps track of the costs of new infrastructure that must be put in place.

The accompanying hierarchy diagram (see Chart 1) shows how each component is broken down into the subcomponent calculators. In all, the WRPF consists of 20 independently executable sub-models or calculators, thereby achieving the desired property of modularity.

Essentially, the WRPF keeps track of the evolution of stocks of people, families, land, building space, buildings and infrastructure, each by zone and a number of dimensions: people by age and sex; land by land use (of which there are about 50 categories, including both developed and undeveloped land); building space by type of space (residential, retail, office, industrial, warehouse and specialpurpose institutional); buildings by building type (of which there are 35 types ranging from single-family dwellings to apartment buildings to multi-storey multi-use buildings and factories); and infrastructure by type, including arterial roads, water and sewage treatment plants, and the local roads and water and sewage distribution systems associated with new land development.

The framework is designed to simulate a 50-year time horizon from 1992 to 2041 in steps of five years. It has been calibrated for the period 1976 to 1991. Calibration involves the compilation of a data base for all the variables in the framework in such a way that it is consistent with the logical relationships of the model. Many of the logical



First, the population and employment forecasts needed to do the transportation modelling are produced within the framework. Typically, this land use information is generated separately from the transportation model and requires a great deal of effort. As a result, it is usually only produced for one land use scenario in one, or perhaps two, forecast years. In the WRPF, these data are easily and quickly produced for the detailed zone system and are consistent with other assumptions made about growth locations and densities, making it possible to run many scenarios for the transportation model.

Second; the traffic forecasting component of the WRPF is concerned only with the total capacity (or number of lanes) needed in a corridor rather than detailed traffic volumes on each link of the network. This reduces the data requirements in that the analysis zones can generally be larger than typical "traffic zones," the road network can be simplified and the capacity of each link is not required. Such a strategic approach to transportation planning has often been lost in the myriad of detail required for more traditional techniques.

A third key difference is that the framework enables planners to be more concerned with the relationship between land development patterns and the infrastructure needed to support such

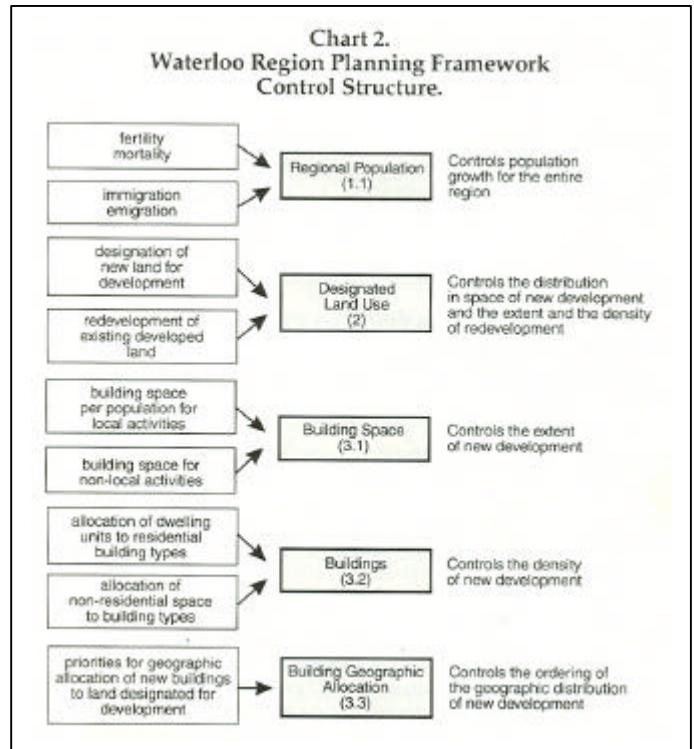
relationships are stock/flow accounting relationships that ensure coherency over time.

The basic framework design was established over the course of a two-day design workshop. This workshop involved all potential contributors, including representatives from health, social services, development, planning, environment, school boards and engineering. The resulting design was documented using flowcharts to aid understanding by all participants.

The main control variables (summarized in Chart 2) enable the user of the framework to explore a range of scenarios: for example, different spatial patterns of development and different densities. The values of these variables may be questioned and changed by the public during open houses and workshops. The fact that results can be seen immediately makes for meaningful public participation.

Many models are already used to forecast separate components, such as population, land requirements and transportation. But what makes the WRPF unique is its ability to integrate these components. This ability should lead to a more consistent consideration of planning decisions and consequences.

To illustrate, let us compare the traditional transportation modelling approach with the integrated approach offered by the WRPF. There are several key differences.



development. Considering the budget restrictions today's governments face, this is an important benefit. It gets away from the more traditional approach of "tell us where development will be and we will provide the roads."

The framework also takes into account the evolution of residences and businesses, and therefore trip-making, over time (five-year increments) in determining road needs. This is more realistic than treating future development as though it occurred all at once, which is the implicit assumption of most trip distribution models (such as the Gravity Model). Under this assumption, the model could predict a high number of internal trips within a district if there is a future balance of jobs and housing. However, this might not really happen if either the jobs or the housing get built first and longer distance commuting patterns are established.

The transportation component of the WRPf has many similarities with traditional models: it supports the detail of several trip types; it explicitly deals with transit trips and goods movement; it will accept a geocoded network from other transportation planning software or a geographic information system; and it can graphically display both network and zone attribute data.

Simulation techniques can provide a valuable tool in support of the planning process. The key elements - modular components, user participation in the design, clear documentation and opportunities for public participation - all contribute to integrated and open decision-making.

The Waterloo Region Planning Framework, which is being implemented within a six-month time frame, will provide these advantages for the analytic phase of the Official Plan review. For the first time planners, members of the public and decision-makers will be able to view the implications of population forecasts and development assumptions in terms of infrastructure (new development areas, roads, water supply, sewage treatment plants and solid waste disposal facilities) required to support those forecasts. •

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REFERENCE

ROBERT Associates. *Waterloo Region Planning Framework Manual*, prepared for the Regional Municipality of Waterloo, October 1992.