Creating Communities of Place

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Memo

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USING THE OSP GROWTH SIMULATION MODEL

***OSPlanning Memo** is a monthly publication which highlights strategies, techniques and data of interest to the planning community in New Jersey. I welcome your comments on these memos and your suggestions for future topics.*

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For several years, the Office of State Planning (OSP) has been developing a computer program intended to facilitate development of the broad-scale, policy-driven master plans typically drafted by State, regional and county planning agencies. Among its key applications are the State Development and Redevelopment Plan, the county master plans that are central to the State Plan cross-acceptance process, and specialized regional plans in fields such as transportation, watershed management, recreation or housing. (It also has potential applications to municipal master planning, as soon as data at the appropriate scale can be incorporated into the model.)

The computer program, called the OSP Growth Simulation Model, is not a substitute for the skills and value judgments that go into good planning, nor is it a "black box" that spews plans. Instead, it is a tool to help planners develop regional and county master plans quickly and inexpensively.

During the upcoming round of cross-acceptance, we intend to make this model available to county planning offices so that they can work with municipalities to develop and test alternative countywide growth scenarios without incurring the high costs normally associated with such an undertaking. Using this planning tool, counties in conjunction with municipalities can identify a preferred set of growth policies to serve as the basis for cross-acceptance discussions with the State Planning Commission.

Typical Steps in Master Planning

To understand the computer model, it is useful to review the five steps usually involved in developing master plans.

1. *Statement of Goals and Objectives* — This step identifies the general principles guiding the plan's development.

2. *Data Collection and Inventory* — This step traditionally includes mapping natural and built features, which are important elements in decisions on where growth should be directed and on the intensity of growth that can be accommodated. Examples of data mapped include wetlands, prime agricultural land, sewer service areas and roadways.

3. *Growth Suitability Mapping* — Sometimes called "opportunities and constraints" mapping, this is the first synthesis of the goals and objectives step and the data collection and inventory step. It identifies the types and locations of natural resources that should be protected, locations where development could occur and intensities of development that may be desirable in these locations.

4. *Alternative Growth Strategies* — Rarely does a growth suitability analysis precisely prescribe growth for a given forecast year. A more common circumstance is that the forecast-year growth requires substantially less land than can be accommodated within the suitable development areas.

Therefore, this planning step consists of two related activities: identification of alternative growth patterns for the forecast year and an analysis of the impacts of these alternatives. This step also begins the development of strategies, such as zoning changes, to encourage the desired growth pattern and perhaps to mitigate the impacts of growth at less desirable locations or densities.

5. *Preferred Plan* — The four preceding steps culminate in a master plan to guide development. The identification of this preferred plan is not a cut-and-dried technical process, but rather a give-and-take political process intended to produce a plan that appeals to all constituencies. Like all good agreements, the plan evolves out of compromises that can be negotiated only by members of the jurisdiction(s) the plan is to serve.

In the following sections of this report, this five-step planning approach will be used to compare traditional planning methods with methods using the OSP Growth Simulation Model.

Problems with Traditional Planning

High Cost of Mapping Data Constrains the Planning Process

The preceding steps are rarely fully implemented because of the high costs of carrying out all of them using the traditional planning tools of base maps, acetate overlays and reams of data.

Incomplete Data Collection

Planners make extensive use of

maps because the process of mapping converts raw data into visual information that can be more easily understood and compared to other mapped information. But frequently, useful data has not been mapped.

For example, sewer service areas are rarely mapped, since the sewer agency is more likely to be interested in utility alignment rights-of-way and detailed engineering features germane to construction and operation of the sewer system. Mapping municipal sewer service usually involves the transcription of detailed information from several data sets onto a single municipal-scale map base.

Also, mapped data may have various levels of accuracy at different scales. For example, road maps may be obtained from the New Jersey Department of Transportation (DOT) or easily constructed from aerial photos. However, the DOT maps may be at a scale different from the natural feature maps issued by the State Department of Environmental Protection (DEP). Because the map scales are not identical, it is difficult to compare these data sets accurately.

While it is a truism that there is never "enough" data for any planning study, it is also important to recognize that the inability to acquire a consistent set of data can mean that some significant data may never be considered while other data, readily available in mapped form, may dominate the discussion. Because of the need to discover data, the need to transcribe data to maps and the need to insure that maps are of a consistent scale, the data collection and mapping phase of a master-planning project can easily account for over a third of the project budget. Many jurisdictions simply cannot afford the cost of extensive data collection, let alone the cost of preparing new maps.

Complications in Developing the Suitability Analysis

Another impediment to comprehensive master planning can be the lack of time and expertise needed to develop the suitability analysis. In this process, data sets are merged to identify areas where growth might be encouraged or discouraged. Ultimately, all suitability maps incorporate a complex mix of mapped information and value judgments — except for those few areas where the land use is established by law, such as freshwater wetlands.

For example, one jurisdiction might chose to discourage growth on hillsides with slopes of 15 percent or greater. This value judgment might result in hillsides classified as "land less suited for development" and level farmlands classified as "land more suitable for development." On the other hand, another jurisdiction might encourage development along escarpments and discourage farmland development to preserve an area's pastoral character.

The shifting of aesthetic and cultural values during a rigorous master-planning process can produce an almost infinite set of suitability maps. However, few planning agencies have substantial experience in developing such maps or sufficient budgets to assign staff to the process. Even fewer can afford complete, but expensive, consultant services. Typically, planning efforts are focused on a single suitability map, which is expected to incorporate most of the community's values.

Limited Number of Plan Alternatives Considered

Another complication in the planning process is the fact that the pattern of growth within these suitable areas could take on many forms and densities. One plan might encourage the segregation of land uses, while another plan might encourage only mixed-use development. Growth, regardless of type, could be channeled into compact forms or it might be allowed to sprawl. Even a single suitability map could be used as the base for developing several programmatic alternatives.

However, the tendency during the master planning process is to constrain the process of reviewing plan alternatives to the few enabled under the available budget. To facilitate the development of this preliminary plan, one of two techniques are widely applied.

The first uses general zoning categories to identify the existing land uses and to fill in the areas available for development. For example, the residential categories that a county might use might include: low-density residential, medium-density residential, high-density residential or mixed-use residential.

The second method maps general categories to which development policies are assigned. The State Development and Redevelopment Plan's Resource Planning and Management Maps (RPMM) provide an example of such categories.

Use of these techniques results in the timely production of a preliminary plan, which then is the focus of discussion and modification. This process is designed to rapidly move to closure on a plan, rather than to explore alternative ways in which the values embedded in the suitability analysis and the growth policies intended for the plan might interact and express themselves as plan alternatives.

Traditional Methods Result in Planning as a Linear Process

A result of these constraints is that planning becomes a linear process based on limited data and limited consideration of how effectively local values might be realized in the plan. (Exhibit 1 excludes the citizen input and review process for sake of clarity.)

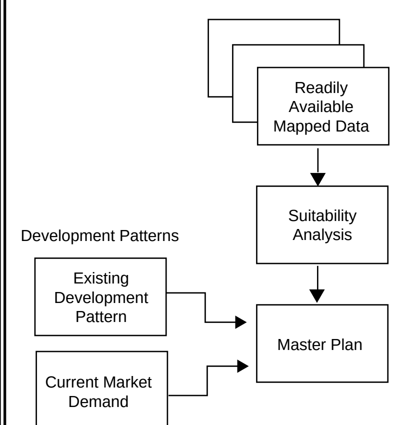
Limited Scope of Traditionally-Developed Plans

Because of the high cost of planning within even a single jurisdiction, it usually is the case that planning studies begin and end at the county, if not the municipal, border. Attempts to coordinate planning with neighboring jurisdictions are usually not timely or significant.

Another problem is that the traditional plan is designed to regulate the location of land uses and define their type. For example, the plan might identify several areas where residential development of various densities is to be located. However, the plan does not prescribe the timing or sequencing of residential growth in these areas. Therefore, traditional planning methods are not well suited for growth-management purposes.

Finally, very few master plans, let alone master plan alternatives, are reviewed to determine the cost outcomes of the plan, whether these outcomes are described in terms of natural resources consumed, dollar costs for infrastructure

Exhibit 1
Typical Master Planning - A Linear Process



or municipal operation, or effectiveness at achieving the policy goals and objectives of the plan itself. The resulting master plan might be defended as a single embodiment of many of the jurisdiction's values, but it is not known if this development alternative achieves optimal benefits or even if it performs better than trend, or market-driven growth.

In fact, impact assessment has been such a costly activity to perform that even such a major planning endeavor as the State Plan could only afford to compare a trend growth scenario with a preferred plan scenario. In most cases, impact assessment is not performed.

How the OSP Model Can Help

The OSP Growth Simulation Model is designed to automate much of the work performed to prepare a policy-driven growth management plan, such as one suitable for cross-acceptance. The model abandons the labor-intensive and costly traditional map-based planning approach in favor of a computerized process of projecting policy-driven municipal forecasts. Using the OSP Model, a county plan alternative can be defined, run and evaluation results produced in about 30 minutes.

The OSP model consists of two computer systems that share information. The first system is a specialized computerized mapping system, called a Geographic Information System (GIS), which stores information about natural and built features on a geographic reference base and can merge data to produce new hybrid data sets. The second computer system uses Microsoft Excel and Visual Basic programming to allocate growth and to evaluate the impacts of any growth scenario.

While the traditional plan produces a map of intended land uses, the OSP model produces an estimate of likely growth forecasts. During early testing of this model, OSP discovered that many planners have difficulty judging growth forecasts at a county scale, but have definite opinions when that growth is presented as municipal forecasts. By using these growth forecasts and the other impact values produced by the model, it is hoped that planners can focus their limited resources on generating and evaluating alternative plans to insure that their preferred plan is more likely to achieve their growth policy intentions.

The following section illustrates how the OSP Growth Allocation Model works. The example given is of a county

Exhibit 2
Data Sets Included in the OSP GIS

- OSP-Generated Maps
  - Planning Area Boundaries
  - Center Locations
  - Critical Environmental and Historic Sites
  - Community Development boundaries
  - High Quality Water Drainage Basins
  - Potable Water Drainage Basins
  - Sewer Collection Areas (1988)
  - Sewer Collection Areas (in progress)
  - Commuter Rail Stations
- DEP-Generated Maps
  - Integrated Terrain Unit Mapping (land use, soils/geology, streams, bodies of water, wetlands)
  - Freshwater Wetlands
  - Municipal Boundaries
  - State Coastline
  - Northern Boundary of State
  - RSNC (resident species and natural communities)
  - State and Federal Open Space
- DOT-Generated Maps
  - Roads from USGS Topos
  - Streams from USGS Topos
- USGS-Generated Maps
  - New Jersey Drainage Basins
- U.S. Department of Commerce, Census Bureau
  - Tiger Files (include roads, streams, rail lines, census blocks, etc.)
- Rutgers/COAH-Generated Map
  - Developed Land for 21 Counties
- Pinelands Commission-Generated Map
  - Pinelands Boundary
- North Jersey Transportation Coordinating Council-Generated Maps
  - New Jersey Commuter Rail Lines
  - New Jersey Freight Routes
  - New Jersey Bus Routes

participating in cross-acceptance of the State Plan, but the process and procedures are transferable, of course, to other types of regional planning.

Of immediate benefit is that fact that the OSP GIS contains several natural-feature data sets produced by DEP, and several built features produced by DEP, DOT and OSP. Exhibit 2 identifies the types of data contained in this computer system.

Data Collection

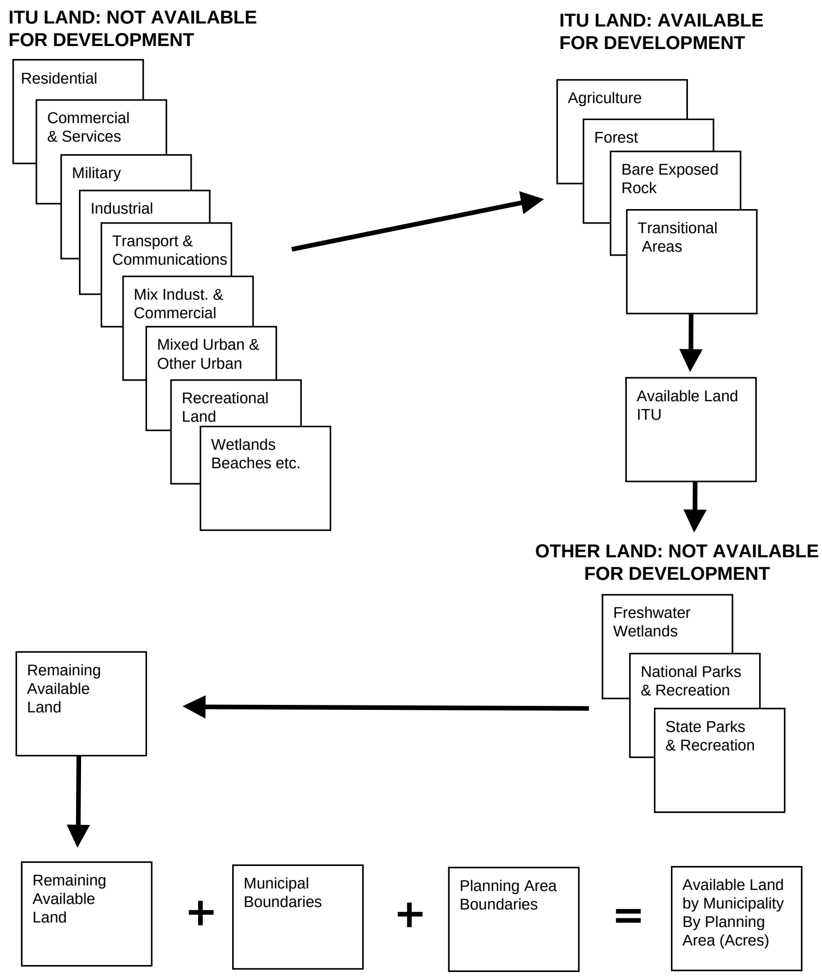
These data sets can be used as the information base for a regional or county plan, or the data sets can be revised or expanded by the user. For example, the OSP GIS contains 1986 existing land use information, which the user may wish to revise by including more recent growth. The user can revise or add data using GIS, if it has cartography capability. The user can also revise the OSP data by providing OSP with spreadsheets or printed tables that contain the new or revised data for each municipality.

The ability to easily revise or modify data has proven to be important. During an early test of the OSP model, farmland in permanent agricultural easement was found to have been erroneously categorized as "land available for development." The correction was made by inputting into the model tabular records of easements by municipality, obtained from the State Department of Agriculture.

Using the Spatial Allocation Simulation to Combine Suitability Analysis and Alternative Plan Development

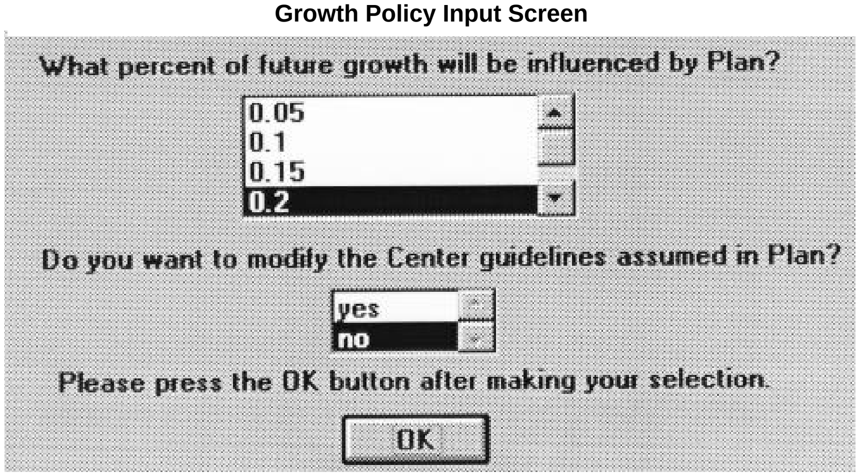
By merging various data sets, the OSP GIS can develop a type of suitability analysis. As currently programmed, the GIS system subtracts from the total land in each municipality land already developed (as of 1986), wetlands, regional parks and some other land-use categories

Exhibit 3
Obtaining Land Availability Information Using GIS



— such as beaches, quarries, barren rocks, the surfaces of streams and ponds — to identify land available for future development. This inventory of available land is then merged with the State Plan's RPMM, which categorizes land by development intensity and natural resources, to identify land available for development in each of the planning areas. The result (Exhibit 3) is the first part of a suitability analysis.

Exhibit 4
Growth Policy Input Screen



The second part of this suitability analysis and the development of policy- driven plan alternatives is performed by the Spatial Allocation Simulation, one of two major programs performed using Excel and Visual Basic. The model uses input screens, such as Exhibit 4, to allow planners to define growth allocation policies.

By combining the "land available for development" information from the GIS with the growth allocation policies, the suitability analysis part of the Spatial Allocation Simulation is completed. The model now "knows," for example, that although thousands of acres of hillsides in environmentally sensitive Planning Area (PA) 5 are available for development, this land is not suitable for development from a policy perspective.

The Spatial Allocation Simulation now begins to construct a plan alternative by trying to re-allocate a specified amount of growth using growth management policies. To perform this allocation calculation, the Spatial Allocation Simulation requires that the development form and programmatic characteristics of each plan alternative be defined.

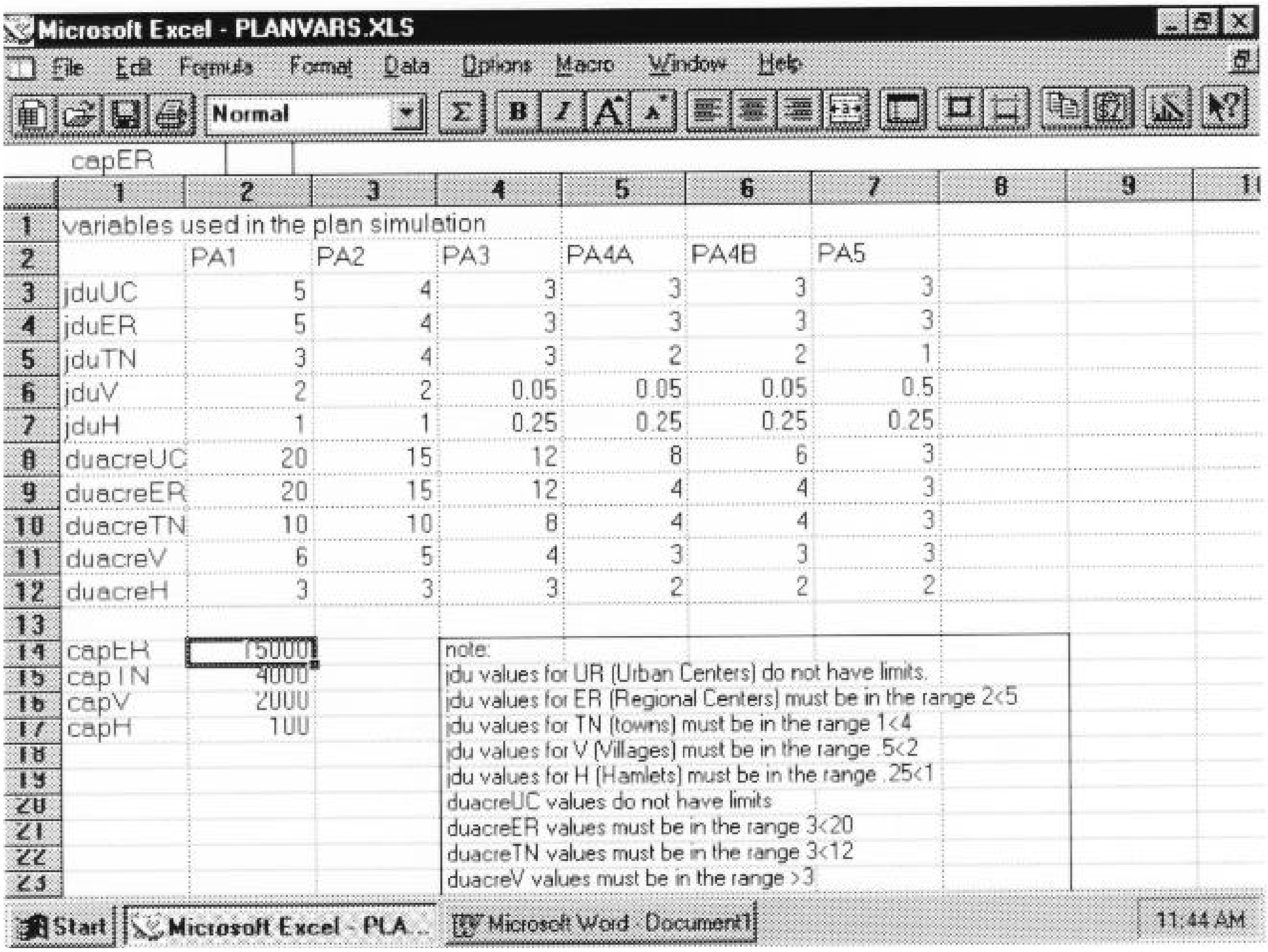
The program asks what density, capacity and land-use mix should be tested for each type of center in each planning area. Centers also must be identified by municipal location and center type as part of the scenario definition process.

This definition process allows planners to incorporate different values into the scenario. For example, a county wanting to preserve its scenic slopes might direct that 98 percent of all plan re-assigned growth be directed to farmland located in PA4, the rural planning area, and that 80 percent of this allocation to PA4 be assigned to Town Centers, with the remainder assigned to villages and hamlets. Conversely, a county wishing to preserve its scenic farming valleys might direct 50 percent of its growth into villages in PA5 and another 30 percent of its growth into towns in PA4; and it may redefine some of its PA4 land as PA3, fringe area, so that it can accommodate less-dense suburban development.

The growth allocation policy definition process is made easier by allowing the user to answer specific programmatic questions using input screens, such as the one shown in Exhibit 5. On this screen, the planner must accept or change various programmatic attributes for centers.

For example, the current assumed value for the job-to-dwelling-unit ratio (jduUC) for Urban Centers in PA1 is

Exhibit 5
Input Screen to Modify Centers Programmatic Attributes



Microsoft Excel - PLANVARS.XLS

	1	2	3	4	5	6	7
1	variables used in the plan simulation						
2		PA1	PA2	PA3	PA4A	PA4B	PA5
3	jduUC	5	4	3	3	3	3
4	jduER	5	4	3	3	3	3
5	jduTN	3	4	3	2	2	1
6	jduV	2	2	0.05	0.05	0.05	0.5
7	jduH	1	1	0.25	0.25	0.25	0.25
8	duacreUC	20	15	12	8	6	3
9	duacreER	20	15	12	4	4	3
10	duacreTN	10	10	8	4	4	3
11	duacreV	6	5	4	3	3	3
12	duacreH	3	3	3	2	2	2
13							
14	capER	15000					
15	capTN	4000					
16	capV	2000					
17	capH	100					

note:
jdu values for UR (Urban Centers) do not have limits.
jdu values for ER (Regional Centers) must be in the range 2<5
jdu values for TN (towns) must be in the range 1<4
jdu values for V (Villages) must be in the range .5<2
jdu values for H (Hamlets) must be in the range .25<1
duacreUC values do not have limits
duacreER values must be in the range 3<20
duacreTN values must be in the range 3<12
duacreV values must be in the range >3

five (this means that there should be five jobs for each dwelling unit in the center). The input screen also defines residential densities (duacreUC) and maximum growth values for different center types (capER is the maximum number of dwelling units allowed in regional centers).

Once all of the assignment policies are input, the program uses them to reallocate a trend forecast of growth in the county to produce the Plan-driven growth forecast. Therefore, it is very important that the model be able to generate a reasonable trend growth forecast. To insure that the trend forecast properly reflects the growth conditions of the county it is simulating, a *model calibration* is completed with the cooperation of the county planners.

To begin this process, the program first downloads the 'land available for development' information prepared by the OSP GIS, including any additions or modifications thought necessary by the county planners. Next the program requires that county planners input a horizon year forecast they deem correct. This forecast can be one of their own projections, or they can select to use currently published Statewide forecasts of population and employment growth already included in the program.

Then the program predicts an initial trend growth forecast using its statistical and mathematical routines. This growth forecast consists of a projection of population and employment by municipality, the sum of which is equal to the county growth forecast.

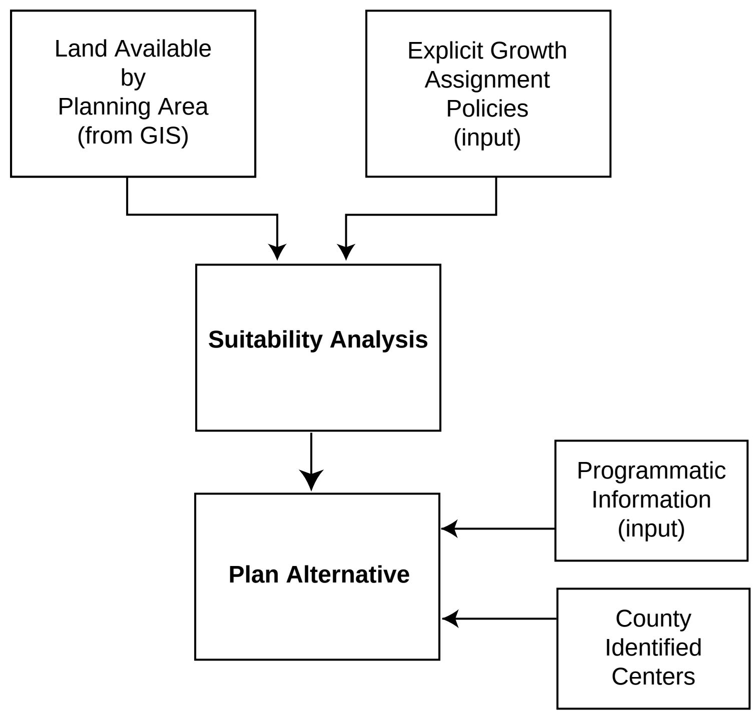
The growth forecast is then reviewed by the county planners and calibrated, or corrected, to insure that it is reasonable. To make this correction, the historic growth rates for each municipality are modified to produce a growth forecast that the county planners find consistent with existing and future market-driven forces.

This careful development of a trend forecast is needed since a major assumption is that the effect of all plan scenarios is to modify trend growth allocations. Preparation of the trend forecast also provides a baseline growth condition, against which all plan scenarios can be compared. (The trend calibration only has to be completed once, and this is done before testing plan alternatives.)

Once the calibration is completed and all the policy information is supplied, the computer chugs out the growth allocation by re-calculating the municipal population and employment forecasts. In performing this calculation, the model develops a policy-driven growth alternative by assigning plan re-assigned growth to available land in accordance with programmatic and policy rules defining the plan scenario. Exhibit 6 illustrates this process.

The result of the Spatial Allocation Simulation is a scenario-specific

Exhibit 6
Spatial Allocation Simulation



set of municipal population and employment forecasts, for the scenario's horizon year.

Impact Modeling - An Integral Part of the Planning Process

The OSP Growth Simulation Model was designed to include programs that evaluate the impacts of each plan (or trend) scenario in a consistent fashion that allows impacts from one alternative to be compared to the impacts of any other growth alternative. In fact, this process of scenario testing is incorporated into the structure of both the Spatial Allocation Simulation and into the impact subroutines.

During the Spatial Allocation Subroutine, policy growth assignments can be achieved only if both sufficient land and sufficient programmatic capacity exists. In effect, the program performs a reality-testing activity to insure that plan policies and plan capacity are consistent.

For example, the county that wanted to assign 80 percent of its plan-reassigned growth to towns in the farming area of the county may discover that the computer-assigned growth allocation to these PA4 municipalities might be much smaller than expected. This outcome could happen either if too few centers are identified for testing or if there was insufficient land available in the centers selected for testing with this growth scenario. This result could also happen if the county chose to allow substantial infill growth in the suburban PA2, thereby making much of the trend-allocated growth, in conformance with plan policies being tested in this scenario.

Finally, in the more explicit Fiscal Impact programs, the computer estimates the costs for public schools, municipal roads, sewers, municipal current expenditures and the total land consumed, by planning area, for each growth scenario. These costs are produced by programs that contain substantial information about local infrastructure systems and utilize algorithms developed by OSP and others, such as the Federal Environmental Protection Agency.

The Fiscal Impact program produces each type of cost for each municipality in the county. These costs are not intended to be used for immediate budgeting purposes, but provide a consistent basis for comparing one growth alternative to another.

Planning as an Iterative Process

The OSP Growth Simulation Model allows county planners to participate in an iterative, non-linear planning process, as illustrated in the following diagram. Although planning deals with complex issues, we hope that using this model will help to make planning less intuitive and more objective.

Although reviewing the results produced by any growth scenario to identify plan revisions for further testing can be a time-consuming process, the Growth Simulation model runs quickly. A plan simulation, including fiscal impacts, can be produced in about 30 minutes, and the results faxed or sent by Internet E-mail.

The creative-thinking part of the planning process — in which impacts are weighed and new plan alternatives are identified for further testing — is not performed by the OSP Growth Simulation Model. This part of the planning process should be performed by the county planning agency, with the assistance of the OSP Staff.

Ultimately, use of the OSP Growth Simulation Model should encourage counties and other agencies to develop and test alternative regional plans. Use of the model allows planners to focus on growth policies and frees them from much of the drudgery and high costs associated with any regional planning process.

Use of the Model as Part of Cross-acceptance

Use of the OSP Growth Simulation Model encourages county planners to directly participate in revisions to the State Plan. The Model allows the county to define its preferred plan using a combination of explicit growth polices and the locational device of the RPMM, in effect to define their plan using the language of the State Development and Redevelopment Plan.

However, it is not the intention of the Office of State Planning to require counties to accept the State Plan, as it exists or in some slightly modified form. Instead, it is hoped that the development of a preferred county plan will highlight growth policies in the existing State Plan that need to be re-examined.

Use of the model should inform this policy discussion in two main ways. First, modeling allows the counties to test the consequences of various growth strategies, so that they can explicitly learn of the trade-offs involved in any given plan or plan policy. Second, use of the model will enable the county to more easily and explicitly identify State Plan policies it may need to modify. This will help county planning staffs to propose policy revisions directly to the State Planning Commission.

Other Benefits of the OSP Model

Although the primary application of the Growth Simulation Model at present is to facilitate the development of alternative growth scenarios during cross-acceptance, there are other advantages to be gained by producing policy-driven municipal forecasts.

Establishing a Baseline Consensus Growth Forecast

First, the process of determining a growth forecast by county for the year 2020 produces a consensus forecast of State growth for that horizon year. The consensus forecast could be the basis for similar forecasts, updated on a regular basis, for use as the growth baseline for estimating all State and county infrastructure and other types of need. This would save the State, State agencies and related agencies, such as NJ Transit and the various Metropolitan Planning Organizations, tens of thousands of dollars each year.

Linking Growth Planning with Regional Infrastructure Planning

DOT and DEP can use the municipal forecasts produced by the Growth Simulation Model to prepare and evaluate infrastructure plans. The municipal growth forecasts generated by the OSP model can be fed into DOT and DEP models to produce forecasts of travel demand, water demand, and air quality.

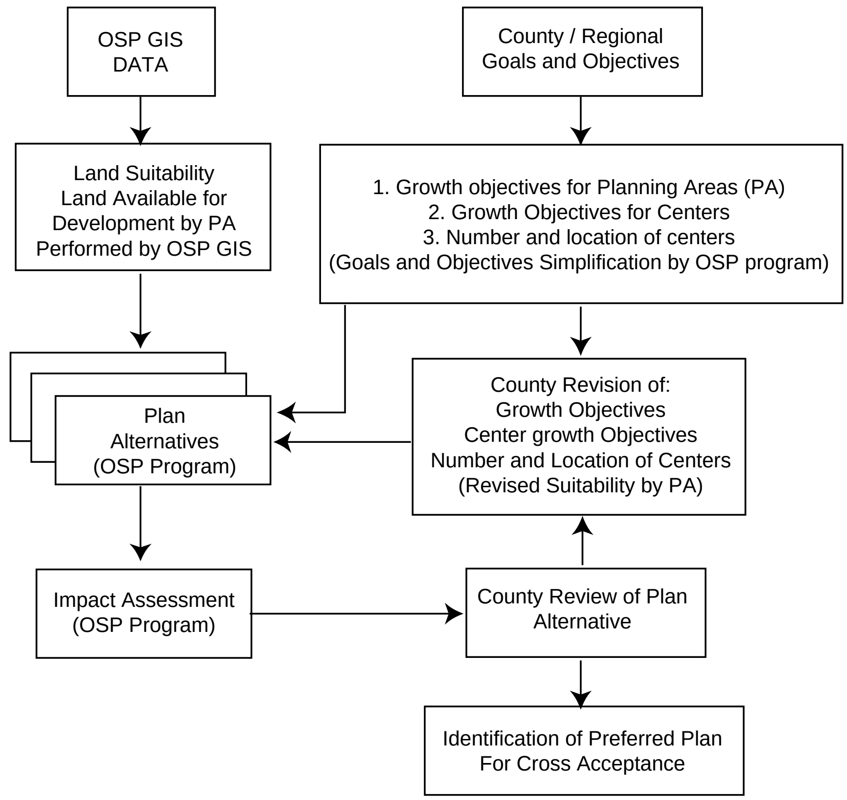
While some of these models are too expensive to run frequently, some are in-house simulations that could provide additional insight into the costs associated with any plan simulation. The linkage of county growth objectives to state-funded infrastructure planning should enhance the implementation of the revised State Plan.

The municipal growth forecasts could also be used to forecast housing requirements. This information would aid the state Council on Affordable Housing in determining affordable housing obligations.

Promotes the Development of Regional Growth Objectives

Finally, OSP can run the Growth Simulation Model using regional, as opposed to county, growth controls, by simulating the plans of several adjacent

Exhibit 7
Planning as an Iterative Process
by Using the OSP Growth Simulation Model



counties to produce new municipal growth and impact forecasts. These forecasts can be used to evaluate plan impacts that transcend county boundaries, such as travel demand, school impacts and the effects of regional growth on taxes in part of the region.

Status of the Model

The most recent versions of the program are now undergoing beta, or experimental, testing with the cooperation of planners from three counties. To date, trend calibrations have been completed and two of the counties are preparing to begin testing the ability of the program to forecast plan alternatives.

The OSP growth simulation model is continuously being developed and refined. OSP seeks to improve the model by incorporating recent research by its staffers and consultants.

A statistical analysis relating local road supply to residential density is to be used to update the costs of municipal roads in the Fiscal Impact model. Recent research into municipal expenditure forecasting is also to be incorporated into the model. Another major improvement being planned is the addition of new sewer service areas data, being prepared in cooperation with DEP, to help assign growth. Beta testing with the counties also is expected to identify needed improvements to the model.

As the model is always under development, it is not available for public distribution. However, a number of technical papers documenting the model's principles and assumptions are available from the Office of State Planning. OSP has also prepared a User's Guide that explains how to use the model to develop plan scenarios for testing. These documents can be obtained from the OSP Area Planning Managers.

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