EVALUATING ALTERNATIVE PLANS FOR GUIDING TOURISM ON NANTUCKET ISLAND

Douglas P. Schleusner and Eugene E. Kaczka

University of Massachusetts

ABSTRACT

This paper discusses the application of a GPSS (General Purpose Simulation System) model to a unique planning situation on Nantucket Island, Massachusetts. Various factors influencing levels of tourism are evaluated in addition to resultant economic and environmental impacts. Specifically, passive regulation of visitor traffic via ferry schedule modification is examined in relation to daily expenditures by visitor type versus the associated costs of increased police and medical services, water consumption, and solid waste disposal.

I. INTRODUCTION

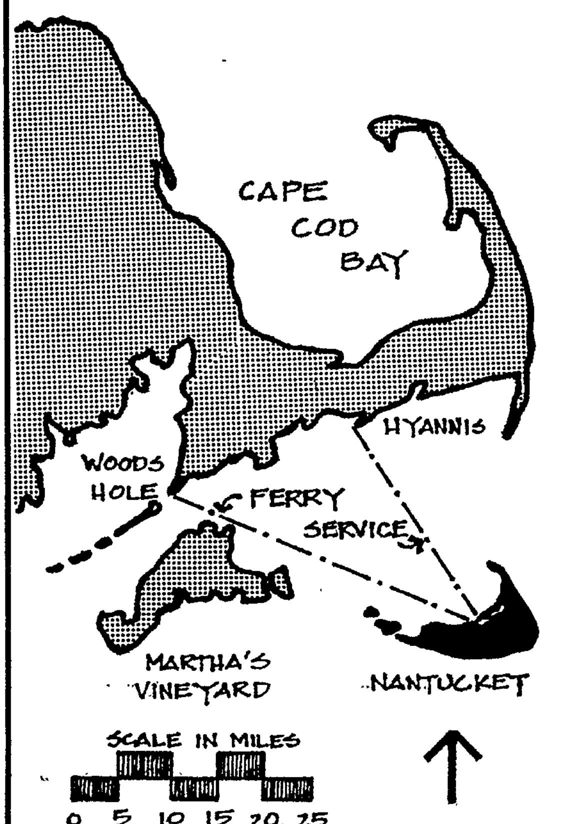
BACKGROUND

Nantucket Island, a nationally famous resort area, is located 25 miles south of Cape Cod (see Figure 1). Thousands of visitors are drawn to the Island each summer, lured by the solitude of the moors, a 1700's whaling era ambience, and a multitude of recreational opportunities. Approximately 49 square miles in size, the Island is inundated by a variety of visitors whose stays range from one day to the entire season. These individuals, who swell the population to five times its winter level, are the main source of income for the Island as a whole. While these visitors support many of the year-round residents with their business, they also place considerable demands upon Nantucket's physical resources and the Town's services and facilities. The following examples illustrate this point.

The Nantucket Planning and Economic Development Commission (NP & EDC) recently estimated that with the current rate of growth, the town's existing sanitary landfill site will be used up by late 1978. (6) A 1976 study by the same office pointed out that over 8500 cars circulate through the Central Business District on a peak summer day, while only 610 parking spaces are available. (4) Finally, a third NP & EDC report, Nantucket Bikeway Master Plan, provides the information that during the height of the summer season nearly 8250 bicycles compete for space on the Island's roadways with over 8000 automobiles. This condition partially exists because only 10 miles of bikeway exist on Nantucket. (3)

These figures only sample the many issues on Nantucket that relate to the summer tourist traffic. While contributing a great deal to the Island's economy, her visitors are a mixed blessing with their inherent demands upon the system. Problems such as solid waste disposal, water supply, and vehicular congestion also exist on the mainland, but appear (and in fact are) less threatening than on a relatively small island 25 miles out to sea. While these issues should be considered by residents, visitors, and town officials, the burden of inventorying, analyzing, and recommending appropriate courses of action falls largely upon the Planning Commission and staff of

FIGURE 1
Location of Ferry Routes to Nantucket Island



the NP & EDC. While current planning efforts may sometimes be referred to as reactionary or "brush-fire actions", long-range and comprehensive planning requires a means for dealing with large amounts of information that often changes periodically--sometimes quite rapidly. Simulation offers this type of analytical tool.

NATURE OF PROBLEM

From 1960 to 1970, the number of year-round residents on Nantucket increased 21 percent, and an additional 29 percent by 1975 to the current population of 5540. While these changes are significant, the major impact is felt during the tourist season. During the summer of 1965 the average density was 320 people per square mile. In 1975 this figure increased to 565 people per square mile, and with the existing growth rate, seasonal density could exceed 800 people per square mile by 1985. It seems fairly obvious that these numbers could represent a threat to Nantucket's natural resources and physical facilities. If this growth occurs without proper planning and guidance, many of those qualities for which Nantucket is famous, and upon which bases much of her livelihood, may be lost. With seasonal visitors outnumbering year-round residents nearly five to one, this seems to be the logical area for initiating some type of control.

While "active" restriction of residents and visitors alike would be extremely unpopular and probably legally impossible (Petaluma, California to the contrary), Nantucket possesses a "passive" regulatory mechanism, the ferries. In that Nantucket is an island, her access points are clearly defined. The Steamship Authority ferries operate out of Woods Hole and Hyannis (see Figure 1). An excursion line, Hy-Line Inc., also operates out of Hyannis during the summer, Nantucket Memorial Airport serves private and charter planes as well as scheduled Air New England flights, and Nantucket Harbor shelters those who arrive on their own craft. The majority of visitors arrive on the Steamship Authority ferries, and this source is the one used in the following model. Fortunately this is also the most detailed and up-to-date information available.

The purpose of this study was to examine changes in economic and environmental impacts resulting from ferry schedule modification. To achieve this, two different ferry schedules were simulated under three different visitor patterns.

II. THE MODEL

CONSTRAINTS

The model was designed to simulate the problem as realistically as possible. To achieve this, certain constraints were imposed, including ferry schedules and capacities, visitor length of stay, distribution of total visitors, cars and bicycles throughout the season, and distribution of visitors, cars, and bicycles throughout the day.

The ferry schedules varied with the season, fewer ferries per day at the beginning and end of the season, and more ferries during the peak months of July and August. Ferry capacities varied with the time of day and which ferry was currently in use.

The variation in visitor length of stay was described in terms of visitor type, "the daytripper", "overnighters", "short-term", and "long-term". Within the total visitors per day, the percentage of each visitor type varied throughout the season, e.g., more long-term visitors arrive in May than in August, more one day visitors arrive in July and August than in May or October.

Distribution of total visitors, cars and bicycles varied throughout the season as might be expected, from a low in April to a peak during July and August, returning to a low in October. Distribution throughout the day was skewed towards the morning ferries, under the assumption that more individuals would prefer to arrive before noon.

DESIGN

As previously implied, the scope and complexity of the variables involved demand more than visual inspection and manipulation by a pocket calculator. The following model provides an analytical tool by portraying the variables as realistically as possible, while simplifying the results to enhance comprehension. The variables themselves can be as sophisticated as the available data base permits.

The model in its present form was constructed in GPSS, and consists of five segments dealing with passenger arrival, ferry arrival, statistic collection and tabulation, passenger departure, and, of course, simulated time. Ferry departures are aggregated under the assumption that all passengers who arrive on Nantucket will eventually be able to leave on the desired day. For the model, passenger departures complete the daily bookkeeping to provide a running tally of the current state of affairs on the Island. The simulation proceeds for 180 days, representing the season from April 15 to October 15.

The passenger arrival segment (illustrated in Figure 2) generates one transaction with each simulated day. This transaction then takes as its first parameter value the number obtained from evaluating the function that describes the average number of visitors as the season progresses. Rather than having "2307" transactions representing visitors on a given day circulating through the model, only one transaction representing each day's visitor in flow, i.e., containing the value of "2307" in Parameter 1, proceeds through the following blocks.

After testing to see if a ferry is available, the number of the day's ferries (obtained from Model Segment 2, illustrated in Figure 3) is created by means of a split block. This number is based on the time of season. Each of the

FIGURE 2
Model Logic for Passenger Arrival Segment

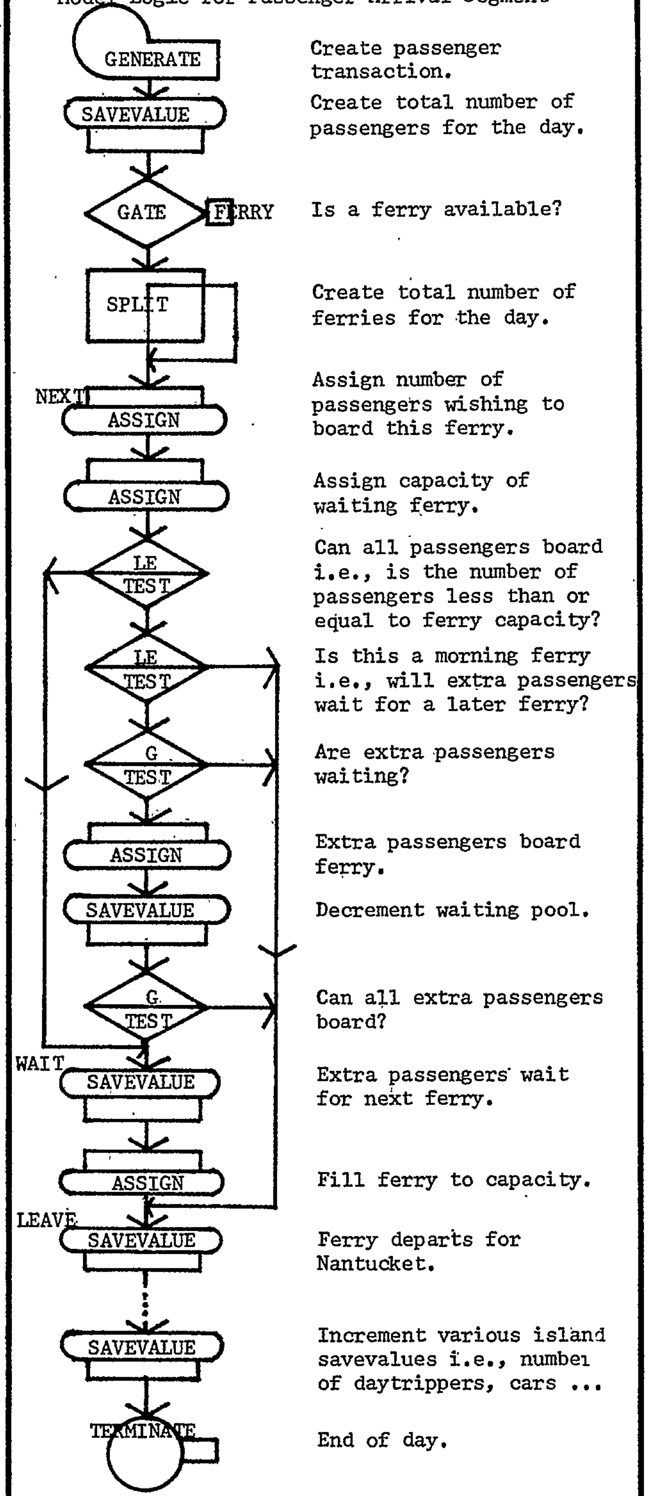
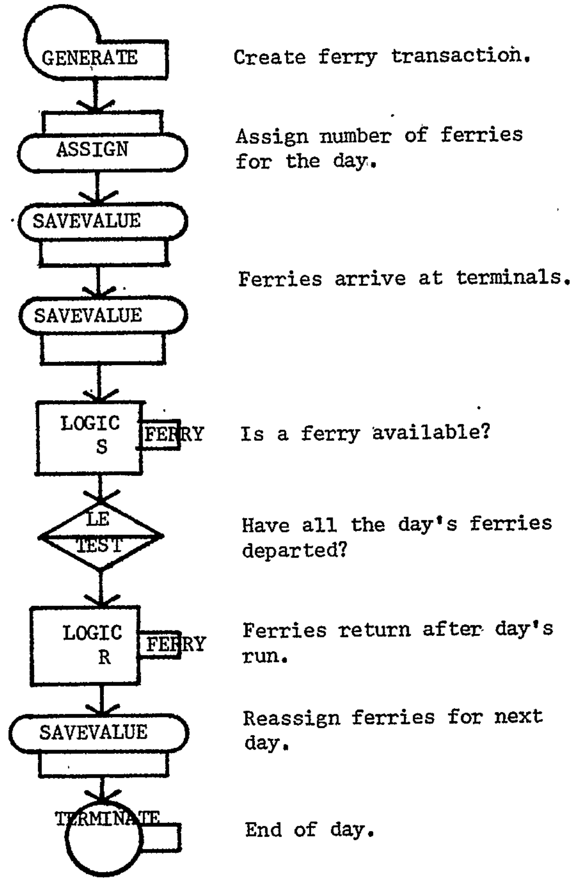


FIGURE 3
Model Logic for Ferry Arrival Segment



resulting transactions is then serialized, i.e., receives a number that corresponds to its departure time. For example, Ferry 1 (the parent transaction) is the first one to leave in the morning, Ferry 2 is the second to leave, and so on until all of the day's ferries have departed. The capacity of each ferry is determined and assigned to Parameter 5 in each transaction. The total number of passengers for a given day is divided according to the number of ferries and a certain percentage of the total assigned to each. It is assumed that more people will attempt to board an early ferry than one of the later ones; this distribution is obtained from another function. At this point potential passengers are compared to ferry capacity, and the excess (if any) is assigned to a waiting pool where they wait for the next ferry. This only holds true for the first two ferries under the assumption that the later ferries would nearly always have adequate space, and that few people would wait for Ferry 3 (an afternoon ferry) if they could not board Ferries 1 or 2. This is more nearly true for the "daytripper" (the majority of visitors) than for long-term visitors.

Each ferry is filled to capacity, or as nearly so as possible. As each ferry departs, the number of ferries remaining for the day is decremented by one. At this point, the passengers are considered to be on the Island, and the various savevalues for number of visitors, cars, bicycles, daily expenditures, and daily costs are incremented on the basis of variable definitions for each type of information. These will be discussed more fully in the section dealing with the input data.

The ferry arrival segment (illustrated in Figure 3) also generates only one transaction. The number of ferries is a function of the time of season, defined in days. This value is assigned to a savevalue that is decremented as each ferry departs. A pair of logic switches are included to prevent the loading of passengers on a non-existent ferry.

The third model segment collects the statistics generated by the first segment and tabulates them on a monthly basis for each type of information. The fourth segment decrements the savevalues in Segment 1 by values obtained from variables that describe the departure rate for each type of visitor. The fifth and last segment is the timer which generates the 180 days of simulation.

INPUT

The previous section discussed the basic logic of the model. In it, potential visitors arrive at the ferry terminal, are loaded on ferries as space is available, arrive on Nantucket, and spend various amounts of money, while in turn imposing certain demands upon the town's facilities and resources. Within this framework exists a great deal of latitude for the detail and complexity desired (or possible). A curve describing the average number of possible visitors throughout the season is required; similar information is necessary for cars and bicycles. Daily expenditures vary with visitor type, and the accuracy of this varies with the source. The best available in this case were the statistics collected in 1975 for the Massachusetts Department of Commerce and Development. (1)

Compared to estimating costs per visitor type, the expenditures assume a degree of simplicity. Costs incurred, or demands placed upon the system, on Nantucket were estimated for police protection, medical attention (emergency room treatment), ambulance service, water consumption, and solid waste disposal. The first three are considered fixed that vary with total number of visitors, and the latter two are variable costs that are functions of visitor type. Fire protection was not included because at initial investigation this seemed to vary little between winter and summer seasons. Time was not available for extensive visitor surveys, so existing information was applied as judiciously as possible to estimate the cost figures. (2-8,10-12) More accurate results and sophisticated simulation can be obtained by increasing the comprehensiveness of these variables.

RESULTS

In its current form, the model provides monthly tables for each type of information desired. These record the number of days that the value fell within certain limits (observed frequency), e.g., there were between 2001 and 3000 total visitors on Nantucket on fourteen of the days between May 16 and June 15. The tables also provide the mean value for the month, the standard deviation, and percent of total value for each observed frequency.

Rather than reproduce the volumes of tables generated, several summary tables are included for selected types of output to illustrate the types of information obtained. Some guarded observations are also made about the effects of ferry schedule modification.*

Table 1 displays the summarized output (mean value for each month) for the simulation of Ferry Schedule 1 with the 1976 visitor curve. The values are totals for visitors present on the island, not the number who just arrived on the ferry or on a given day. For example, during the period July 16-August 15 there was an average of 7678 visitors on Nantucket each day. Table 2 provides the same information for Ferry Schedule 2 with the same visitor curve. Table 3 summarizes the output for the simulation of Ferry Schedule 2 with a 6 percent growth in the visitor curve over 1976.

In examining these tables, one finds that the ferry schedule reduction expectedly reduces the number of total visitors (and their expenditures and costs), as well as the number of cars and bicycles. Interestingly enough, this drop is apparently balanced by the 6 percent increase in the visitor curve. Comparing expenditures to costs on any of the tables shows a more dramatic rate of increase for costs than for expenditures during the first three months of the season. This is due to the incremental costs associated with police and medical services that don't take effect until June 15. While figures for visitor totals follow an expected pattern, the end of the season is skewed to the high side because of the model's current visitor departure process.

It also appears that during the middle of the season this ferry reduction affects visitor totals more than car or bicycle totals, while the opposite is true earlier and later in the season.

*Ferry Schedule 1 is the one currently in use. Ferry Schedule 2 reduces the number of ferries by one for each time period. The distribution is as follows:

	Number of Ferries Per Day			
	4/16-6/15	6/16-9/15	9/15-9/30	10/1-10/15
Ferry Schedule 1	3	5	4	2
Ferry Schedule 2	2	4	3	1

These observations are based upon a limited number of simulations, and are intended to illustrate the type of information that can be produced. It should also be noted that other sources of visitors exist, and while figures were not available at this writing, the next obvious step is to obtain a more complete figure for total visitors--including airport figures, private boat data, and information on Hy-Line excursion boats.

III. IMPLICATIONS FOR REGIONAL PLANNING

One of the major problems in planning is avoiding obsolescence. Growth rates change in a matter of years, the economy can change in a few months (especially in a region or locality) along with the public's willingness to spend or save, and changes in technology can alter demands on natural resources in a short time. All of these factors make long-range planning difficult at best. If one asked the director of the NP&EDC what condition the

TABLE 1. Summarized Output for Simulation of Ferry Schedule 1 and 1976 Visitor Curve

Month	Daily Average Visitors[a]	Daily Average Expenditures[b]	Daily Average Costs[b]	Daily Average Cars[a]	Daily Average Bicycles[a]
4-15/5-15	1040	33,173	218	239	93
5-16/6-15	2370	67,914	548	558	274
6-16/7-15	4860	130,507	1460	1003	597
7-16/8-15	7678	199,952	2205	1245	1036
8-16/9-15	8569	216,635	2462	1337	1229
9-16/10-15	5820	145,964	1509	1239	740

[a]Refers to total number <u>present</u> on Nantucket.
[b]Expenditures and costs are for total visitors <u>present</u> on Nantucket.

TABLE 2. Summarized Output for Simulation of Ferry Schedule 2 and 1976 Visitor Curve

Month	Daily Average Visitors[a]	Daily Average Expenditures[b]	Daily Average Costs[b]	Daily Average Cars[a]	Daily Average Bicycles[a]
4-15/5-15	993	32,657	203	219	87
5-16/6-15	2167	62,699	498	529	264
6-16/7-15	4661	125,784	1409	977	585
7-16/8-15	7457	194,438	2147	1238	1031
8-16/9-15	8345	211,246	2404	1336	1228
9-16/10-15	5698	143,766	1473	1248	749

[a]Refers to total number <u>present</u> on Nantucket.
[b]Expenditures and costs are for total visitors <u>present</u> on Nantucket.

TABLE 3. Summarized Output for Simulation of Ferry Schedule 2 and 1976 Visitor Curve Plus 6% Growth

Month	Daily Average Visitors[a]	Daily Average Expenditures[b]	Daily Average Costs[b]	Daily Average Cars[a]	Daily Average Bicycles[a]
4-15/5-15	1018	33,304	210	234	91
5-16/6-15	2314	66,947	530	559	277
6-16/7-15	4921	133,104	1466	1026	612
7-16/8-15	7810	204,026	2233	1298	1082
8-16/9-15	8757	221,925	2504	1403	1285
9-16/10-15	5996	151,307	1547	1330	784

[a]Refers to total number <u>present</u> on Nantucket.
[b]Expenditures and costs are for total visitors <u>present</u> on Nantucket.

ground water supply might be in five years from now if tourism increased 5 percent each year with a 10 percent increase in long-term visitors, and the Steamship Authority added one additional ferry run per day during July and August for each of those five years--he would be hard-pressed to give a realistic answer. Most people, including planners, would have a difficult time with that or similar questions. Models similar to the one just presented are steps in helping the director of the NP&EDC, and other agencies, to address such complex situations.

The use of such a model need not be restricted to islands. It should also be feasible to apply it to any reasonably bounded area--whether it be topographical, political, or economic--assuming major access points can be identified and monitored. With this type of analytical tool, several potential scenarios can be projected, and various economic and environmental issues can be studied from a simulated point in the future. This provides an opportunity to shape policies and programs to address possible problem areas before they reach threatening proportions.

BIBLIOGRAPHY

1. Massachusetts Department of Commerce and Development (collected by Department of Economics and Department of Hotel, Restaurant and Travel Administration, University of Massachusetts, Amherst). "Expenditure and Visitor Day Information for 1974-1975".

2. Nantucket Planning and Economic Development Commission. Basic Data Report - 1975. Nantucket, 1976.

3. ________. Nantucket Bikeway Master Plan. Nantucket, 1977.

4. ________. Nantucket Central Business District Circulation and Parking Study. Nantucket, 1977.

5. ________. Nantucket Taxpayer Questionnaire. Nantucket, 1975.

6. ________. "Planning Notes". Vol. III, No. 1. January, 1977.

7. ________. Residential Growth Impact Study - 1974. Nantucket, 1975.

8. Schofield Brothers, Inc. Solid Waste Management Plan. Nantucket, 1974.

9. Schriber, Thomas J. Simulation Using GPSS. Wiley and Sons, New York, 1974.

10. Urban Design Group. Master Plan for Nantucket Island. Newport, 1970.

11. Woods Hole, Martha's Vineyard and Nantucket Steamship Authority. Annual Reports. (1972-1976).

12. Zube, Ervin and Carlozzi, Carl (ed.). An Inventory and Interpretation of Selected Resources of the Island of Nantucket. Amherst, 1966.