OPTIMIZATION OF BUILDING SHAPE WITH RESPECT TO BUILDING ORIENTATION AND LOCAL CLIMATIC CONDITIONS

CHAPTER I

INTRODUCTION

Energy consumption in the building is largely due to the heating and cooling requirements for maintaining comfortable indoor environments. In identifying and assessing this energy need, local climatic conditions, building orientation, configuration, material and building occupancy schedules might be considered the most important factors.

When a building is designed, orientation of the building is usually restricted by the site conditions and/or existing street patterns. Under the circumstances, the designer makes decisions about the shape, orientation and material of the house with respect to the local climatic conditions and architectural contexts, usually in an intuitive fashion.

As a result, even though the building may be considered reasonable from the point of view of the form and orientation of existing architectural context, the energy efficiency of the building may be limited by the building orientation[1] which may be deviated from optimum direction. Usually the optimum building orientation in north hemisphere is south[2].

Any possible incorrect decisions result in a high energy bill over the useful life of the house and may not produce a comfortable environment for the occupants. In this context, when assuming that building materials and occupancy schedules are determined, the need for an analytic approach to the configuration and orientation of the building under a given climatic condition is recognized.

Victor Olgyay stated in his book, "Design With Climate (1963)," that the optimum shape is that which loses the minimum amount of outgoing heat in winter, and accepts the least amount of incoming heat in summer. Olgyay's analysis is based on minimizing the total heat flow through the exterior walls. He, then, suggested basic optimum forms, in terms of building length-to-width ratios, of houses oriented toward south in four different climatic zones (Olgyay, Victor, 1963, pp. 87-93).

In case, orientation of a building should be deviated from south direction, the energy efficiency of the building will be enhanced by taking an optimum shape for that orientation and local climatic condition. In this connection, the need of a different approach from Olgyay's work might arise. Table 1.1 shows the major differences between Olgyay's

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[1] In this study, the term 'building orientation' indicates the orientation of a wall which includes major window area.

[2] This indicates the solar south, not the magnetic south of a given location.

work and this study.

Table 1.1 Differences between Olgyay's work and this study

Item	Olgyay's Work	Current Work
1. Climatic Zone	Four Different Zones	A Given Zone
2. Building Orientation	South	16 Orientations
3. Major Window Area	40% of South Wall Area	10% of Floor Area
4. Minor Window Area	20% of Other Wall Areas	4% of Floor Area

The goal of this study is to identify the optimum building shapes, expressed in terms of the proportions between its width and length, with respect to building orientation and climatic conditions of a given location. To meet this goal, the following objectives were established and discussed in each chapter.

In Chapter II, preceding studies concerning the two major factors, i.e., socio-cultural factors and physical environmental factors, which affect the shape of the primitive buildings were discussed.

In Chapter III, general concepts of climatic forces on architecture were discussed, then the major weather elements which should be given great importance were identified.

In Chapter IV, the algorithm for estimating building heat gain and heat loss were studied. Especially, Room Thermal Response Factor Method (Mitalas and Stephenson, 1967) for estimating hourly heat flow through opaque building elements such as walls and roof was studied. Then, a computer model was developed for estimating hourly heat gain and loss.

In Chapter V, a set of hourly model weather data base to be used in building energy calculations was constructed for Oklahoma City area as a case study. This data set consists of 8760 hour critical weather elements which might represent the long term climatic conditions of the area.

In Chapter VI, optimum building configurations for 16 orientations were identified through a series of computer simulation of hourly heat gain and loss using the weather data set for Oklahoma City area.

In Chapter VII, the conclusions were drawn and the topics of further study were introduced. Figure 1.1 shows the overall procedure of the study.

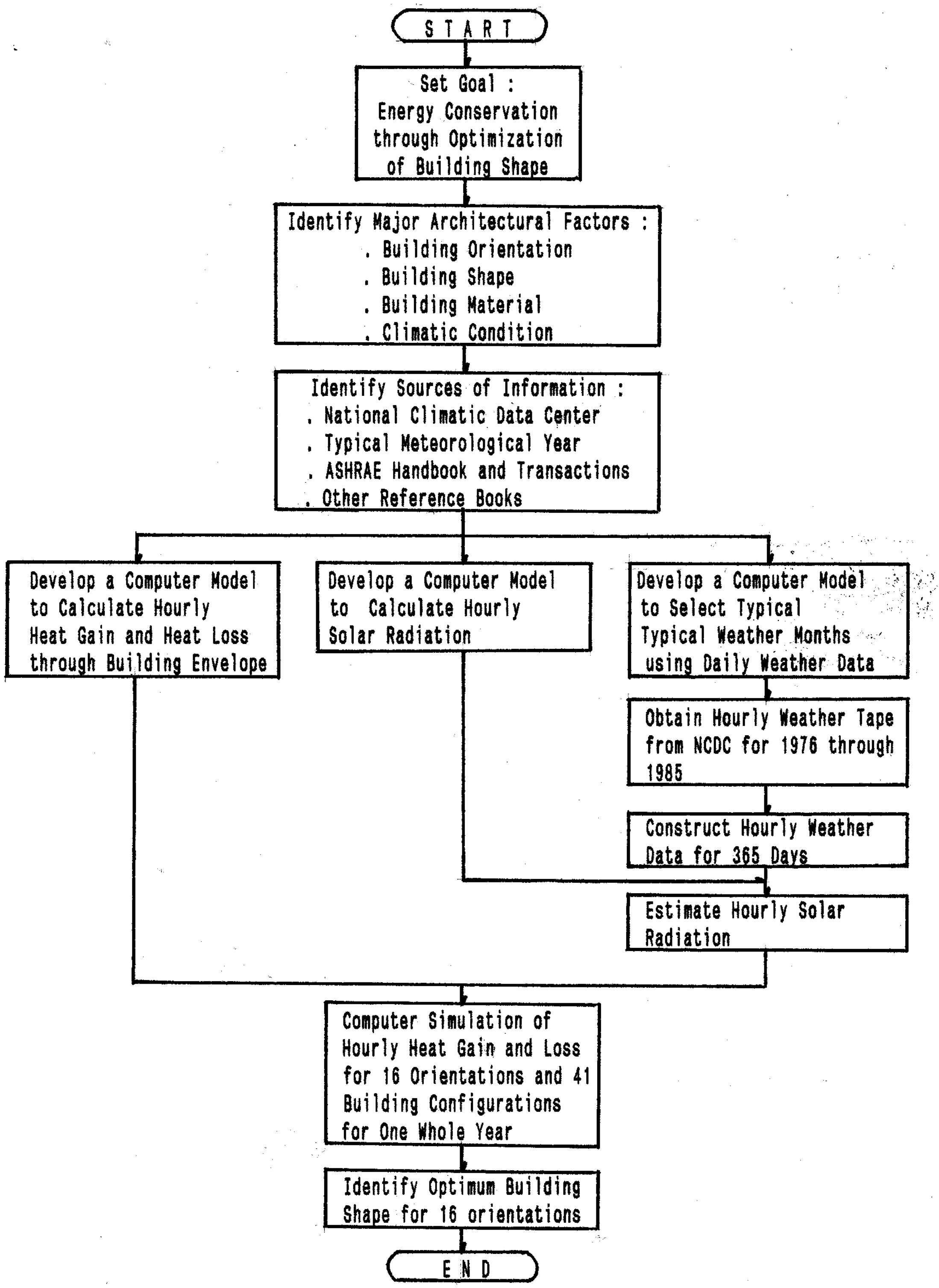

Fig. 1.1 Procedure of the Study