preferential pattern of transfer from each mesh to its ajoining meshes. Speed of transfer of a tribe in question on a mesh in question is calculated through the algorithm related to its character and population density of tribes in the meshes concerned. The mutual relation of the preferential transfer direction among the tribe in question and the other tribes, namely "cross" or "parallel", is taken into account in the algorithm. The results of the research of Part 1 are also used in the algorithm.

Here we show an example of the simulation. The reformation of Ueno Station in Tokyo as the terminal of Shinkansen New Tohoku Line is now in progress. In Fig. 6, the platforms of the new line is under construction deep under the right hand side of the central concourse, being shown by dotted line. The stairway and escalator connecting with the central concourse is shown there likewise. Fig. 7, an output by line-printer, shows thedistribution of passengers in the central concourse at 3 minutes after a concentrated train arrival of the new line and existing lines. The density of dots corresponds to population density. Passengers changing trains are jamming before the stairway to intracity lines at the bottom left of Fig. 7. The result of simulation has shown the necessity to widen the stairway or to take some other measures.

Original papers:

(1) Yuichiro Naka, Study on Complicated Passenger Flow in a Railway Station, Transactions of the Architectural Institute of Japan No. 258 August 1977

(2) Yuichiro Naka, Simulation of Passenger Flow in Railway Stations, Railway Technical Research Report No. 1153 September 1980, Japanese National Railways

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HOUSING AND COMMUNITY DESIGN RESPONSES TO THE CANADIAN CLIMATE

Summary

This paper describes the authors' experience and developments in thinking and design of low energy housing and community planning in a northern climate over a period of 10 years. The characteristics of this climate inlcude considerable extremes of cold in the winter and heat in the summer.

The principles used in these low energy designs range beyond limited considerations of passive solar collection, to include site selection and design issues, heat retention and energy conservation measures, and summer cooling methods.

From the earliest designs, emphasis has been on low cost and low maintenance as well as low energy. Rigorous engineering and careful architectural detailing are seen as essential. But a house is not a machine for heating and cooling, and the lifestyle and aesthetic aspects of the designs are considered integral components of the solutions.

The paper describes a few examples of projects which are representative of the major developments in thinking and experience in this field. They reflect an evolution from small projects for individual clients to multiple housing, non-residential and community planning work for institutional, government and developer/builder clients. Technically, they represent progression from tentative (but very successful) explorations to designs which draw from the most recent advances in reserach and computer simulation in energy conserving design.

They demonstrate that dramatic energy savings can be effected through low cost design which is responsive to a climate of great extremes.

Introduction

"Every one talks about the weather, but nobody does anything about it."
- Mark Twain

There is a commonly held image of Canada as a frozen wasteland from coast to coast. Certainly it is characterized by cold and interminably long winters. But much of the populated area of the country also has very warm summers. Even many Canadians do not realize that Toronto lies a little south of balmy Nice and Cannes.

These extremes of climatic conditions pose some very challenging problems of thermal design. We have been intrigued by them for over a decade and this paper briefly summarizes the climatic design approach we have developed and adopted in our housing projects.

Climatic Design

Climatic design ranges over a variety of considerations beyond passive solar collection. It also includes energy conservation measures, total building design, thermal zoning, heat retention and summer cooling. It extends outside of the housing unit to include factors of site selection, micro climate, site design, landscaping and community planning. The architectural work most closely follows the approach outlined by Olgyay (Design with Climate):

"The aim in designing a structure thermally is to establish an indoor environment which most nearly approaches comfort conditions in a given climatic setting. In architectural terms this means that the planning and structure of a building should utilize natural possibilities to improve conditibns without the aid of mechanical apparatus."

From the earliest designs, emphasis has been on low cost and low maintenance as well as low energy. Rigorous engineering and careful architectural detailing are seen as essential in the building designs. But a house is not a machine for heating and cooling and the lifestyle and aesthetic aspects of the designs are considered integral components of the solutions.

The Cool Temperate Zone

Definitions of climate zone somewhat from expert to expert. Most of the projects described in this paper are situated in Southern Ontario and lie in a general transition zone between the Temperate to the south and the Cool Region to the north. On the balance, "Cool Temperate" seems to be a well accepted and reasonable description of this zone.

Although minimization of heat losses and optimization of direct solar gain in winter are the most important criteria in thermal design for its region, the need for cooling in summer is also a significant factor. Temperatures can range from below 30° F in winter to above 100° F in summer. Moreover, relative humidity ranges from extremely dry on cold winter days to very high during certain hot summer periods. Snow and frost are important factors in winter, while the highest precipitation is generally in the summer. Two characteristics particularly aid and abet climate design. It is generally sunniest when it is coldest. And the prevailing winds tend to blow from different directions in winter and summer.

The winter and summer extremes call for a chameleon-like response to the climate. In winter, dwellings should be sheltered, air-tight, super-insulated igloos which optimize penetration of the southern sun. But in summer they want to be airy, well-ventilated and deeply shaded "Southern plantation" houses.

These dichotomies, combined with the varying demands of site, program and budget, provide a constantly fresh architectural challenge; a challenge which does not lend itself to stock solutions, cookie-cutter cliches or formalist jargon.

Four Generations of Solar Homes

Early designs include an attached green house (which does not overheat) and an earth-sheltered passive solar house (which won a National Canadian Housing Design Award). Recent and current projects include significant technical advances in the design of individual houses and the application of these advances to larger-scale multiple housing, non-residential buildings and community designs.

Passive Pioneer, Forster House, Guelph, Ontario

This 1973 house was a pioneering attempt to achieve a measure of self-sufficiency at low cost. The design predates the oil crisis and associated solar "fashion" boom. Design features included reduced demand for external food sources and water as well as energy.

It incorporated a double-glazed greenhouse as the "collector". In addition to heating and growing plants for food and decoration, the greenhouse provides an extension of the living and studio areas, but it is separated from them by folding glazed doors to enable maintenance of different temperatures. It also serves as the major circulation space of the house (eliminating corridors) and in winter it provides an "outside" living area inside.

Light and Airy Under-Ground Home

This sod roofed house is dug into a hillside 25 miles northwest of Toronto. The earth stabilizes the temperatures and protects it from the prevailing winter winds. The micro-climate is measurably cooler than that of Toronto and has heavier snowfalls.

The house is designed as 3 separate thermal zones: living areas, bedroom block and workshop/garage.

The windows are oriented to take advantage of the dramatic views over the plain towards Toronto. Their orientation and design ensures very good sun penetration in the winter.

Phase X Bridlewood, Scarborough, John Boddy Developments Ltd.

This moved our work from experiments for private clients into the speculative housing market, a major milestone for passive solar design. This house is a winning design in a recent Ministry of Energy-sponsored, HUDAC-administered Passive Solar Housing Competition.

According to computer model calculations by HUDAC, the modifications will result in energy savings of 75% over a comparable standard builder model. This reduction is the largest of any of the projects selected from various regions in the Province.

The two most important energy reduction measures are:

1. Passive solar heat gain through large south-facing glazed areas in a double-height Sunroom added to the rear of the house.
2. Control of cold air infiltration through the use of "air locks" at all entries to the building together with the direct supply of air to combustion equipment.

A variety of additional measures, combined with meticulous care in detailing and construction, further contribute to a high level of insulation, air-tightness and efficient absorbtion of solar heat.

Grenville, Christian College, Brockville, Ontario

A 22-unit housing project, believed to be the largest passive solar housing project in Canada at this time.

The thermal principles are similar to those developed in the single family houses described above. Relatively small sunrooms are separated from the livingrooms by sliding/folding glazed doors, providing enlarged living space when opened.

The program has many unique features. These include the requirements of covered access from the college buildings to all the housing units, and a view to the St. Lawrence River to the south for all living spaces. Accommodation of these requirements, as well as solar access for all units in this east-west oriented building has resulted in quite an intriguing geometrical solution.

NON-RESIDENTIAL PROJECTS

Passive Solar Greenhouse, Brock University, Ontario

A 200m^2 teaching and research greenhouse which is currently under construction. This project will demonstrate the effectiveness of a building configuration which responds to the local climate (in contrast to the "standard" greenhouse configuration which evolved in response to the very different characteristics of the Dutch and British climates). It will utilize between one seventh and one tenth of the energy required for such greenhouses. Use of the vent stack effect will produce the equivalent in natural ventilation of 17 tons of airconditioning.

Calgary City Hall Competition, Alberta

Demonstration of the application of climatic design principles to a building type in which the needs for cooling outweigh those for heating. The design incorporates shading devices, exploits the vent stack effect, refines the design of the building envelope and incorporates sophisticated energy recycling techniques.

MASTER PLANNING

Craigleith Village, Collingwood, Ontario

Craigleith Village will be a resort community adjacent to ski slopes and near the shores of Georgian Bay. It will be a model of energy efficient design. At the community design scale, the siting and landscape principles will serve to modify the micro-climate significantly and will minimize the dependence on cars for local movement. Many of the proposed measures are inexpensive or even cost-free. Frequently they involve the adoption or adaptation of principles in common usage before the advent of mechanically heated and cooled air.

Quetico Centre, Atikokan, Ontario

Master Plan for a conference/educational centre located on a semi-wilderness site in Northern Ontario.

The plan incorporated site design and detailed architectural measures to adapt and upgrade the Centre's facilities to reduce a heavy reliance on energy within this very harsh climatic region.

CONCLUSION

The technical developments and increasing public and private interest in climatic design principles over the past few years are truly remarkable.

On the technical side, the latest projects incorporate not only greatly improved conservation measures, but also solar fractions varying between 45% to as high as 78% are being obtained. In terms of acceptance, government departments, developers, bodies such as HUDAC and Ontario Hydro, private clients, etc. are all displaying increasing interest in the design of thermally efficient buildings.

The buildings demonstrate how the energy issues of the 1980's can be tackled in our northern climate while maintaining environmental quality and creating settings for family life. The planning projects introduce fresh site planning opportunities which are responsive to the dictates of the region.

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NON-MECHANICAL AND NON-ARCHITECTURAL CLIMATIC SOLUTIONS IN A TRADITIONAL SETTLEMENT: Case Study Al Diraiyah, Saudi Arabia

Summary

Saudi Arabia, a rich and a modern country. Almost every space is air-conditioned to increase living-working standards. About three centuries ago, this muslim community tried their best to create a physical environment to cope with extreme climatic conditions without depending on magnificent and expensive mechanical devices and also without the help of the architects.

Al Diraiyah, the old capital of Saudi Arabia, is located 15 kms NW of the modern capital, Riyadh. The town at the present time consists of two parts, the modern town and the historical town. Al Turaif district of old Diraiyah has some impressive buildings which have survived until today. This research was carried on in this district, which contained the residences of the al-Saud rulers and their retinue, as well as government buildings, forts, castles, and stables.

Although the Arabian peninsula is surrounded by sea on three sides, central Saudi Arabia has a long, hot and almost dry summer with a short, cool winter with little rain as the air masses are largely exhausted before they reach S.A. The climatic extremes of this area can be summarised as minimal rainfall with extreme variability; high mean duration of sunshine; high levels of solar radiation intensity; extremely high and low air temperatures; dust and sand storms.