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ABSTRACT

This report is concerned with suggestions for translating changing educational requirements and community needs into appropriate school facilities that are designed, or changed, t be cost beneficial and to conserve energy. Planning guides are offered for the construction and the improvement of elementary and secondary schools. Some preventative maintenance procedures and hea recovery methods are noted. The report also looks at alternative wa of heating and cooling but particularly at solar heating and heat pumps. Some figures from limited studies given to indicate energy savings that various modifications could be reasonably expected to offer. The uses of building systems and windmills are also examined (Author/MLF)

THE CONSERVATION OF ENERGY IN SCHOOLS - A FEASIBILITY REPORT

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March 1976

THE CANADIAN SCHOOL TRUSTEES ASSOCIATION

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THE CONSERVATION OF ENERGY IN SCHOOL FACILITIES
A FEASIBILITY REPORT

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A FEASIBILITY REPORT DEALING WITH THE CONSERVATION OF ENERGY IN SCHOOL FACILITIES

Preamble

How can we plan school buildings for today and tomorrow from experiences of yesterday and what we know today? Upon what factual information and background of experience can we draw to gain this vision? This is our challenge, one for which there is no definite answer available. The most important concept we have to begin with is that of space. It is not a simple matter of suggesting that each student have more or less space. Rather it focuses attention on a kind of space that can be adjusted to changing needs with minimum delay and cost. For today education needs fluid space not restricted by tradition. Spaces need not be more costly, but they must be more functional and productive in the educating of boys and girls, and be used more in a greater variety of ways. And this must be carried out cost-effectively in the light of growing scarcity of energy and materials, and despite inflationary tendencies.

THE CONSERVATION OF ENERGY IN SCHOOL FACILITIES - A FEASIBILITY REPORT

INTRODUCTION

Canada with 0.5 percent of the world's population uses some 3 percent of the world's energy, or about 1.7 million barrels of oil daily plus gas, coal and wood. The schools which provide for about a quarter of our population use some 10 - 11 percent of the energy for heating, light and transportation or some 8 million barrels of oil and 24.6 million cubic feet of gas. The lamp of learning burns oil (energy).

The Canadian government has decided that energy conservation is now an important, permanent part of our energy policy to ensure adequate supplies for the future. It should provide not only short term benefits, such as saving money and the importing of less oil; but a comprehensive long term plan fundamental to our future and that of our children in this rapidly changing, shrinking world where supplies are limited, with some non-renewable sources running short. In its booklets our Government points out that staff and students are not being asked to shiver in cold schools, strain their eyes with poor lighting, or be uncomfortable, a situation experienced in many log and frame pioneer schools. The Government is counting on a program made up of voluntary action, mandatory measures and Government initiatives. The education enterprise can make a real contribution in this.

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To help conserve energy school boards could undertake the following, concerning school facilities, and some are doing this already: To solicit the aid of teachers and students in saving energy through turning off lights when not needed, keeping the thermostat as low as compatible with comfort (sweaters could be used by those who feel cold), and avoiding heating the outdoors. To instruct the heating engineers to keep the equipment clean and operating efficiently, and turn down thermostats when school is not in session. The boards should take steps to ensure that the schools are not cold and draughty, etc.

This report was therefore undertaken essentially because: first, the need to conserve energy; second, rapidly rising prices especially for oil; and, third, increased demands that the facilities more closely meet the needs of the new programs. Concern here is for the designing of school facilities that will conserve energy, especially from non-renewable sources, with the removal of constraints on today's programs, and the meeting of the needs of the community. To achieve these aims each school should provide flexible space, be cost beneficial, and be aimed at full utilization. Since most older schools need renovation and change to house today's forward looking education practices concern should be directed to modernizing them in cost-effective ways. It is also recognized that separate specifications and plans are needed for elementary, intermediate and secondary schools, at least. Essentially the report is concerned with suggestions for translating changing educational requirements and community needs into appropriate school facilities which are designed or changed to be cost beneficial, and to hoard energy.

More specifically some of the projects which might

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be undertaken to make school board members more fully aware of what is happening in education and to help them where decision making is necessary, are as follows:

1. Making available of concise, readable factual materials on: energy saving; solar heating; use of heat pumps; preventative maintenance.

2. To provide a selected, annotated bibliography covering school construction, maintenance and repair; to provide information on basic principles and approaches for construction from which relevant help can be derived for individual projects.

3. To suggest where information is available on facility specifications at the elementary, intermediate, or high school levels, and for special education, etc. These should be able to be adjusted to take account of education change, technological advance, availability of energy and other relevant factors.

4. To provide suggestions re. specifications related to educational needs, methodology such as IPI, CAI, CMI, seminars and onferences, large groups instruction, etc.; and checklists for monitoring, feedback and evaluation.

5. To consider providing forms to help monitor operation, repair and maintenance of equipment.

6. To make all Boards, Teachers and others aware of the need to conserve energy and means of accomplishing this.

7. To provide guidelines for the development of a systems approach in school administration - one especially designed to meet the needs of administrators. A survey of present practices at least in the Department of Education and larger school boards should be undertaken.

8. Technological capabilities already developed or soon to be ready will probably profoundly and fundamentally alter the shape of education, the nature and function of education institutions

and the function of educators. There is need for work and understanding in instructional technology, in the uses of both the older and newer media.

9. There are many other innovative practices that deserve serious consideration, some that are practical, some optional and some conflicting, for example: ungrading, individualized instruction, computer aided learning, teacher aides, cross-age tutors, community volunteers and resources, differentiated staffing, language laboratories, all the newer media, early childhood education, drug abuse and many more.

10. Professional development, in-service training and the use of media in this.

SCHOOL PLANNING AND CONSTRUCTION TO SAVE ENERGY AND MEET NEEDS

"Therefore does the school building, whose useful life is technically forty years (or 50) when built in terms of the present curriculum incur the risk of being unsuitable for requirements of the programmes in effect ten, fifteen, twenty or thirty years later."
Report of the Royal Commission of Inquiry on Education in the Province of Quebec.

This submission is concerned primarily with the construction of new elementary and secondary schools which will meet the needs of today's society for functional education, being constructed and operated in such a way as to conserve as much energy as is economically cost-beneficial. Secondly its concern is with the reconstruction of older schools so that they can function satisfactorily in meeting our needs.

Because of constraints imposed by dollar limitations, material shortages, and expertise in some localities, it seems necessary to consider not only a better sharing of technical information, but also the reduction and elimination of all that is unproductive and under-used while increasing the efficiency and use of educational facilities. Modern media and increased technology which have revolutionized much of office procedures and homemaking can be expected to have as great an influence on the education offering long before schools being constructed today will be considered for replacement.

Our purpose therefore must be to provide for the construction of elementary and secondary schools which are cost beneficial, which are designed and operated to save energy, and which take cognizance of the changing dynamic situation in which education must function today and tomorrow.

The problems of school construction will have to be attacked systematically to ensure that all reasonable alternatives are considered, both their main results and side effects, that costing is attempted, models are devised and pilot projects tested where deemed desirable.

Other purposes are to provide basic principles and approaches so that individual projects can be derived from these: To provide suggestions for monitoring and feedback and evaluation checklists. To construct facilities which can provide a flexible moving framework adaptable or adjustable to education change, technological advance, availability of energy, etc. To effect savings in the use of fuel and energy of 30% to 40% or more.

Some of our schools are 50 years old or older. When they were built wood beams were used which limited room width to 24 feet (now 60 foot spans using steel, concrete,

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or laminated beams and loft construction are used). Walls were concrete, wood or stone (now the variety of composition materials is much greater). Roofs were cedar shingles (now composition materials are available for flat or peak roofs). Partitions were generally load-bearing, heating was wood or coal, any electrical wiring was simple and temperature and lighting depended much on nature, and was variable. Plans were fashioned to utilize natural lighting and ventilation e.g. H.E.L.T.O.U., etc., with many of them two or three storey. In outward appearance many copied classical models, or used the models provided by Departments of Education. Today's aim is for flexible space with teaching and studying areas, an ample resource centre inclusive of the library, studio and darkroom, and cooperation by the teachers with pupils being consulted.

Because no one can predict future needs, and because even today the variety in innovative methods demands variety in facilities, recent trends in school construction place emphasis on flexibility, which requires that major changes can be made in the interior, easily, quickly and cheaply. There are to be no interior weight bearing walls in the teaching - learning area (there could be exceptions for offices and other ancillary areas), and the windows, exterior doors, washrooms, heating, and ventilation systems and electrical wiring and apparatus, should allow for rapid changing of the interior. Suggestions for accomplishing this have included the following and more: throw-away schools or temporary structures designed to last from 10 to 20 years; a pre-fabricated modular system; small schoolhouses separate, or several on a campus; combinations of schools with other buildings; and even a central meeting place with classes held in museums, art galleries, etc. All suggest the need for planning to accommodate individual needs and differences. Neither compartmentalized egg crate type of construction nor central station, loft or shed open construction provides the answer, for both constrain possible activities. This should not be surprising. Few people would opt for either a house with all rooms uniform despite variable functions, or for an all-in-one large room.

While school planning and construction is somewhat unique it has much in common with other construction in homes, offices and other buildings. Just as houses have changed from much partitioning and many rooms to a variety of rooms for one or more functions, have reduced waste space in halls and stairways somewhat, and have more functional built-in features to save space, many offices are now open space with barriers of bookshelves, etc., to provide flexibility, quiet and aesthetic appeal. Whereas dwellings are used up to 24 hours a day every day, schools are generally in operation only from September 1 to the end of June five days a week from 9 AM to 4 PM or thereabouts. More are now open some nights and a few the year round. In Canada this is more important for heating than cooling, although a number of schools have found it expedient to introduce air-conditioning for comfort, to increase work production at little or no extra cost.

From a consideration of cost benefits from schools and schooling and considering the wide variety and range of schools found in use today, it is not surprising to find constraints on many programs which have serious consequences in some cases. On the negative side some edifices suggest that the board, architect or others regarded schools as personal monuments, producing grandiose facilities from the outside, good offices, halls and gymnasia inside, but poorly equipped conventional classrooms suited only to conventional lecture, note taking or listening procedures. Other structures were designed to meet only minimum standards with the contract going to the lowest bidder. The sites were sometimes badly chosen and small. Nor has it been unusual for "new" buildings to require substantial alterations and repairs. Considering that building a schoolhouse is a once in a lifetime experience for many schoolboard members, and some architects selected never build more than one or two, it is hardly surprising if some schools were neither functionally nor aesthetically pleasing. Better practices are needed today when demands are much greater.

There is a strong possibility of greater waste in the near future from either continuing to produce typical schools, or by erecting schools from whim or caprice, or with little thought of needs tomorrow. There is growing recognition of the direct intimate connection between the nature and design of school buildings and school programs and procedures. There is need for planning boards; and for studies of performance, durability, and the strong points and weaknesses of existing and proposed schools to provide guidelines for future construction. This suggests the need for compiling and maintaining systematic records, the undertaking of pilot projects, the formulation of basic lists of specifications and requirements for school facilities, and the making available of a number of general designs easily adaptable to meet local needs.

THE CONSERVATION OF ENERGY AND SCHOOL OPERATION

Everyone is familiar with structures that at times are too hot, too cold, too draughty, too dry, too bright

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or too dull, too noisy, or too quiet or otherwise fail to please a majority of persons whether the inconvenience is due to the heating, cooling or other equipment. Most such inconveniences not only produce discomfort but are wasteful of scarce energy. Under the assumption that the present critical energy situation will continue or worsen, the careful use and monitoring of energy must become a primary concern in school operation as elsewhere. When it is realized that the energy used for building comfort represents 20+% of the national energy consumption and that a saving of 50% can be effected in some buildings, as compared with traditional practices, then planning to conserve energy in school operation becomes a paramount goal. Aiming to save 30% to 40% without increasing discomfor would seem to be a reasonable objective for the present situation.

It is therefore the purpose of this section to indicate some possible savings, whether for new or old buildings as appropriate. It will note some preventative maintenance procedures and some heat recovery methods. It also looks at one or two alternative ways of heating and cooling but particularly at solar heating and heat pumps.

SOME POSSIBLE SAVINGS IN THE USE OF ENERGY IN SCHOOLS

To keep the discussion down to earth in dealing with the energy savings which various modifications could be reasonably expected to offer, some figures from limited studies will be given. Other considerations are the main and side effects of making the changes, the time necessary to recouperate capital investment and any increases in maintenance and repair. Where the suggestions are for

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other than simple measures such as turning off the lights when not in use, it might appear expedient to conduct pilot projects or research studies which are well monitored.

Some Changes to be Effected	Possible Savings in Energy Used
1. Increase insulation in ceiling and walls, caulking windows, etc.	from 20% to 40% or even 50%
2. Shut off exhaust fans 3 PM to 7 AM	40%
3. Hold maximum intake and shutoff fan	50%
Reduce intake by 50%	14.5%
4. Reduce glass area 35 to 17%	4%
28 to 10%	9.8%
18 to 10%	1%
5. Cut lighting wattage 15%	2.4%
6. Heat recovery system (80% efficient)	18%
7. Double glazing	12 to 13%
8. Reduce temperature to 60° 3 PM to 7 AM	(depends on heating system, insulation, etc.)
9. Close school for January	2% to 24% (if heating system drained, etc.)
10. Adopt 4 day week in Jan. and Feb.	0.7%
11. Adopt 4 day week all year plus one extra hour school	0.7%
12. Start school at 10 AM	2.4%
13. Start school at 11 AM	5.2%
14. Reduce temperature 75° to 70° F.	17.1% or 3.4% per degree
15. Reduce outdoor intake 25% to 12.5%	3.4% (or more according to temperature)

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PREVENTATIVE MAINTENANCE

Savings figures were not available but the total could be considerable, possibly 25% to 30%.

To cut cost by:

1. turning off lights when not in use;
2. using fluorescent lights rather than bulbs;
3. using a large bulb rather than 2 or 3 small ones;
4. install fluorescent lights in panels or bands - use only what you need;
5. photoelectric control is more expensive to install but more efficient photoelectric switching and high low ballast save money;
6. avoid mishandling of ventilator - unit ventilator recirculates interior air, adds outside air, forces it across water or steam heated coils and circulates it, can be used for cooling as well;
7. use damper control with low limit settings, thermostatic control and blower motor switch;
8. inspect and recaulk doors and windows;
9. check insulation on steam, hot water and chilled water pipes, etc.
10. keep equipment clean as dust can reduce efficiency by 25% or more. Leaking faucets and radiators should be repaired. Lamps, reflectors and shades should be cleaned or replaced. Clean or replace air conditioning and other filters;
11. consider replacing clear glass with heat absorbing glass to cool; add an extra glass layer (storm windows); have venetian blinds between panes; use awnings or other shading devices outside the windows in summer;
12. consider wall shading using deciduous trees, canopies,

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projecting mullions, louvres, solar glass screens, shaded glass, colour, etc.;

13. consider air conditioning as a possible economy in new buildings; this is particularly pertinent for schools used the year round, or with hot, humid weather, or in a city centre, etc.;

14. make teachers energy conscious;

15. consider using industrialized school construction.

WASTE HEAT RECOVERY

Considering that well insulated schools will probably need more cooling than heating in spring, summer and fall, and that poorly insulated schools will need cooling particularly in hot days, the salvaging and storing of heat should be considered. Schools are heated by persons, lights, the sun and heating systems. Each person gives off about 390 BTU's per hour. Artificial light bulbs yield 10% light and 90% heat. Fluorescent lights yield about 50% light and 50% heat. Heat from the sun through windows, attics and walls varies greatly, but an attic may reach 130° F., or 54° C.

Light generated heat may be removed by: 1. piping cooling water through a jacket in lighting troffers, with the heat used or stored; 2. or exhausting room air through an air cooled fixture. Recovery of exhaust heat is from 30 to 35% effective.

Thermal energy storage of heat may be short term or day to day, or long term or seasonal, or heat may be transferred from one section of the building to another or where it is needed using air or water currents. Heat can be stored in water, loose rock, or salt hydrate crystals. Salt hydrate

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crystals that freeze at 55° build ice on TES panels by compression. Water storage must be kept above the freezing point. Rock holds less heat per unit volume.

Rotary wheel exchanges, water cooled coil exchanges, and water in coils and fins are used in smaller buildings to transfer heat from exhaust to the airstream supply. Heat pipe banks and air-to-air exchanges can provide preheated fresh air intake. Heat pipe banks and air-to-air heat exchanges require mechanical engineers to keep them operating.

Electrical heat is inefficient as a primary heat source but may be good as an auxiliary source, using solar energy and heat pump. Its cost varies from area to area and its main use is generally to operate heating systems.

OTHER HEATING DEVICES - THE HEAT PUMP

The heat pump normally consists of a compressor, an evaporator, a condensor with an electrically operated reversible cycle for cooling or heating. It uses a technique similar to that used in refrigeration to transfer heat from one source to another. It can for example use heat from the outside air, even when the temperature is below zero - but this is not recommended for heating a building. A second source of heat is the ground, below the frost level. A third, and a good source, is from flowing streams or wells. The latter is worth considering seriously from the view of cost-effectiveness.

Power used with the heat pump is generally electrical but as with refrigeration gas can be used. As noted a heat pump operated by electricity is more efficient than generating heat from electricity using resistance. Its cost-effectiveness

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will depend on the cost of electricity, etc.

All school boards should obtain copies of the following booklets: 100 Ways to Save Energy and Money in the Home, and The Billpayer's Guide to Furnace Servicing; Office of Energy Conservation, Department of Energy, Mines and Resources, 580 Booth Street, Ottawa, Ontario, K1A OE4.

SOLAR HEATING FOR CANADIAN SCHOOLS

Because of impending shortages of oil, natural gas and hydro-electricity, alternative sources are being sought such as geothermal, tidal, wind, solar and atomic. Solar energy probably shows the greatest promise for short term application for heating buildings. It may be used to provide all the heat, or be supplemented by auxiliary sources such as a heat pump or electricity. At the present time it must be considered to be in the experimental stage, but depending on the cost of other energy it might become economically competitive in the next two or three years. There is no cost for solar energy but the amount received varies from area to area, season to season, day to day, and hour to hour. The cost is in the installation of the system, its operation and maintenance, its life expectancy and the heating load of the building. Savings from solar heat usage could be about one-half the cost of conventional energy. Where solar heating is used construction should aim at saving energy as for electric heating.

Two factors to be considered in maintenance are corrosion, where a water system is used, and breakage from system item failure, thermal stress and vandalism. Size of the heat collector is another factor since a collector area of about 1/3 to 1/2 of the instruction and ancillary floor space

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(excluding basement) is needed to meet half the total heating requirements, assuming a seasonal storage capacity is provided. Storage of excess heat for the night and following day is considered as short-term storage. A bigger system, large enough to hold more than half the heat needed during the whole heating system is long-term or seasonal storage. The heat transport fluid may be air or water or an anti-freeze solution in the collector with a heat exchanger. Because of the danger of freezing, boiling or corroding in Canada, air seems preferable. This requires fairly large ducts and fans.

Also to be considered are the use of a black coating on the absorbing surface; a transparent cover over the frontface of the absorber to reduce convection current loss, and a radiation screen with insulation on the back of it. Multiple glazing honeycombs in the air space limit convection heat loss. A double glazed cover may be used. Tempered glass or plastic may be used to provide protection from vandalism, breakage, etc. Optimal tilt angle for the collector is latitude plus 20°. Also a reflective surface may be used to direct additional sunlight at the collector.

An experimental pilot project would seem in order since this would appear to be justified by the information at hand. It should be funded and carefully monitored. It would seem that for the site selected there should be interest by the Board in considerable spring, fall and winter sunshine. Seasonal storage and supplementary heat would have to be provided. Such a project should be subsidized.

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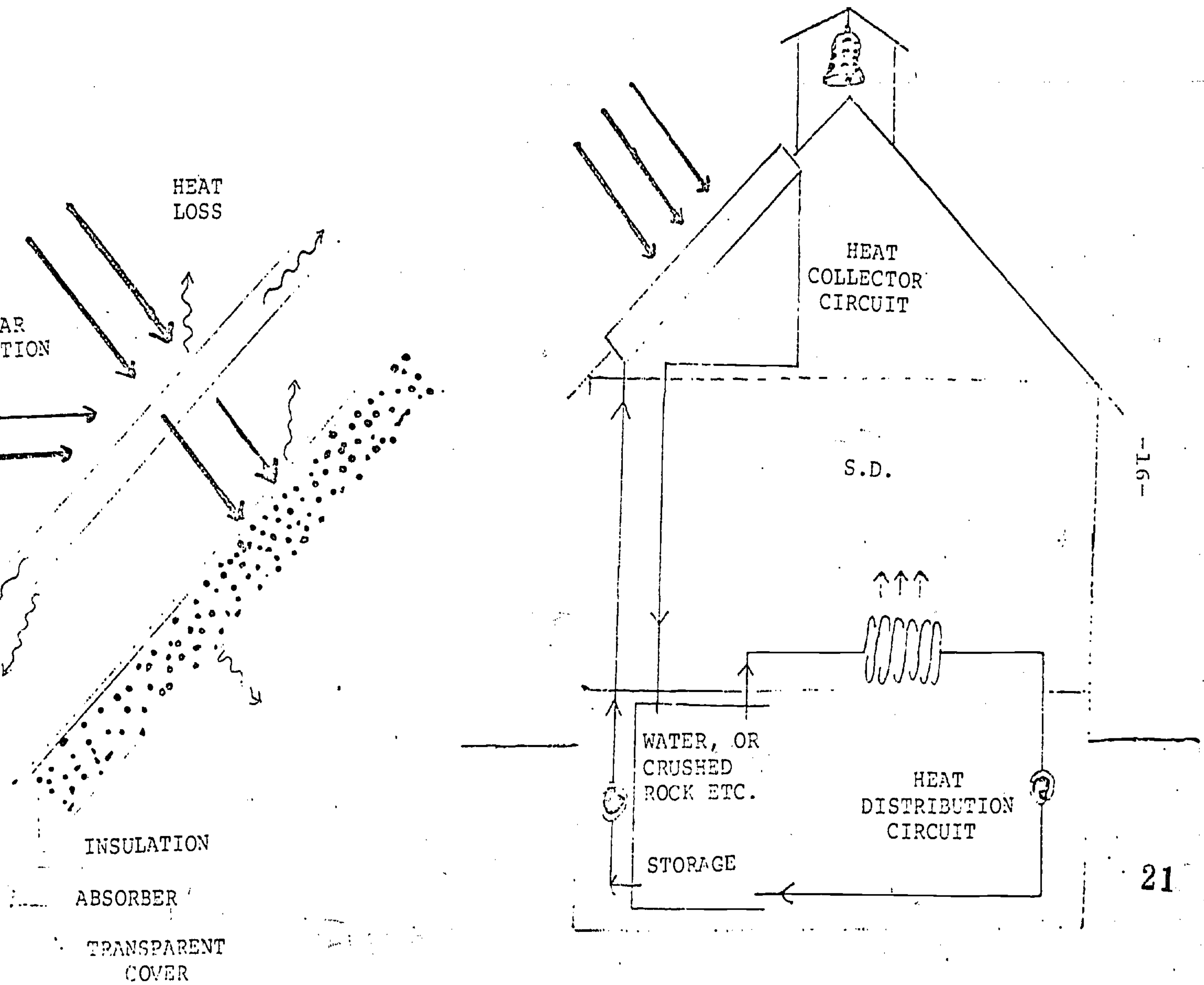

SOLAR HEATING SYSTEM and section of collector

NEW CONSTRUCTION

The construction of a new school is oftentimes a major undertaking. Construction plans have passed through various periods of emphasis, for example, from a time when the board selected one or other of approved plans and was concerned mainly with meeting costs, to a placing of emphasis on appearance, to the consolidating of a number of schools, to putting emphasis on initial costs as against long term costs, and such. Today's efforts may be directed at overcoming the constraints of buildings on education programs and cost benefits. With greater adoption of the open concept philosophy, folding or flexible partitions and equipment, sharing of some school facilities and encouraging greater community participation, emphasis is on providing space to accommodate a variable program.

In providing new schools, where needed, whether as replacements due to obsolescence and decay, to the introduction of newer programs, or because of population growth related to urbanization in the city proper or suburbia, or for other causes, there is need for cooperation among policy directors, planners, educationists, administrators, architects and engineers, a situation that should last from their first meeting until the school is built. Since the edifice to be constructed is public property, it is expected to meet the wants of many publics. Those in charge of construction will likely be pressured from many angles to provide as many products as there are different views and will have to take a stand. It may be that where the educators think progressively while the community is staunchly conservative, or vice-versa, that a P.R. campaign will have to be mounted and directed at one or the other or both to get support so

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that a modern type functional and flexible structure will result.

Where the population is settled they should provide input from the beginning and work with the educators to provide basic performance criteria. A statement of user requirements, following a survey of school district needs in terms of activities and converted to performance specifications is necessary.

Those responsible for new construction today are understandably concerned with saving money in construction and energy while providing flexibility in spaces and buildings that meet the needs of education - that is, spaces suited to program needs. They must appreciate the limits of resources and be concerned with cost, benefits within the constraints of the situation since there are limits to the money that can and will be allocated to school construction.

School building costs are basically determined by the standards of space and uses to which the schools conform. A balance must be reached between quality and quantity, considering demand and resources. This concerns space per pupil, range of facilities provided and use of the facilities. It also assumes that no real economy will be achieved by depressing standards below the level needed to facilitate the aims, the techniques, and the teaching methods used in good schools. Emphasis can be on the reduction and elimination of all that is unproductive or under-used, on savings from more efficient methods of construction, and reduction in operations, maintenance and repairs.

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Some factors to be considered in new construction:

1. (a) Non-construction costs inclusive of meetings, surveys, legal fees, professional fees, etc.;

   (b) land purchase and development;

   (c) playgrounds, playing fields, etc.;

   (d) fittings, furnishings, furniture; and

   (e) teaching equipment, apparatus, books and supplies.

2. Construction costs are affected by:

   (a) shape of building, number of storeys, minimize outside walls, roof, etc.;

   (b) orientation - East-West exposure better for cooling, North-South for heat from sun;

   (c) colour of roof and walls to reflect light or absorb it;

   (d) windows - keep to a reasonable minimum;

   (e) consider climate, storms, earthquakes, winds, topography, trees (deciduous trees shade buildings in summer, etc.);

   (f) wall shading, wide eaves, etc.;

   (g) consider availability and cost of fuel (varies from area to area);

   (h) consider competence of maintenance crew - can affect savings in energy;

   (i) consider access for physically handicapped (expensive but desirable);

   (j) school requirements - planning based on probable use of space in teacher-learner situations together with soundly conceived educational uses of media to be employed. Aim for flexibility of spaces;

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(k) provision for flexible teaching area, classrooms or open space, laboratories;

(l) auditorium, auditorium gymnasium, gymnasium, resource centre (includes library), etc.;

(m) non-instructional or ancillary areas -

circulation area - halls, etc., and

storage - fuel and heating, etc.
- cloakrooms and lockers
- administrative records, etc.
- teaching storage;

(Note: Britain reduced this from 30% to 16% of total.)

(n) play space and equipment;

(o) dividers - moveable walls mechanically controlled with adequate sound absorption in auditorium, gymnasium, cafeteria, study halls, and between rooms,
- semipermanent walls, utilitarian dividers, psychological dividers (cement block walls or composition board), prefabricated units, part solid, part glass of varying heights, cubicles,
- chalk boards, bookcases, audio-visual screens, deployable fixtures, sculpture, planters, and
- conversation pits, carpet blocks installations, etc.;

(p) heating and cooling the buildings (see section on conservation of energy);

(q) lighting (see S.E.F. reports).

SOME ADDITIONAL CONSIDERATIONS

Among pioneer attempts to relate school to program was the Crow Island School where the Winnetka plan was developed. In recent years many efforts have been directed

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towards accomplishing this, whether open space construction, or modular construction.

To a great extent interest was focused on suburban schools in the 1950's and redirected to city centre schools in the 1960's. Because of rising land prices efforts were directed to increasing teaching space while reducing ground floor space. Some attempts were:

1. The construction of schools of up to five or more storeys;

2. The use of open space elementary schools where 40% of floor space was used for teaching and more for education activities;

3. Attempts at joint occupancy with schools in or on land of a high-rise development;

4. Community schools, where additions to the schools or wings of the school complex house a public library, child clinic, centre for out of school adolescent youth or senior citizens, etc.;

5. Use of computer in planning facilities, to date used mainly at college and university level, but used in S.E.F.

NEWER MEDIA AND FACILITIES REQUIREMENTS

An important consideration in construction today is application of instructional technology but particularly use of the newer media. Today these include a variety of systems and separate components such as radio, television, computer assisted instruction, telephone, intercommunication systems and recorders, overhead and film projectors, language laboratories, tape, disc, microfilm, microfiche, etc. Planning for these should be based on soundly conceived educational

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uses of media to be employed. An instructional materials centre with provision for ordering, producing, storing, distributing, previewing, broadcasting, programming, planning audio-visual materials seems necessary. Provision has to be made for listening spaces for small and large groups and individuals, for a production area, darkroom, work counters, electric outlets, construction materials, sinks, duplicating facilities, etc. Light control is important with translucent and opaque drapes, shades, screens, acoustic tile, etc. A teaching, filming and broadcasting studio may be desirable.

Schools lacking electric outlets, light control and handy, safe storage space will probably make minimum use of equipment they have. The Resources Centre may be the hub of the school, a crossroads for several schools in a school pack, an addition to an old school, or a misfit. It is likely that the newer media will revolutionize both the program and the facilities used. The possibility of wired cities, of CAL systems, multiple use of TV outlets and new stand alone equipment as well as other media and new developments will affect not only what is learned at school but at home and at work as well.

PREFABRICATION AND THE INDUSTRIALIZED CONSTRUCTION OF SCHOOLS

This relates to factory made building components, the preparation of building systems, the systematic coordination of design, of production and of marketing. This is a systems approach to the plant manufacture and pre-assembly of selected components of a school building. It

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takes advantage of mass production and economies of scale through the normalization or standardization of school construction. With components mass produced, the quantity warrants research and a pilot project. It is expected to result in, first, a reduction in cost of school construction per square foot, second, in time saved in erection through prefabrication, and third, in providing schools with easy accommodation to emerging education policies, and which are transformable to meet short and long term needs.

The purpose of industrialized construction is thus to introduce standardization of component parts into construction as with automobiles, grain elevators, some chain stores and service stations, equipment, etc. It assumes that there is enough similarity in school operation to warrant a fair degree of standardization, for a proportion of school construction covered, which varies from one attempt to another. It does not assume that all schools will be identical, only that the best combination of components will be assembled from factory components, the rest of the construction being undertaken locally.

Work in Britain was started to meet the needs of their increased school population. It resulted in recommended standard sets of structure components, window units, roof decks using skylights, etc. In Europe O.E.C.D. reports on the Mediterranean Regional Project and the Development and Economy in Education Building designed to provide an integrated approach to educational development.

In the USA some California schools make use of subsystems for the structure, air conditioning, ceiling and lighting, and relocatable partitions, but report that there is still need for sophisticated architects who understand systems construction. Work in Florida has been directed

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at programming, preliminary design, contracts, bidding and construction approval and fast-track scheduling. They reported savings of 20% or more and efforts covered more than 20% of new construction in 1969. Other American systems have benefited from Canadian experience in pre-fabricated construction.

MONTREAL'S RAS (RESEARCH IN EDUCATIONAL FACILITIES) PROJECT

Canada undertook two internationally known programs, and others such as work in New Brunswick which are not so well known. Toronto developed an open building system, while Montreal operated essentially a closed system which was expected to become more open when established and operating. In Toronto manufacturers of sub-systems must guarantee compatibility of their components with other sub-systems. In Montreal manufacturers bid as teams or consortia agreeing to supply components needed. This resulted in integrated research efforts by companies to meet performance specifications mandatory to tendering or bidding.

The Montreal Catholic School Board Study of Education Facilities was undertaken from 1967 on to meet a heavy demand for CEGEP institutions following the Parent Commission Report. Since technical requirements were to be standardized within reason it was felt necessary to: systematically analyze the essential functions of the school; relate these to school components; investigate interrelationships among the components; consider further integration and define technical criteria for all components. The system of bidding selected made it necessary for industries to coordinate

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their endeavour in prefabrication and partial prefabrication, thus orienting the manufacturing process and setting problems for them to find solutions. Adequate purchases were guaranteed to interest the manufacturers in research and cooperation.

The project was a team effort, interdisciplinary and representative of architecture, mechanical, electrical and civil engineering, education, economics and sociology. Some materials developed in the process have resulted in: 1. The development of a Code of Standards for Educational Facilities stating educational requirements in terms of technical data giving construction standards and a maintenance manual, 2. The formulation of an integrated Component Construction System, 3. Systematic use of modular coordination, 4. Planning of various component specifications, 5. Definition of a suitable construction program, 6. Standardization of materials and equipment, 7. Some unique methods for awarding contracts.

The Montreal system covered the following five components: the structure component (concrete frame but not walls, roofing or plumbing); heating-ventilation-cooling component; the ceiling-lighting component; the partition component; and, the electric-electronic services component. The structure was aimed to create large free spaces integrated with other components. The heating-cooling and lighting allowed for rezoning of corridors and other areas, and removable lighting fixtures. The partitions provided visual and acoustical separation free of electric equipment.

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TORONTO'S SEF (STUDY OF EDUCATION FACILITIES) 1966+

SEF is a major computer tested, open system, building project devised after examining the needs for conventional school buildings, relocatable facilities, and mixes of schools with other buildings. The program embraced: "The development of user requirements and specifications for elementary, intermediate and secondary schools; the development of a building system which offers total interior flexibility; the study of high-rise and mixed-use facilities for educational purposes; the study of short-term accommodation needs and the development of a system of relocatable facilities."

The building was divided into 10 sub-systems - structure, atmosphere, lighting-ceiling, interior space division, vertical skin, plumbing, electrical-electronic, caseworks, roofing, interior finishes, carpeting, gymnasium flooring, finishing hardware, blinds. There was concern for packaged air conditioning, long span structural framing, relocatable partitions, coordinated plug-in electric-electronic distribution networks and pogosticks, as well as fire alarms, clocks, telephone outlets, AM-FM receivers, computer terminals, etc. A four-foot long distribution box consolidates all interior electrical services within a 42 foot radius. They are located 60 feet apart.

In the Toronto system each sub-system must guarantee compatibility with the other sub-systems. This assures some degree of standardization. The schools produced may be either open plan, flexible or closed, and can be variable in size.

The planners found that students prefer to be active learners rather than passive recipients. Generally they preferred to work in library resource centres, in a space

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for cooperative teaching and individualized instruction, with flexible time tabling, and access for the community. They recommend the systems approach to ensure cost-beneficial construction both for construction and for upkeep over the years as well as servicing.

Evaluation of schools erected found the one-storey rectangular building most economical to construct with savings in walls, etc. The two-storey was next followed by mixed storey designs. For maintenance the two-storey building was best followed by the mixed and the one-storey. Again where land is high-priced, the two-storey used less followed by the mixed and one-storey. Over 40 to 50 years expenditure would be lowest for the two-storey, followed by the mixed and one-storey.

In looking at the direction and nature of changes facing the public education system, they found the schools functioning in a rapidly changing environment, and strongly recommended flexible facilities. In general they found that SEF had saved some 30% in costs, and there were notable savings in time to produce the building.

COST ANALYSIS - FOR BUILDING

Preliminaries and insurance - temporary supplies of water, electricity, insurance, etc.

Contingencies

Structural Elements

Work below ground level - - excavation, moving soil, planking stratting
- concrete & filling & membrane, service ducts, etc.

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Frame - - - - - - - - steel or concrete, or wood mortices in floors, bolts, grouting concrete cover to steelwork and dust covers

External walls - - - - -brick, stucco, insulation, etc.

Windows - - - - - - - -subframes, glass, ironmongery

Doors - - - - - - - - subframes, glass, ironmongery

Roof construction

Upper floor construction

Staircase

Partitioning elements

Inside doors

Finish

Wall finishes

Floor finishes

Ceiling finishes

Decorations finishes

Fitting

Cloakrooms

A/V materials, library

Furniture (built-in)

lockers, cloakrooms, cupboards, pin-up boards, chalkboards, blinds, curtains, library display, etc.

Plumbing

Gas, oil, electric installations

Heating and cooling equipment

Drainage

External - - - - - - playground and paved areas

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Omitted

fencing, gates and grounds equipment, flowerbeds, trees, roads, sidewalks, etc.

ON MODERNIZING SCHOOL BUILDINGS

Most of the school buildings in use today will be used for many years to come. Replacement would not be practical for all those which are found inadequate to meet today's education needs. A practical second-best alternative would be to see what can be done to modernize the building. This assumes, rightly or wrongly, that the staff have practical ideas for realistic changes, for the work should be planned by the board and staff.

What is meant by reconstruction? This can cover: (1) rehabilitation of schools, or of other buildings for school purposes; (2) remodelling or making over; (3) adding to or enlarging; and (4) face-lifting or changing the outward appearance.

When should remodelling or rehabilitation be attempted? Whenever the building is of good architectural design, is sound and was originally well built, meets safety standards and building code requirements. Thus the buildings should be structurally sound, be well located for schooling and be able to support new programs. Cost of modernizing should be less than 50% of that of a new building. Doubt should arise when two or more of the following are needed: major plumbing, heating, total electric wiring, complete roofing, basic structural changes and complete fenestration. School buildings normally last 40 to 50 or more years, modernized ones 20 to 30 years.

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Other factors to be considered for renovation are community sentiment, new land acquisition possibilities and costs, population composition change and dispersion, adequacy of light, space, noise, etc. Aging of buildings on the average requires:

first 20 years - small improvements, mostly heating, electrical, plumbing;

20 to 30 years - required maintenance, replacement of worn-out mechanical equipment;

30 to 40 years - mechanical equipment, roofs, exterior masonry, lighting, etc.;

40 to 50 years - deterioration, change in population density.

It should be noted that education inadequacies can occur at any time. Today buildings should be designed to use modern media; to house a resource-centre-library; to use chairs and tables, have carpeted floors where appropriate, etc.

Some changes to be considered:

1. air control - temperature, fresh air, odours, air filtration
   - cooling - heat loss and gain through walls, roof, etc.
     - use outside air below 55°F.
   - ventilation, movement of air, noise, etc.
   - air conditioning unit;

2. corridors - large corridors can waste space
   - can be used in elementary school, if wide enough for exhibits, etc.;

3. lowering ceilings in some older buildings;

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4. adding storeys depending on need, frame structure, price of land, etc.;

5. new wiring, adequate for newer media which require many outlets, storage, light control, etc.;

6. well integrated additions, a second storey, auditoria, classrooms, library resource centre, studio, darkroom, etc.,

   portable classrooms, mobile, semi-mobile and permanent;

7. classroom rearrangement for flexibility;

8. heating, lighting, classroom equipment;

9. additional insulation, etc.;

10. windows - may replace clear glass with tinted glass, add a glass layer or storm windows, shading devices;

11. inspect and recaulk doors and windows;

12. noise
    - want neither dead silence nor bothersome hum, roar or high-pitched noises
    - outside noise (double windows help)
    - inside noise - from other classes
      - from heating and ventilation
    - can use carpets, drapes, acoustic tile around perimeter of room, etc.;

13. colour of walls and partitions (see colour dynamics for various rooms);

14. need for more equipment and storage for new education methods inclusive of use of newer media;

15. comfort - combining many of the above and providing space for alternatives. It considers noise inside and out, colour of walls, equipment and storage, chalk and tack boards, and a resource centre.

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PROVINCIAL POLICIES REGARDING THE CONSTRUCTION OF SCHOOL FACILITIES

All provincial Departments of Education are committed to programs of school construction and some major cities have undertaken major programs to provide cost effective buildings. Provincial programs generally include: building regulations; procedures for building schools; regulations concerning grants, etc. These normally will provide guidelines, will have considered building codes, labour laws, professional registrations of designs, quality standards of materials and workmanship, etc.

All four Atlantic provinces are committed to programs of school construction. The financing of new schools is the total responsibility of the Ministry of Education in Newfoundland, Prince Edward Island, New Brunswick and Nova Scotia. Newfoundland and Nova Scotia leave maintenance to the local boards but help with major alterations. Prince Edward Island places responsibility with local boards. In New Brunswick local boards are responsible for minor renovations; the province looks after major changes and repairs.

In Quebec the education corporation reviews needs regarding facilities and equipment. Each district submits a proposal reporting existing equipment and facilities. The Ministry may approve and accept the proposal. The corporation arranges for the preparation of outlines and plans which are submitted to the Ministry. The corporation then calls for tenders, grants the contracts and supervises the work. It then takes legal possession of the facilities, and responsibility for their management, upkeep, etc.

For more than 10 years Ontario has been concerned with achieving flexibility in school facilities aimed at

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overcoming constraints of buildings on learning activities. It has adopted an open concept philosophy favouring demountable and folding partitions and barriers and other movable school structures. Because of population drop and shifts the sharing of facilities such as auditoria, gymnasia and swimming pools has been considered, and the development of community schools with specialized facilities such as health rooms for conducting public health facilities, swimming pools, day nurseries and libraries.

The Western provinces have provided regulations covering minimum standards for quality of construction, allocation of space, and suitability of accommodation and utilization by staff and students. Safety and comfort of teachers and students are considered. The Department must approve final plans and makes arrangements regarding meeting costs.

The Boards undertake the initial planning and design, set out educational specifications, refer these to architects after which bi-level planning with the Department is undertaken. The Departments provide advice and information to School Boards, undertake research in design and innovative practices.

HARNESSING THE POWER OF THE WIND

For centuries wind powered Dutch factories sawed timber, ground spices and dye woods, fulled wool cloth and pumped water to keep the sea out. Each day and night that the winds blew, the windmill sails turned and work went on. But just as sailing ships gave way to more controllable reliable steam and gasoline motors, so were the windmills replaced with steam, gas and oil. In North America thousands of windmills dotted ranch areas and farms, pumping water for

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horses and cattle, with a few supplying power for other purposes. But where they couldn't compete with cheap oil, steam, gas, the combustion engine gained ascendancy and many windmills became scrap metal. In the more isolated places they remained in use. Today however the pendulum is swinging back. With oil prices quadrupling or more and the supply of gas and oil, as unrenewable resources, running short in many fields, with the others having a limited supply, there is a renewed interest in harnessing the wind to meet some of our energy needs.

Consequently today scientists and technologists are looking for alternative energy creating devices which will utilize renewable resources and inexhaustible sources, for example resources such as trees that can be replaced, and water power that can be converted to readily usable energy forms. Among the relatively inexhaustible forms are the sun's energy, torrential ocean currents, the earth's heat and the wind. We have looked at solar energy and heat pumps. Now we shall turn to windmills, to consider whether they can do a job for us and whether at the present time they are economically feasible.

In Canada the National Research Council is conducting research in this area using wind tunnels and designing a variety of wind turbines.

In the USA there are currently fifty or more new major projects aimed at designing a wide variety of windmills and turbines, and interest is increasing in Europe. A new generation of windmills is coming on the scene. Some will resemble the old somewhat, but others are quite different. Back in the 1940's the most famous was a giant windmill on Grandpa's Knot, Vermount with two eight ton blades stretching 175 feet from tip to tip and capable of producing 1250 kilowatts of power, enough for 200 homes or many schools. Today the new are more ingenious.

Many of the new generation windmills look much less like the pinwheels children play with. They do not necessarily have oblique vanes or sails radiating from a horizontal shaft. But they still need a set of blades, an impetus to start them revolving, a housing which holds them in place and directs those where necessary at the wind, and has a generator which converts their momentum or kinetic energy into electricity which can be used or stored. Some predictions today foretell of skyscraping wind machines off shore having as many as 34 propellors which could light up a city; of vertical axis designs with two or three or more rotors; of turbines with skipping rope looped blades; of super speed turbines with aerodynamically shaped blades operating the generator from the hub, and many others. Just which one, or ones, from among these will prove to be most cash effective or popular is anybody's guess.

What are some of the problems as seen today? A few are the following but there are many others:

1. First is cost, capital cost and upkeep; with operating cost, life of the equipment, liklihood of becoming obsolescent, length of life, etc. Current costs could be cut considerably through mass production, but whether this could be enough to make the equipment cost effective is not known at present.

2. Second is location of the windmills. Already many countries have maps showing estimated average wind power available per square mile, such as produced by N.R.C. This map shows Kw/sq. mile figures for much of Canada indicating that P.E.I., part of the N.W.T., border areas in southern Saskatchewan and Alberta average 400, whereas

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the area north of Lake Superior and east of the foothills in Alberta average 100. No data are given for the Pacific coast.

Actually average wind velocity may be misleading since major storms, calms and periods without winds affect power generated differently. A steady wind speed of 11 m.p.h. for example will generate less electricity than if the wind blew half-time at 7 m.p.h. and half-time at 15 m.p.h. Power generated increases as the cube of the wind velocity; thus power from a 10 m.p.h. wind equals 1/8 of a 20 m.p.h. wind, not half. There are also practical limits to the number of windmills that can be located per square mile, the average power being about 200 KWH. Also the wind 30 feet up is much more powerful than the wind three feet above the ground. Finally there is the question of destructive storms. Today's turbines are generally designed to withstand winds of 100 m.p.h. with gusts of 130 m.p.h.

3. Normally an alternating current of 60 cycles per second is wanted and can be obtained through feathering the blades so that they will turn at the same rate irrespective of wind speed. This is difficult so that providing a generating system that keeps the current strength uniform appears to be a better solution.

4. Storage of electricity for periods of calm presents an expensive problem. Actually wind generated electricity can be fed into a network, to be supplemented by other generators as necessary which is a relatively cheap, efficient system. Storage of electricity may be done through using conventional batteries, giant flywheels, compressing air in caverns, or breaking down water into Hydrogen and Oxygen (since H_2 is violently explosive, witness the Hindenburg dirigible, that put an end to trans oceanic dirigibles, so

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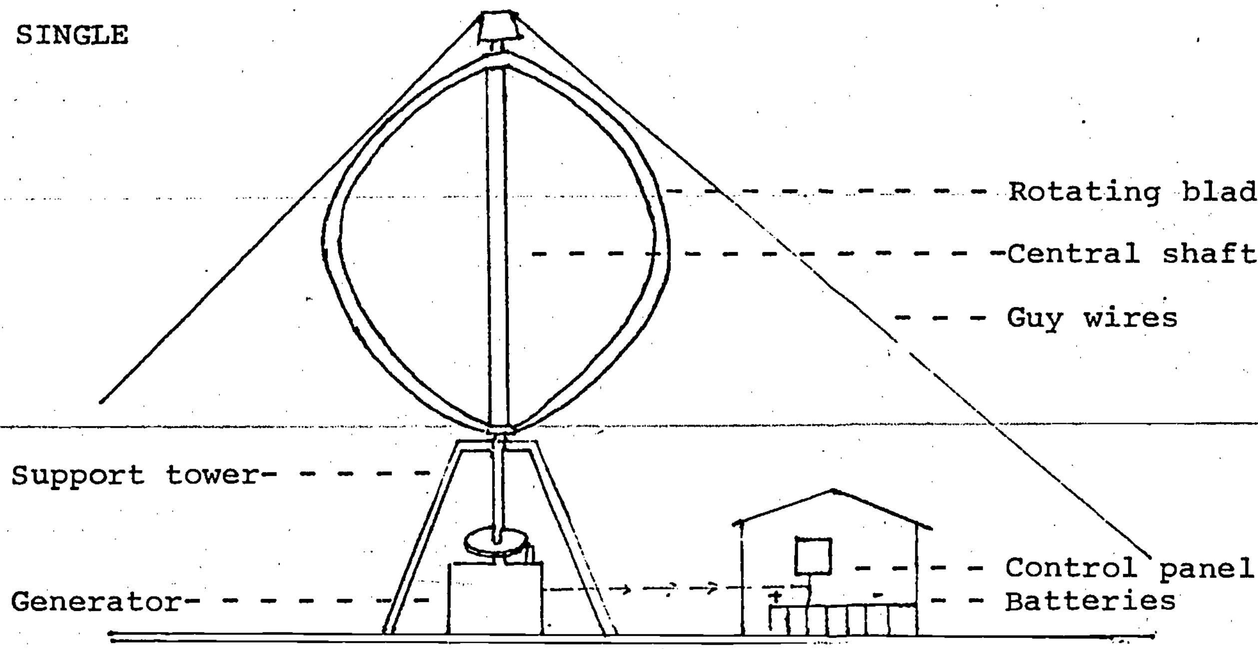
should only be handled under instructions). Windmills without storage could probably provide about 10% of power needed (this assumes some 200 - 400 generators).

5. Considering popular reactions to billboards, power lines, aerials and such, would they take kindly to mushrooming windmills filling the landscape, whether off shore, on the hills, on the prairies, in the back yards, above the schools, in the Arctic or elsewhere? Holland's experience has suggested they can be tourist attractions. Some skeletal structures are functional but not pleasing esthetically, but others are quite attractive. Or again there is the question of danger to climbing youngsters. These are problems, none of which are insurmountable.

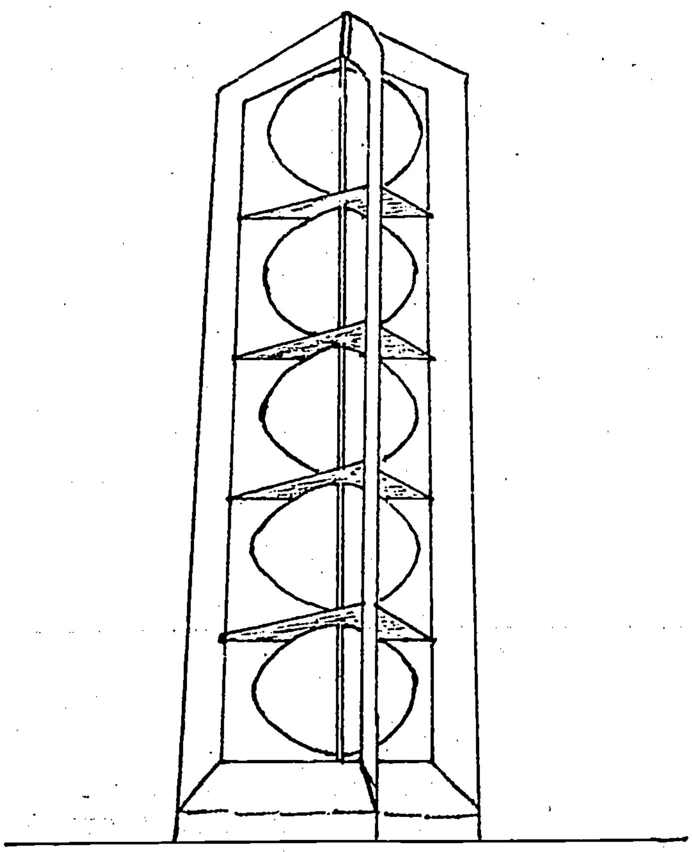
One cannot recommend without further research that, except under extraordinary circumstances, a school board decide to use windmill power as a source of energy for their school or schools. Location, average annual velocity of wind, average temperature outside for the school year are important considerations, as are ready availability of oil, gas or electricity and cost of these. However, one could recommend that pilot projects be set up in appropriate areas and subsidized. Selected schools should meet as high standards for insulation as for using electrical heating, adequate fenestration, weather caulking, etc., and should have auxiliary heating facilities to be used when needed. They should be carefully and fully monitored. Tomorrow the situation could change drastically with the need increasing. Today we should prepare for possible eventualities tomorrow by conducting pilot studies on which decisions can be taken.

ROTOR TURBINES

SINGLE



MULTIPLE



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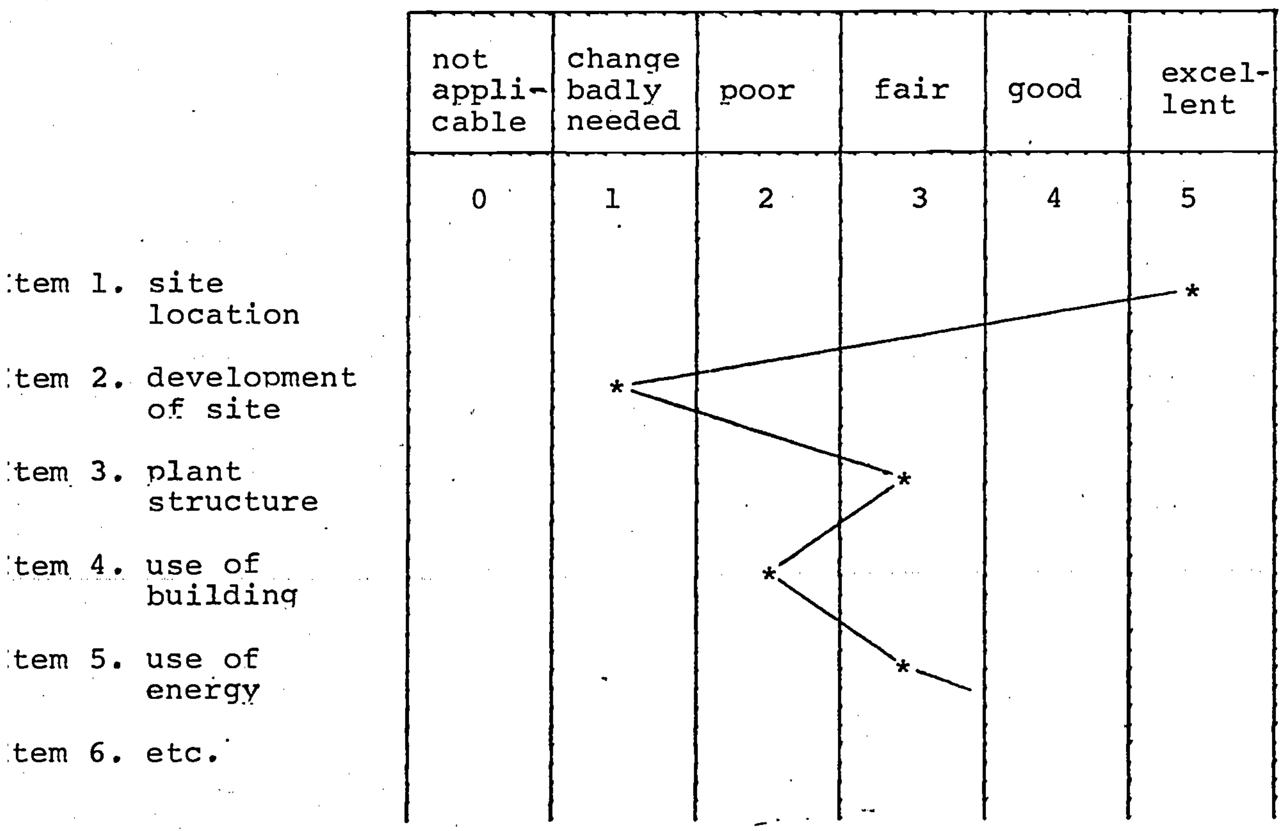
A CHECKLIST FORM FOR ASSESSING ADEQUACY OF SCHOOL FACILITIES

From time to time every school board should evaluate their school plant(s) to see what needs to be done: to conserve energy from non-renewable resources; to make the facilities more appealing to youth; to coordinate sources more closely with program; and, to consider alterations, repair, replacement, expansion or sharing.

The development of a check-form seems desirable. Each board should devise its own after consideration of item, detail, degree of sophistication needed and such. A simple form could list items, allow for 5 degrees of adequacy and allow for making a profile, e.g.,



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Some items which could be considered in developing a form:

1. The site:
   - (a) location - central, easy access, no air or noise pollution, etc.
   - (b) development - well drained, free of hazard, good landscaping
   - (c) use - sports, walks, recreation, bus loading, parking, etc.

2. The plant:
   - (a) adequacy of spaces for instruction, movement, relaxation, etc.
   - (b) use of spaces - full use of all, some seldom used, wastage
   - (c) design - good outside appearance and inside decoration, care adequate
     - suited to present program, use of media, etc.
     - flexible space, movable partitions, light movable furniture
     - adequate for administration, record keeping, etc.
     - adequate for storage, public use, first aid
     - safety, acoustics, outside and inside noises, etc.

3. Conservation of energy:
   - (a) insulation in ceilings and walls
   - (b) draft proof windows and doors, etc.
   - (c) weather stripping and caulking
   - (d) lighting adequate, fluorescent bulbs, light controls
   - (e) furnace care, humidity control, heating costs

4. Instruction and related areas:
   - (a) spaces for large groups, small groups, individual work
   - (b) business education, sound control, well equipped

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(c) art, ceramics, photographic facilities, tackboard, displays, darkroom, etc.

(d) vocational-technical wing, safety, storage, etc.

(e) science laboratories and classes, equipment, safety devices, etc.

(f) resource centre for a/v materials, reproductive equipment, studio

(g) library - stacks, storage, reading areas for groups and singles

(h) home ecomomics, cooking, dressmaking, design, display

(i) food service facilities (2 - 2½ sq. ft. floor space per person)

(j) music, equipment, recording studio, work areas, etc.

(k) auditorium facilities - stage, lighting, scenery, sound system

(l) gymnasium - floor surface and space, 24' ceiling, conduits, storage

(m) swimming pool - shower and locker facilities, team rooms, official size

Other:

(a) Provision for physically handicapped ramps, facilities, etc.

(b) Use and adequacy for pre-school activities, family counselling

(c) Use and adequacy for creative arts, teenage centre, etc.

(d) Use and adequacy for post school and adult courses

SUMMARY

This paper was undertaken in response to the general growing concern for the achieving of cost-beneficial school facilities at a time of increasing awareness of mushrooming costs, uncertain markets, and a world shortage of non-renewable energy sources that is expected to worsen. It was aimed at problems related to the construction of new school buildings, the remodelling and rehabilitation of older ones, and above all at the conservation and efficient use of energy.

In constructing a new school the purpose is generally to meet the needs of the community for one or more segments of the school population, providing a suitable environment in which the school program can function effectively. The building of a new school represents a 40 - 50 year investment counting original cost, upkeep and modernization. It also provides constraints on the program for that period, a limitation that is felt more keenly as the program changes.

Many board members never have the responsibility of monitoring the construction of a school from the construction of plans through to the grand opening. For others it is a once in a lifetime event, while for still others in larger centres it can be an annual undertaking. It is not surprising therefore that schools show both originality in some cases and yet reflect a great deal of sameness. The schoolhouse in any community may therefore be designated by the public chiefly as a landmark, pride of the citizens; as a functional environment; as an ordinary run of the mill utility; or even as a white elephant or grotesque monstrosity.

Those in charge of building projects face limitations

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and constraints from the preparing of plans; the selecting and preparing of the site, the providing of adequate sound control and audio-visual accommodation; to the providing of air conditioning where approved; heating and ventilation; carpeting and decorating; while staying within the amounts budgeted. They may also have problems in determining program goals and converting these to space requirements; and in forecasting future enrolments.

Before reaching the specifications stage, in considering cost effectiveness estimates should be made for original cost plus upkeep for the expected life of the building where initial cost is low but replacements and upkeep will be fairly high, as against higher original cost and lower upkeep. Inflation is a consideration in this.

A second consideration is that of determining available expertise for planning and construction, especially in rural areas. This may help determine the approach to use. Choices include: the conventional, where construction documents are prepared, open competitive building invited; or segmented bidding or alternative bids may be used. Other procedures include negotiated contracts with a fixed project cost, completion date, etc.; a turnkey procedure with the owner specifying what he wants and buying the building when completed; tendering following a general description, a purchase lease-back basis or leasehold where rent is paid for some 15 years, then the purchase made as agreed. Finally, but not least, is the use of a component systems approach (as in Toronto, Montreal or New Brunswick, etc.) where the selection can be made of the standard modular components which are mass produced in factories. This can provide for column free interiors, movable, flexible, operable and relocatable partitions, acoustic carpet, special lighting units, humidity control, air conditioning and electronic systems. This can shorten construction time, control costs, and eliminate or simplify some of the normal implementation tasks, e.g. engaging architects, formulating instructions for architects, checking designs and estimates, choosing building contractors, supervising erection, furnishing and equiping the school.

Today's demands are therefore for a building that is flexible enough to meet such changes in program as the extensive use of a resource centre and the newer media, with adequate wiring and outlets for projectors, radio, television, the preparation of films, cassettes, transparencies and other materials, and for movement for these and their storage. The building should provide adaptable structured spaces, flexible partitions and movable furniture for a variety of accepted methods of instruction and learning. In addition to functional design the building should have aesthetic appeal both outside and inside, should aim for comfort and safety, all these within the economic limits set. These provide a real challenge to the school board who at the same time must work to engender a feeling of pride in the school by the community and students. This can best be done by providing for involvement and some participation from the first. It is particularly necessary today because of the increase in vandalism and because of the spate of criticism of the schools from many quarters.

In considering rehabilitation of older schools it was noted that repairs and modernization of the schools should only be undertaken when they are structurally sound, and would last for another 25 years and meet program needs. When they will be used for 10 years or more consideration

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might be given to adding insulation, fenestration renewal, the adding of wiring and outlets, or providing carpeting and such, so long as the changes made are cost effective.

Emphasis was placed on conserving energy resources used in lighting, electrical appliances, air conditioning and such, in monitoring the oil, gas, or other heating system to ensure that it is operating efficiently, and that a minimum of heat is being wasted when the rooms are not in use, and in heating the unlimited areas outdoors. Maintenance check lists should be kept and regular service provided.

Heating is the biggest item in the energy budget, and in Canada during the school year keeping warm is more of a problem than keeping cool. All of this suggests we should keep the heat within the schoolhouse by bundling it up in a thick warm coat of insulation on the walls (R value of 14 or more) and a thicker cap over the ceilings (R value 20 or more); using custom fitted windows with double panes, but not single metal uninsulated frames (consider using security latches and unbreakable, unscratchable glaze for some windows to prevent vandalism); provide double, or storm doors, and weather striping and caulking around windows and doors; and keep the temperature at 20° C. (68° F.) when rooms are in use and lower otherwise with the air reasonably humid. All of these should not only help to provide suitable working conditions, but save energy and money as well.

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APPENDIX

PROPOSED NEXT STEPS

This report was accepted by the CSTA executive as were recommendations that further work in the area be undertaken. It was recognized that possible contributions of CSTA are largely contingent on money available and expertise. It was therefore agreed that efforts be directed towards preparing submissions to be forwarded to selected appropriate federal government bodies, foundations and corporations. Such proposals for funding could be of two kinds, the first would be requests for funds for fairly specific proposals for pilot projects in the construction of schools designed to conserve energy. One such project might be that of having an interested board conduct a pilot project to test the use of a heat pump in some locations where running or open water were available. A second would test a solar heating system with a stand-by reserve heating system. A third would be related to the use of wind turbines to produce some of the energy needed. Other projects would relate to the use of shared quarters, community-type schools, and portable facilities if and where feasible.

The second type of proposal would be that of a request for money, over three years, to establish a Policy, Program, Research Centre in Education within the CSTA offices designed to undertake work in areas selected or approved by the CSTA executive. School Facilities would have a top priority in the program. In addition work could be directed to the preparation of audio-visual displays in addition to the preparation of reports, and the promoting of innovative pilot projects.