BUILDING RESEARCH WORLD WIDE

Proceedings of the Eighth CIB Triennial Congress, Oslo, June 1980

Volume 1c

Key-note papers, invited papers and submitted papers

Edited by

Norwegian Building Research Institute

RECHERCHE MONDIALE DU BÂTIMENT

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PREFACE

This volume, of the proceedings of the Eighth CIB Triennial Congress, contains a few papers which arrived too late to be included in volume 1^a and 1^b.

We regret to inform you that at least the following two submitted papers in volume 1^a and 1^b have been placed under a wrong subject.

The paper of Dr. Sahap Cakin: "Use of the Feed-Back Information in Housing Appraisal" is placed under subject 4^C; it should be 3^C.

The paper of Dr. A. Alphan: On the Design of the Use and Discharge of Water in Building is placed under subject 4^A, it should have been 4^B.

We have also received correction from one author

The correction arrived too late for being made in the preprints in volume 1^a and 1^b, and are included in this volume.

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Volume 1c

LOCAL BUILDING MATERIALS - PROBLEMS OF IMPLEMENTATION

By Mr. Mwamila, B.L.M. Assistant Lecturer, University of Dar es Salaam.
and Dr. Mlingwa, G. Lecturer, University of Dar es Salaam.

Summary

Research on local Building Materials has a two-fold goal to achieve. First, it is the establishment of the material properties. And, second, is the communication of the research findings in a form that can be easily adopted for implementation.

In an effort to minimise the use of foreign currency on what can otherwise be obtained locally the Tanzania Government has greatly encouraged research on Local Building Materials. The positive response to this can be judged by the great number of proto-types in the close vicinity of the Building Research Unit (BRU) in Dar es Salaam and that of demonstration houses built by the same establishment in a number of regions in the country.

Two things need be done before a country-wide implementation can be initiated: People must be educated on the techniques involved. And, also people must be convinced about the socio-economic advantages of adopting the new technology.

In the paper, the authors make a presentation of some local materials being introduced for the building purpose in Tanzania. They then discuss problems and efforts to solve them in the implementation programmes. Amongst the materials considered are soil-cement, sisal-concrete sheets and, pozzolana and pozzolime.

INTRODUCTION

Better housing is one of the essential requirements of human kind. However not all can afford better housing for a number of reasons. The following are true for Tanzania:

- great escalation in the cost of conventional building materials
- non-availability of conventional materials or their constituent parts
- transport problem, and
- the level of skill required may be too high for the average person.

In order for the average person to afford better housing it is necessary that the building materials industry searches for "local" building materials least affected by most of the above factors. This in turn required that the material be "locally" available at the place most required to minimise the transportation constraint.

SEARCH FOR LOCAL BUILDING MATERIALS IN TANZANIA

Conventional building materials in Tanzania fall into two categories. Those commonly used in urban areas form one category and those in use in rural areas form the other. In urban areas building elements for walls, floors and footings often have sand, gravel and cement constituents in them. Whereas sand and gravel are natural materials, cement is a factory product which is inevitably expensive and very often in short supply. Cement is therefore a material the use of which is to be minimised. On the other hand, sand and gravel have to conform to a set of requirements for their use. It, therefore, means that in areas where sand and gravel are deficient, the materials have to be transported from elsewhere. These materials may therefore also require substitution in areas where transportation costs appear prohibitive.

Roofing for simple houses is commonly of corrugated iron, alluminium or asbestos sheets all of which are imported in one form or the other. They, therefore, involve foreign exchange in addition to escalating prices, non-availability and have finally to be transported to the places they are required. Substitution of these materials is therefore required.

In rural areas where about 95% of the population lives the conventional and rather traditional building materials include, wooden poles and mud blocks for walls and thatch for roofs. Here the main problem is the low and very variable quality and durability of the materials. Therefore quality and durability have to be improved for these materials without introducing the other problems. A search for new and better building materials is also required.

From the preceeding paragraphs it is clear that the new local materials should whenever possible be available in the close vicinity to the locality they are required. Amongst the new materials on which research has been made in Tanzania include:

- Cement stabilised soils for the substitution of cement stabilised sands.
- Sisal-concrete roofing sheets for substitution of metallic and asbestos-cement sheets.
- Pozzolana and Pozzolime for partial or whole substitution of Portland Cement.

CEMENT-STABILISED SOILS:

Research in cement stabilisation of soil has been intended to assess the feasibility of:

- substituting for mud and poles to improve the durability and easthetics
- substituting for concrete and cement stabilised sands to reduce the cost of the materials.

Substitution by cement stabilised soils would be most appropriate in sand-deficient areas. Where sand is abundant without trucking cement-stabilised sands can be substituted for mud and poles.

To meet the requirement warranting its use as a substitute research in the material has had two main objectives:

- to establish the material properties
- to work-out techniques for different construction purposes

Application of soil-cement in a house may include, the foundation, external and internal walls, floors and sewage and drainage pipes and linings. Soil-cement blocks are necessary for the walls and may be used in foundations. In order to form soil-cement blocks, either by hand or using the Cinva-Ram the soil has to have the following physical properties:

- easy friability upon drying
- easy compactibility
- little drying shrinkage
- sufficient cohesiveness

The first three physical properties fix the upper limit of fines content whereas the last property fixes the lower limit and the desirability of clay and silt content. Moriarty et at (1) has proposed the following rangesin the physical properties of the soil with the Cinva-Ram compaction:

- the soil should be inorganic sandy clays or clayey snads of low to medium plasticity.
- range of the silt and clay contents 10% - 45%
- range of liquid limit, 20% - 45%
- range of plasticity index, 10% - 25%

Results of an investigation on the type of soils found in Dar es Salaam has shown that most building sites possess the lateritic type of soil suitable for cement stabilisation (1). It is observed, further, that about three-quarters of the Tanzanian land is dominated by lateritic soils (2) and that the areas without laterites are around river, lakes and depressions where sands are readily available. It, therefore, means that cement - stabilised soils would easily be used in many parts of the country without significant transport problems.

The results of the tests carried out at the Building Research Unit in Tanzania (1) have shown the main factors governing soaked strength and durability to be:

- the compacted (dry) density
- the cement content and,
- the curing period.

The soaked strength varies linearly with the dry density. Moriarty et al (1) observed that compaction achieved using bush-poles was approximately the same as that achieved by the Cinva-Ram in the production of blocks.

The variation of soaked strength with cement is linear i.e. increases with the increase of cement content. However, the optimum cement content varies with the type of soil, more specificically the fines content. For 10% cement content and 1.90 gm/cc dry density the soaked strength ranges between 36.5 kg/cm^2 and 23.5 kg/cm^2 for the fines content ranges 10-20% and 30-40% respectively (1).

The soaked strength varies parabolically with the curing period. The strength - curing curves are similar to those from cement and concrete studies.

Before a decision to use soil cement is made, however, three consideration have to be made. These are:

- the suitability of soil for cement stabilisation
- the optimum cement content appropriate to the type of soil and use to which it will be put.
- the relative cost of soil cement.

SISAL-CONCRETE SHEET-ELEMENTS

Sisal is a cheap and abundant local material in Tanzania. The sisal fibre properties are adequate for concrete/mortar matrix reinforcement. The fibre strength ranges between 400 and 800 N/mm^2 (3). The main factor influencing fibre strength is the moisture content of fibre. There are a few short-comings of the sisal fibre which include (3):

- water-absorption tendency of the fibre
- dimensional instability
- susceptibility to deterioration
- low-modulus of elasticity

Except for the last shortfall, all the others are a direct result of the fact that sisal is a hygroscopic material. They, therefore, influence the durability of the material. The durability of the material has not been fully studied yet. The low-modulus nature of the sisal fibre does not very much affect its applicability in reinforcing sheet elements. When more structural bearing members are considered the low-modulus impairs the reinforcing ability of the fibre.

The technique used in reinforcing concrete/mortar employs either chopped or continuous fibres. The fibre incorporation in the case of chopped fibre is simply random mixing in a mixer. Incorporation of the continuous fibres is done by alternatingly placing the plain matrix and fibres in perpendicular directions. Test results (4) have shown that the use of continuous fibres yields products with better performance properties than those obtained from the use of chopped fibres. Improved post-cracking performance is registered in the former case over that of the plain specimens.

Proto-type studies have so far centred on roofing as an application area for the material. They have included roofing sheets of corrugated and open-trapezoidal shape, tiles and curves corrugated sheets. These have been done collaboratively in Sweden and in Tanzania. The results (4) revealed that it was possible to produce roofing sheets spanning up to 3.3m and the trapezoidal type was capable of supporting 10 health persons with an average weight of over 65 kg. One clear advantage over alluminium or iron sheets is the fact that little or no secondary construction is required to support the sheets. The curved sheets are intended to simulate traditional roofs in gogoland and hehelands in Tanzania.

Other than the roofing sheet, the sheet-elements can be applied for cladding panels and non-structural partitions. It is also possible to use sisal-concrete beams as lintels over window and door openings.

POZZOLANA AND POZZOLIME

Of the two classes of pozzolanas, the natural and artificial pozzolanas, research in Tanzania has concentrated on natural pozzolanas which are mainly materials of volcanic origin. Some examples of this materials include volcanic ash, pumice and certain types of laterites.

Pozzolana is a material capable of hardening when mixed with lime and water. It is this property which make research on its use as a building material attractive. The objectives include:

- the assessment of its ability to combine with lime to yield pozzolime
- the evaluation of properties of pozzolime stablized sands.
- the study of the properties of pozzolime stabilised soil and,
- the assessment of the quality of Portland-pozzolana cement.

Pozzolime is a mixture of lime and pozzolana which can be used as a substitute for conventional cement for a number of unreinforced concrete constructions. The proportion of lime to pozzolana can be varied from 1:1 to 1:3 by volume (5). The pozzolime thus obtain can be used to stabilise sand mixtures in lieu of cement to yield plaster or mortar. Addition of coarse aggregates to pozzolime yields a material appropriate for concrete or building blocks. Pozzolime stabilised soil can have as good strength properties as pozzolime stabilised sands. In this connection clayey soil has been found to have superior strength properties to those of sandy soil (5).

It has been shown that materials obtained by substitution of cement by pozzolime yield only up to half the strength of the cement-based materials.

They also exhibit poor wear resistance when compared to cement-based materials. The setting and hardening of pozzolime has been observed to be much slower than of cement and is dependent on the activity of the pozzolana constituent part.

For small scale construction, however, weather resistance is a more important parameter than strength, the adoption of pozzolime in building in such cases is therefore acceptable.

The volume of pozzolime needed to substitute cement is generally 2-3 time the amount of cement. Pozzolime can, however, be produced for only 20% the cost of cement (measured by volume). This results in a net cost saving of about 50% compared with the cost of conventional cement.

The partial substitution of cement by pozzolana yields pozzolana - cement. Here pozzolana is used to reduce the amount of cement content in the concrete. The research so far has shown that, the pozzolana constituent part in the concrete has negligible contribution on the final strength of the concrete (5)

Pozzolana - cement, however, has the following advantages over Portland cement:

- reduced heat evolution
- better resistance to aggressive environment
- may inhibit the alkali-aggregate reaction
- savings in the use of Portland Cement resulting from improved durability.

For small scale construction where durability is required rather than high strength, pozzolana-cement may be used to reduce costs.

IMPLEMENTATION

With the introduction of local materials, non-availability of material ceases to be a limiting factor and the cost constraint reduced quite considerably. With widerpread and cheap communication of the know-how to the people skill becomes less difficulty to acquire and the market value of hired labour drops. This underline three important stages towards the goal of better and cheap housing. These are:

- identification of and research on potential local materials
- dissemination of research findings to potential consumers
- training of personnel for and monitoring of the implementation.

It will not suffice to do research and stock findings in some library. Too few of the would-be consumers bother to visit libraries for the purpose. It is still inadequate in a number of cases to supply people or even institutions with the documents and hope they will proceed on their own. More is therefore demanded from the research institutions to ensure a sure take-off in the implementation.

Dissemination of research findings and recommendations:

It is important to distinguish between communication of research findings for implementation and documentation for future researchwork to base on. The former is supposed to be straight-forward and void of as many unnecessary technical details as possible. Information for implementation should best be directly communicated to the relevant bodies. Documentation for future researchwork is supposed to be technical and it suffices to stock the documents in libraries.

The medium of instructions in higher schools and colleges in Tanzania is English. There is therefore a big tendency of putting most scientific reports in English. This may serve the purpose well if the recipients are institutional bodies. But for the consumption by average person in the village the medium should be the country's lingua franca, Kiswahili in the case of Tanzania. The use of the radio is not adequate mainly because radio instructions are not illustrative. A well prepared TV - programme on the other hand can prove very helpful.

As part of the dissemination process, seminars to the recipients can be very helpful. Seminars can be organised such that both the necessary theory and practice are communicated to the recipients. These may be conducted at the research institute or at some appointed village or centre outside the institution.

Training of personnel by research institution

Training of personnel is another very important stage to ensure take-off of implementation. This may take two possible forms depending on suitability:

- "Fundis" (craftmen) report to the research institutions for training in the institution premises.
- The research institute sends "fundis" and technicians out to train people in appointed areas ("out-of bound" training)

The training programme has to be organised in a manner that by the end the recipients can:

- identify the appropriate materials on their own
- conduct the mixing of the different ingredients
- produce the building elements and,
- carry out the construction in the recommended manner.

This full training will enable the researcher to get a feed-back on some constructional and other practical difficulties on the implementation.

PROBLEMS OF IMPLEMENTATION

The implementation process starts with the dissemination of research findings and culminates in the acceptability and application of the acquired know-how. In the experience of Tanzania the problems involved here are three fold:

- those inherent with the dissemination process
- those associated with the training process and,
- those of monitoring the actual application of the techniques.

Dissemination Process:

The problems in the dissemination stage are dependent on the method employed. Publications intended for implementation are required to be simple and void of unnecessary technical details, nevertheless such jargon cannot be completely eliminated if the true meaning is to be conveyed. Secondly the medium employed in such cases is either English or Kiswahili. When English is employed the consumption of such publications becomes limited. On the other hand Kiswahili has not fully adapted itself to the technical vacabulary.

Organisation of the seminars also poses some problems. In cases where seminars are held at research institutions the number of possible participants is in most cases restricted to those in the close vicinity. On the other hand "out-of-bound" seminars face transport problem for the instructors. Ideally, seminars on a new building materials or techniques require to be accompanied by practical illustration or demonstration units. Any discontinuity in the process results in losses of morale and enthusiasm.

Conservatism among individuals also appears to be a leading problem. It is like a "Newton's Law" on social behaviour where people tend to continue with accustomed ways of doing things until and unless acted upon by an external force. The external force against this pessimism on new and local building materials may take the form of:

- clearly spelt out socio-economic advantage of the new venture
- encouragement in form of moral and material support to those who show interest.

For instance, in the case of materials mentioned in the previous sections the following advantages over traditional materials may be advanced:

- the improved durability
- the low-cost compared to the conventional materials
- the better easthetic appearance.

The help offered to those who show interest is also aimed at winning the interest of those in the neutral camp. This may entail training and helping to construct their own houses.

Training of Personnel

In the first case where interested individuals report at the research institute for training, the major problem is that of failure to meet financial support on the part of the trainees. This is particularly the case for the self sponsored and those sponsored by villages. On the other hand "out-of-bound" training include those cases where demonstration houses are built by the research institution. There are many such demonstration houses built by the Building Research Unit in Tanzania. Here the problems are mainly those related to the non-availability of materials. Although one of the main purpose of introducing new materials is to discourage dependence on cement for reasons of high cost and non-availability, it is not possible in a number of instances to completely eliminate the use of cement. This being the case work on some demonstration houses has suffered delays because of non-availability of cement. The other problem in regard to demonstration houses is connected to the fact that the demonstration house has to be put to use and is subject to critical scrutiny. What is otherwise torelable under normal circumstances can appear to be grave in this case. So more than normal care is taken during the construction. This makes them less realistic cases.

Monitoring the implementation

Monitoring the use of new building materials by private individuals presents problems especially in areas remote from the research institution. Effective supervision in these cases is impaired by the lack of enough personnel on the part of the research institutions.
The problem however, may be alleviated in cases where, housing schemes are organised at village or institutional level where collective supervision may be employed. On the other hand, lack of adequate supervision may lead to wrong application with negative results, an experi-

ence which must be avoided.

Application of all the three materials reported in this paper no doubt demand certain levels of supervision. In the case of soil cement, the assessment of the suitability of the soil for cement stabilisation and the evaluation of the optimum cement content requires expertise. In addition, the moulding moisture content, the level of compaction, as well as curing require to be monitored. The importance of pulverisation need to be emphasised.

In the case of sisal-concrete sheets there is a tendency of using too little fibre, less than the recommended 2%. Appreciation of the amount of the fibres as well as the method of incorporation of such fibres may not be so obvious to the initiated user. Due to poor nailability of this material, preformed holes are required to be provided for during casting, an operation which if not properly performed would lead to problems during mounting of the sheets. All these factors, demand proper supervision from skilled personnel if proper use of sisal concrete is to be realised.

Finally, in the case of pozzolana, the assessment of its activity demands some level of expertise and the importance of polverisation in enhancing the activity of pozzolana need emphasis.

CONCLUSION:

The need to search for Local Building Materials is necessitated by the prevailing World Economic crisis of which the developing countries are the greatest victims. Research alone does not alleviate the problem and is an incomplete process as a solution. Proper dissemination is paramount for the initiation of the implementation. The implementation that sparks off needs to be monitored to avoid wrong application which might lead to negative results.

The research institutions in developing countries should therefore be charged with the following tasks in addition to research:

- proper dissemination
- training of personnel and,
- monitoring of implementation.

This in turn entails that the share of research institutions in the government budget be adjusted accordingly to enable them discharge these additional duties:

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INNER CITY ENERGY EFFICIENT HOUSING PROJECTS IN PITTSBURGH, PA., U.S.A.

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INNER CITY/ENERGY EFFICIENT HOUSING

ABSTRACT:

Since 1975 the projects of the graduate, multidisciplinary program in Advanced Building Studies, Institute of Building Sciences, at Carnegie-Mellon University focused on energy efficient rehabilitation of low to moderate income neighborhoods. While the initial emphasis was on the rehabilitation and/or new construction of single buildings, the concerns gradually expanded until, at present, an entire neighborhood is under study as a national pilot project. This pilot project is funded by the US Department of Energy.

Results to date include the construction of a passively and actively heated solar row house, and plans for the reconstruction of an urban block. Currently in progress is an inner city case study and demonstration project. The following paper gives a brief overview of the housing situation of the United States of America, as well as a discussion of the projects at Carnegie-Mellon University.

PROBLEM INTRODUCTION AND BACKGROUND:

In the United States of America the initial decades following World War II were marked by pronounced population growth and unprecedented population movements. Steadily rising incomes, transportation changes, inexpensive - nationally abundantly available - energy, and federal policies encouraged urban sprawl. Furthermore, the advent of inexpensive, commercially available air conditioning enhanced the attractiveness of southern regions of the United States. Large numbers of middle class and affluent people started to leave the relatively densely populated north-eastern part of the US and moved south and south-west. Many of those who stayed, moved to the suburbs.[1]

During the 1950's and 60's, the inner cities were partially vacated by the middle and more affluent classes, and poorer people - many of them displaced by an increasing mechanization of farming - migrated toward the cities, predominantly the manufacturing centers of the north-east. These people lacked the means to maintain the inner city housing and commercial stock. Both migration patterns created large underpopulated areas subject to rapid decay. In these decaying neighborhoods a multitude of interrelated problems become apparent, including high crime rates, unemployment, deterioration of buildings and lack of services. While a variety of programs were designed and implemented to combat these problems, they could not reverse the effects of the underlying forces which created the situation in the first place; i.e., the exodus of the "White, Middle Class America" from the inner city neighborhoods.

The 1970's brought dramatic changes in the set of underlying forces. Three of these - personal income, cost of living, and energy - (before discussing them in greater detail below), can be summarized as follows.

Incomes were rising more slowly than before and, in many instances, barely kept pace with living cost increases. The housing cost increases outpaced the rise of median income by a factor of two. Inflationary pressures, by the end of the decade, have reinforced these tendencies. Perhaps most dramatic of all, "convenient" energy (derived from natural gas and oil) has become more scarce and costly and subject to increasing foreign control. In the late seventies, the US derived half of the required energy from oil and half of that was imported at rapidly escalating costs.

These trends, continuing in the 1980's make a re-evaluation of urban and housing policies imperative. The projects at Carnegie-Mellon University's Institute of Building Sciences are designed to investigate the potential for solutions.

EXPLORING THESE FORCES THROUGH PROJECTS:

Most recent developments indicate that these trends will continue during the 1980's, making a re-thinking of housing and urban policy imperative. The projects at Carnegie-Mellon's Institute of Building Sciences are designed to aid in this process by examining the feasibility of energy efficient, low to moderate income housing (through rehabilitation and new construction) for inner city neighborhoods.

PROJECT RATIONALE:

Following decades of urban sprawl, recent energy shortages and associated rising costs have stimulated extensive discussions about costs and benefits of alternative modes of living. Studies show that the US energy consumption breaks down as follows:

a) approximately 25% for transportation;
b) 19% for residential;
c) 15% for commercial (building servicing mostly); **and**
d) 40% for industry.

(Between 30-40% of the national energy consumption is attributable to the construction and operation of buildings).

Comparing population densities and energy consumption patterns of the US that are presently being achieved in alternate development schemes, the Real Estate Research Corporation, in Costs of Sprawl,[3] concludes that significant energy and capital savings can be achieved by constructing high **density** planned communities, instead of low density unplanned settlements. Among the many conclusions reached in Costs of Sprawl, the following are of particular relevance to the work discussed in this paper.[4]

1. Energy consumption, because of reduced auto travel, is eight to fourteen percent less in planned developments than in nonplanned developments.
2. Direct capital outlays for townhouses or walk-up apartments are approximately fifty percent of that of single family houses.
3. Capital outlays for utilities in townhouses and walk-up apartments are between one-third and one-half of those necessary for single residences.
4. Energy and water consumption in high density developments is forty percent less than in low density sprawl developments (reduced travel, reduced space heating demands and less lawn watering).

The number of households will continue to increase as the populations reaching the age of thirty years increases during the next decades.[5] It is predicted that the total number of households will rise by 11.9 million to 83.0 million during 1975-1985.[6] Where these households seek to locate, and, consequently, where investments will be made, depends, to a large part, on the future development of housing costs, the cost of energy and the relative attractiveness of existing neighborhoods and new developments. The following statistics give some insights into recent investment changes.

During 1970-1976, monthly ownership cost for median priced homes increased faster than median income and the consumer price index (median income and consumer price index rose by 47%, monthly ownership costs for median priced new homes by over 100%, those for median priced existing homes by over 73%).[7] As housing costs out-paced incomes from 1972 onward, expenditures for new residential construction increased rapidly before taking a substantial dive in the years of 1973-75.[8] However, remodeling expenditures increased steadily during the whole period, eventually reaching almost the same level as expenditures for new residential construction in 1975, approximatley 30 billion dollars annually.[9]

During 1970-76, the segment of US families able to afford median priced new homes declined from about forty-six to twenty-seven percent. In the same period, the segment of families able to afford median priced existing houses fell less rapidly, from about forty-five to thirty-six percent.[10]

Therefore, as costs for new housing increase more rapidly than for existing housing, and incomes are more rapidly out-paced by the increase of new housing cost than that of existing housing, remodeling becomes more attractive.

Providing useable space by extending the lifespan of existing buildings through remodeling and repair, instead of new construction, a trend indicated in the discussed statistics, has positive impacts on energy conservation. Remodeling is less energy intensive than destruction and new construction in respect to the energy content of materials and construction.[11] In addition, if energy conservation is an integral concern in remodeling and rehabilitation, then existing structures can be made more energy efficient. This would potentially save large amounts of the energy needed to operate the building stock.

The potential for energy conservation through rehabilitation and remodeling is much larger than the potential for savings through energy efficient new construction, since only 1.5 to 2.0 percents of the total building volume are replaced through new construction. And it follows that, from year to year, even if this new segment of the building stock would be a very efficient user of energy, the impact on the national energy consumption would be minimal.[12]

Thus, rehabilitating the inner city neighborhood housing stock, aside from many other benefits, can make a strong contribution to the conservation effort on several levels.

On the building level, energy efficiently rehabilitated buildings conserve valuable resources for construction and operation;

On the neighborhood level, energy is conserved by utilizing existing site and service facilities (e.g., roads, sewerage, power distribution systems, etc.);

On the urban and regional level, rehabilitated neighborhoods often prove attractive for middle and upper income groups who enjoy living close to work, thereby reducing urban sprawl and energy consumption in transportation; and finally,

On the national level, considering the sum total of all these savings, energy efficient rehabilitation might prove to be the single most promising conservation effort to be supported by the Federal Government.

As the trend to provide useable space through remodeling and rehabilitation is increasing, research and development is needed to generate information on how to integrate energy conservation into decisions affecting planning, design, construction and operation of rehabilitation projects. Research is also needed to establish how much energy could be saved through such efforts and how these efforts would affect industry, financial institutions, community organizations, and consumers, in order that federal policies can be formulated.

Incentives which increase the attractiveness of inner city housing are required so that the potential of energy conservation through rehabilitation can be realized. Past experience shows that policies that affect the availability of finances, the quality of local amenities (pollution abatement and the provision of cultural and recreational facilities, for example), and policies that affect the quality of schools will also lead to changes in the distribution of the urban population.[13]

Urban policies should be designed to channel a large segment of future homebuyers and tenants into existing, presently underpopulated neighborhoods, instead of encouraging the construction of new subdivisions or new towns. Since jobs follow people,[14] successful policies would contribute to the solution of 2 national problems: the problem of ailing cities and the problem of huge oil imports to satisfy an ever-growing energy demand.

These policies should be sensitive to the potential displacement of low income residents by inflowing; more affluent populations who rediscover the value of city life. Should the poor be displaced, as in such recent or current developments as Georgetown and the Capitol Hill District (both in Washington, D.C.), inadequate and energy inefficient housing for the poor will continue to plague the US at increasing energy and social costs. Policies should be designed to encourage the social integration of various income groups.[15]

DESCRIPTION OF CURRENT PROJECT: Inner City Case Study and Demonstration Project:

Presently the Advanced Building Studies team in the Institute of Building Sciences, assisted by a contractor, the City of Pittsburgh, and the Manchester Citizen's Corporation (Project Area Committee), conducts an inner city case study, leading to a demonstration project. The Inner City Case Study and Demonstration Project lays the groundwork for the redevelopment of an entire block in Manchester, a currently underpopulated, low income, inner city neighborhood in Pittsburgh. The Demonstration Project focuses on the following aspects:

- initial and future energy costs of the project;
- financial and economic feasibility; and
- cultural and social acceptability.

In the Inner City Case Study, the present energy consumption of selected households in Manchester is being established, and the potential energy conservation through retrofitting existing housing and construction of new units will be predicted. Initial energy investments, as well as operational energy consumption, are being predicted. The Inner City Case Study also entails the development of designs for the energy conserving redevelopment of an entire block in Manchester.

The demonstration will implement prototypical designs for infill housing and retrofit, and test the validity of the predictions made in the Inner City Case Study. The Advanced Building Studies team functions as consultants and will monitor the construction of the housing units. Construction is scheduled to commence late 1980 or early 1981, and will entail the energy conserving rehabilitation of existing buildings and the construction of new housing units on presently vacant land. A proposal concerning evaluation will be presented to the Department of Energy during early 1980.

Parallel to, and based on, the Inner City Case Study and Demonstration Project, workbooks are being developed. These workbooks are to illustrate the appropriate steps in the planning, design, construction and operation of an inner city housing block recommended to conserve energy. The workbooks are to be directed at planners, community representatives, lenders, developers, contractors, architects, engineers, homeowners, and residents.

The proposed Housing Case Study and Demonstration Project are also to function as a first stage of a study examining national implications.

PREVIOUSLY COMPLETED WORK: The South Oakland Solar House:

The 1976-77 project course of the graduate multidisciplinary ABS program at CMU, supported by a grant from the National Science Foundation, conducted feasibility and energy studies and developed designs for a passively and actively heated solar house for moderate income persons in a declining inner city neighborhood of Pittsburgh. In 1978 the Urban Redevelopment Authority of the City of Pittsburgh granted a Neighborhood Housing subsidy. Construction of the house was completed in Spring 1979. With US Department of Energy (DOE) funds, the performance of the lived-in house will be monitored for two years, starting Fall, 1980.

Significance of Project:

Many northeastern inner city neighborhoods are partially vacant. In such neighborhoods opportunities for increased energy efficiency exist because: 1) urban infrastructures necessitate continuous energy investments for maintenance (fully populated neighborhoods and, therefore, fully utilized infrastructures would likely reduce the energy required for maintenance per capita); 2) urban infrastructures require energy investments when being constructed (it seems therefore logical that instead of building new infrastructures for the 10-12 million new households, which are going to form in this decade, to increase the use of those presently existing); 3) increased densities in northeastern neighborhoods will result in more shared walls and, therefore, less heat loss; 4) the use of existing but vacant housing units will cut down on the energy required for construction; 5) densely populated inner city neighborhoods make public transportation viable; and potentially most important of all - 6) the majority of the urban poor live in partially abandoned neighborhoods. Most of their dwellings are energy inefficient. Energy conservation and solar utilization subsidies are by far preferable to consumption subsidies, since they will result in a deduction of energy consumption.

Description of Inner City Solar House:

Heating: The passive solar contribution is achieved by direct gain - through approximately 180 sq. ft. (net) of double pane windows on the south (dining area, living, bath, and master bedrooms) and isolated gain - through an attached sunspace (located before the kitchen on the south) with approximately 50 sq. ft. of double pane windows. Storage mass for isolated gain is provided by means of a 4" concrete slab located above rock bed (see active solar). For the direct gain system, the ½ wythe brick party wall, a water bed and water filled bottles in the railing of the living area will act as storage. All direct gain windows are protected against night time heat loss by rolling shutters (Rolladen).

The active solar contribution is achieved by 360 sq. ft. of air collectors, integrated into roof (no roof membrane below). Collectors: two panes of 1/8" glass, airspace, corrugated sheetmetal (flat black latex paint), airspace, metal trough, 3½" fiberglass insulation. Approximately 20 cu. yds. of rocks provide heat storage.

Backup heat is assured by a 32800 BTU/hr. electric furnace. Heat pumps would have been economically feasible, but because of first cost budget limitations, could not be applied (electric energy was chosen to avoid building a chimney and having stack losses). Hot water: no solar participation; electric only.

Total system performance will be monitored during 1980-81 with support of the US Department of Energy. Expected solar contribution is 70% - 80%.

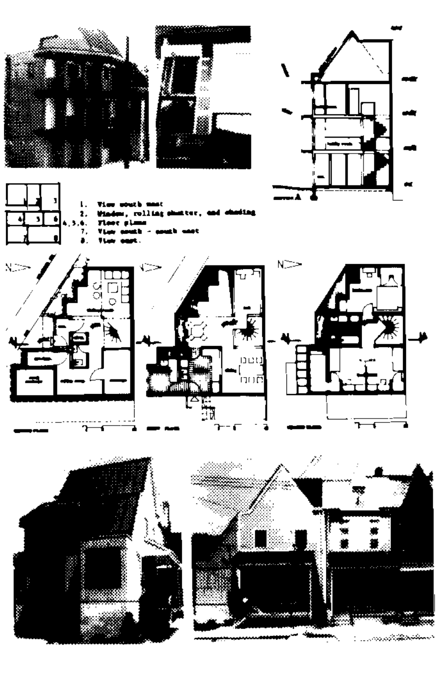
Acknowledgements:

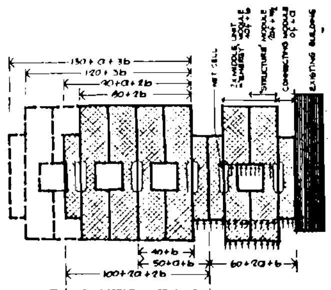
Community Human Services Corporation of South Oakland - community relations. Urban Redevelopment Authority, Pittsburgh - Neighborhood Housing Program Grant (construction subsidy). Tom Mistick & Sons, Inc., Developer, Builder. Fred Maolie, carpenter. Students and faculty of ABS program, feasibility and design studies. Stephen Kurpiewski, construction supervision.

DESIGN CONCEPTS FOR INFILL HOUSING IN MANCHESTER:

Design Goals:
1) To create prototypical housing for inner city sites which can be built: (a) as infill between existing buildings; (b) as separate structures on empty lots. 2) To combine dwelling units in order to create higher densities and reduce envelope exposure. 3) To more fully utilize existing, currently under-utilized urban infrastructures.
Design Concepts:
In response to these goals and in consideration of the fact that row houses are prevalent in northeastern cities in the US, the study focuses on the adaptation of the row house type to present conditions (i.e., users preferences, energy conservation, etc.) 1. "In-between" units and "end" units are major components of a row house development. Combinations of these generic types are to fit any potentially vacant "infill" lot size with a frontage not smaller than 40 ft.

SOUTH OAKLAND SOLAR HOUSE





* The center unit with a frontage of 20 ft. to 24 ft. and a floor area of 1200 to 2400 ft^2 (2-4 bedrooms).
* The end unit (or connecting) unit with a frontage of 10 ft. to 14 ft. and floor area of 500 to 900 ft.^{2} (efficiency/studio).

Figure 1. Building Modules

2. Solar gain during winter months is to be encouraged while preventing heat loss.
* Creating a two tiered south facade for direct gain; integrated heat gain components and a light shaft at the center.
*Lowering the height of the north facade by burying part of first floor in the ground.

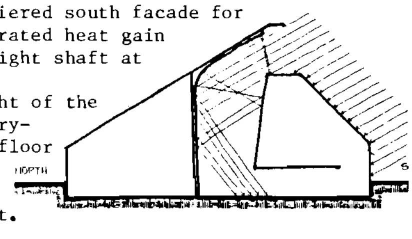


Figure 2a. Section Through Light Shaft.

* Minimizing the envelope facing north by slanting the roof.
* Minimizing openings on the north facade.

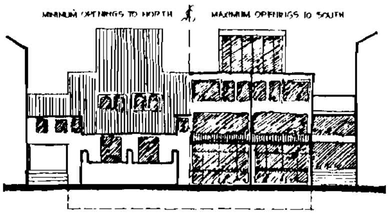


Figure 2b. The Difference Between North and South Elevations.

This proposal addresses a general short-coming, characteristic for units with narrow frontages which reduce the exposure to natural light and solar radiation. 3. New buildings are to be kept in scale with neighboring ones in order to maintain or encourage historic continuity.
* The formal composition of components of existing historical houses can be addressed by examining the original uses and finding new uses of such components. For example: greenhouses attached to the southern facade of a new building can take the place of porches on existing structures.

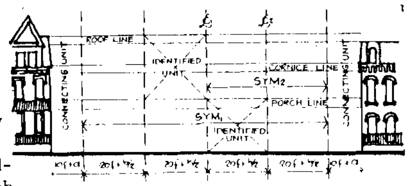


Figure 3. Elevation Morphology

Roof appertures can take the place of dormers, etc.

4. User needs and preferences are to be an integral part of the design. Preliminary design alternatives following the design concepts present expected needs and preferences such as:
- attitude toward private and public spaces
- attitude toward independence of residence
- variety of dwelling unit types
- potential for manifest personalization
- inclusion of familiar residential images and patterns
- inclusion of 'congenial' energy efficient solutions.

5. Integration of structural and energy building components are to be preferred.
* Creating building components with multiple functions such as floor and wall components which are loadbearing and store/distribute solar heat gain as well. (This concept was developed by Architect Santiago Moreno, a member of the 1978/79 ABS class.

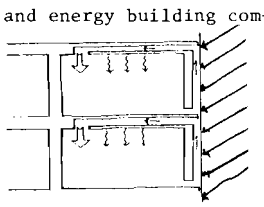


Figure 4. Conceptual Section.

6. Efficient utilization of internal heat generation ("free heat") from lights, appliances and people by judicious layout.

* Kitchens and bathrooms located to the north side of dwellings as a buffer zone and heat generator.

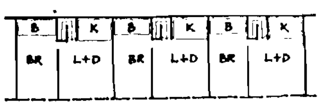


Figure 5a. Kitchens as Buffer Zones

* Kitchens located in the middle of the dwelling as heat generators, with provisions for ventilation during cooling periods.

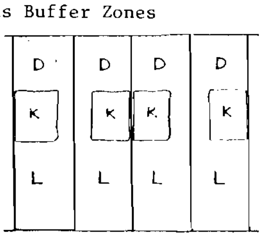


Figure 5b. Kitchens as Heat Generators

Discussion of Alternatives:

Based on design goals and concepts, two alternatives were developed in response to different expected users' preferences. In both alternatives, however, all dwelling units are connected to the ground, face south and north, and provide a variety of design options to be chosen by future owners.

Alternative I includes a shared semi-private space on the ground level as the access spine of the building. It is used as a protected area (from outsiders and climate) in front of individual entrances. Natural light is provided by the light shaft.

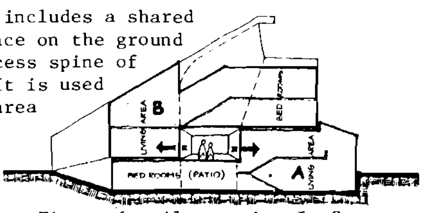


Figure 6a. Alternative I, Conceptual Section

Alternative II has separate external entrances from street level on both facades.

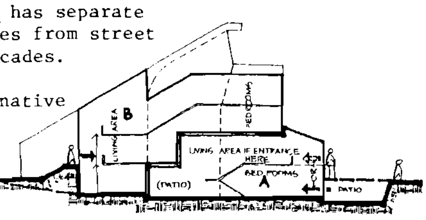


Figure 6b. Alternative II, Conceptual Section.

Dwelling Variations:
In both alternatives, 2 dwelling types, "A" and "B", are developed to overlap each other (emphasis on design concept No 3 and design goal No 2). The main differences between them centers on open space allocation. Dwelling Type "A" includes an inner patio (under the light shaft) and greenhouse/porch to the south (which is the entrance area in alternative II). Dwelling Type "B" includes an open veranda and yard to the north (entrance area in alternative II) plus a roof area.

Other Variations:
(1) Size: Dwelling "A" is fixed in floor area (1280ft^2 2-3 bedrooms). Dwelling "B" has the possibility for future expansion and different ways of using the roof area (1260 ft^2 to 1640 ft^2, 2 or 3 floors, 2 to 4 bedrooms). (2) Flexibility in Using Space: "A" is developed differently in alternatives I and II, giving the possibility of entrance/living space and bedrooms to be located in different levels. "B" takes advantage of its "growing potential", but living area and bedrooms are fixed in location. (3) Entrance and Parking: Alternative I provides the same conditions for all dwellings: shared space in front of individual entrances and shared parking lots on one side of the site. In alternative II, parking lots are placed in conjunction with entrances. In the "Manchester Project", dwelling "A" has a more formal entrance from the main street, but uses street parking, and dwelling "B" has a less formal entrance facing the alley, but has private parking as part of its front yard or a protected garage underneath the first floor level.

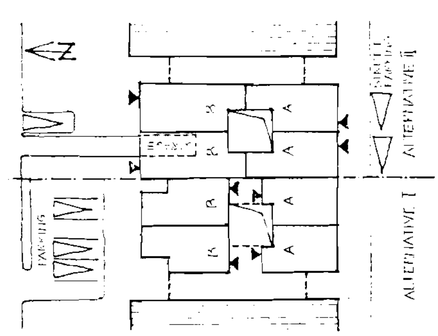


Figure 7. Conceptual Site Development

(4) Energy Performance: "A" is potentially more energy efficient than "B", since dwelling "A" is protected by being partly below ground level and sheltered from the north (partly in alternative I, entirely in alternative II) by dwelling "B".
Final design will be developed after energy evaluation (a result of the "energy taxonomy", see following part of paper) economic studies and interaction with the potential users.

Passive Energy Taxonomy/Abstract:

Purpose: As part of the analysis for the design project, the "energy" team's goal is to organize an energy taxonomy for selecting a number of effective passive energy patterns according to their predicted energy performance in the Pittsburgh area. Each pattern, as part of the design concept, will then be combined with and evaluated according to other aspects specifically for the Manchester community such as users' needs, structure, economics and marketability, in order to achieve feasible energy efficient solutions for the "Sheffield block". Method : A passive energy taxonomy chart for the heating and cooling seasons was conceived, based on climate analysis, human comfort considerations and generic energy types. The energy patterns can be formulated and/or classified by alternating the combinations of the generic types with all or part of the possible components. Theoretically, every combination has to be evaluated. However, a selection method will be developed for helping eliminate the unnecessary combinations. Tools: Three main tools are used. 1) The Psychrometric Chart, which summarizes climate data in a specific area, showing the distribution of wet bulb temperature, combined graphically with dry bulb temperature, resulting in "clusters" of climatic conditions in a range of 12 zones from "cold" through "shade comfort" to "hot". The seasonal distribution for day and night stresses the main problems which have to be taken into consideration. 2) The Passive Energy Taxonomy Chart is developed and organized as a tool for describing existing energy patterns and creating new ones as well as a combination of various components. The patterns are "created" in two main steps: first, by means of a combination of the heating season components (starting from two basic solar heat gain types: direct gain and indirect gain) and the different possibilities for heat-gain promotion and heat loss prevention, becoming the "winter patterns". 3) Evaluation/Simulation Models are used for the selection of the best energy patterns for the Pittsburgh area, which were described (or created) by means of the taxonomy chart. Since results of every pattern depend on the components' combinations and its position in the building, "a basic building" which is divided into nine modules (3 stores x 3 units per store) is used. The modules have the same volume but different envelope exposures according to their mutual positions. Every one of them describes a possible unit in an apartment building. The "TRYNSYS" computer simulation program was chosen as the primary tool for evaluation of the energy performances. Results: 1) The general passive energy taxonomy, as a structure of describing, combining and manipulating building and energy and climatic components ends up with a table of passive energy patterns. 2) The computer evaluation of these patterns yields a more localized list of the most satisfactory energy patterns, prioritized according to their energy performances. 3) These patterns will then be an input to the design process which combines all other aspects in the project and which leads to the final product, in this case - energy efficient infill housing - a prototype for the Manchester community in Pittsburgh.

"TRYNSYS": A Transient Simulation Program, Solar Energy Lab, University of Wisconsin-Madison, Madison, Wisconsin. (Version 10.1).

CONCLUSIONS:

The United States are at a crossroads regarding energy consumption. Currently energy consumption per capita in the US is about twice as high as in other industrialized countries with similar per capita industrial production and standard of living (Switzerland, Federal Republic of Germany, Sweden, etc.). The reasons for this are complex and have many facets. One reason, however, is seen in urban sprawl. During the decades of cheap energy, economic expansion, federal policies favoring suburban construction and highway building, society became increasingly segregated (separation of income and social groups) and cities increasingly dispersed, with the ensuing result of low density suburban developments and the decay of formerly densely populated inner city neighborhoods. Energy conservation can be achieved by reconstructing these neighborhoods and creating additional housing capacities on formerly vacant land or by rehabilitating vandalized buildings. This should be approached by including the present low income populations which reside in these areas, rather than displacing them and thereby displacing the problem. To aid in this effort is the primary goal of the urban projects at Carnegie-Mellon University.

FOOTNOTES:

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Building services installations and energy saving

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Summary

In the industralised nations building services consume each year more than 40% of the total primary energy consumption. Possible developments in building services are discussed, in partic lar those for space and water heating by traditional means and newer developments such as heat pumps and solar collectors. A brief discussion is given of future possibilities in lighting and ventilation. It is concluded that there is a great need for flexibility in future building services to take account of the likely changes in fuel supplies over the lifetime of buildings.

Le Résumé

Parmi les nations industrialisées les services du bâtiment consomment chaque année plus de 40% de la consommation totale d'énergie première. On discute les développements possibles en services du bâtiment, en particulier ceux de chauffage d'espace et d'eau par moyens traditionnels et plus nouveaux tels que pompes de chauffage et collecteurs solaires. On considère en bref les possibilités futures d'éclairage et de ventilation. Pour conclure, il y a grand besoin de garder la possibilité de changements de services pendant toute la vie d'un bâtiment selon les combustibles disponibles.

Introduction

Figure 1 shows the World primary energy consumption in millions of tons of coal equivalent so far this century (1), in terms of the overall supply and the individual fuels. Figure 2 shows the project World energy demand for the next 75 years consistent with the low energy growth case (barely doubling between 2000 and 2050) put to the 1977 World Energy Conference (1). This has many important consequences since the world population is also expected to grow over the same period leading to only a small energy growth per capita. Currently the Western Industrialised World with less than 15% of the World's population consumes more than a half of the total energy demand (2). The greatest growth in energy consumption is in the countries with currently less than average consumption per capita thus if the currently non-industrialised nations are to gain economic strength and the projection in fig 2 is achieved, the per capita consumption of today's major consumers must fall.

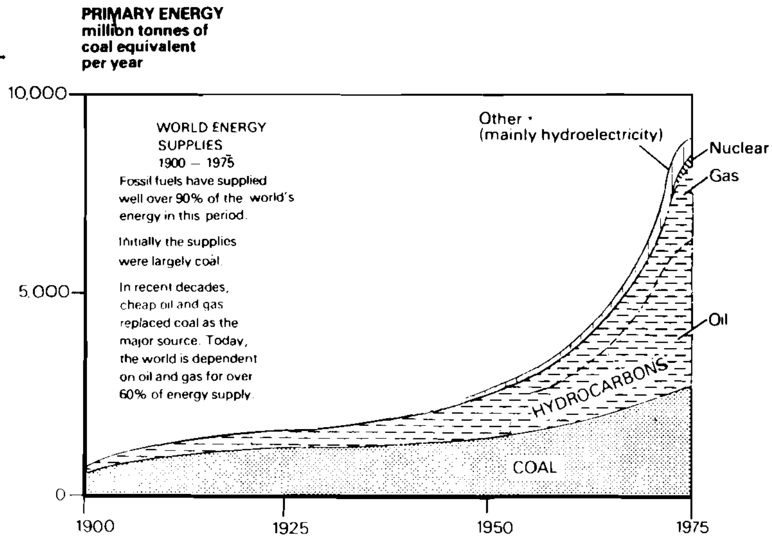


Fig 1 World Energy Supplies - The 75 Years 1900-1975.

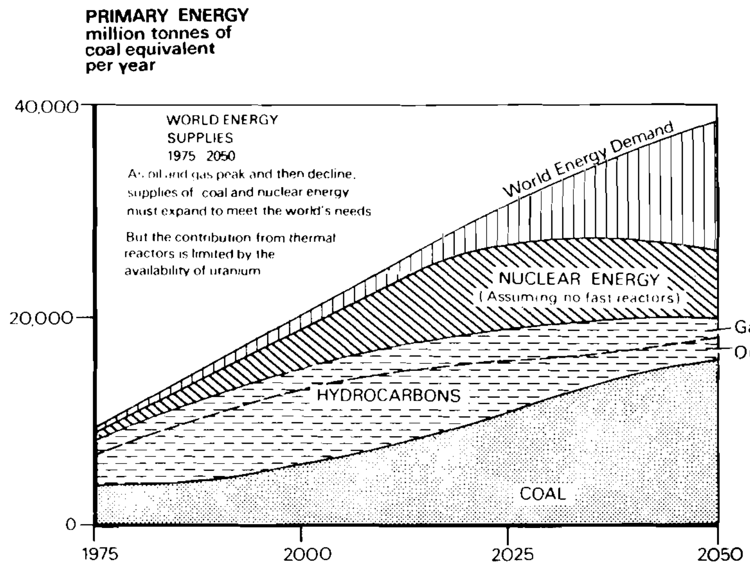


Fig 2 World Energy Requirements - The 75 Years 1975-2050.

It is not the purpose of this paper to discuss all the important economic, political and social consequencies that will follow from the World energy demand and supply situation as outlined above, but to consider only the consequences for building services. Building services for heating, cooking and lighting account for at least 40% and in some countries more than a half of the energy consumption in industrialised nations. Reducing the energy consumption has a large role to play in reducing the enormous pressure on energy supply to come, shown in Figure 2. Dr Guido Brunner, the member of the European Community response for energy has recently said "I firmly believe that our top priority must be in the reduction of energy demand.

It is clear to me that energy saving can make a larger (and cheaper) contribution to our needs than can action on supply. Of course, we must make the correct decisions on long-term investments for production. But the scale and glamour of new oil production or advanced nuclear engineering sometimes detract from what is more important now: by this I mean energy saving. This is the key to our problems. It should be given priority at all levels - Community and Local, political and technical." (3)

The emphasis towards energy conservation rather than energy supply arises because increasing demand on limited resources is leading to real (in relation to general inflation) increases in fuel supply costs. This paper discusses how more efficient building services could lead to significant reductions in energy demand.

Building lifetimes are long, for example houses typically last for more than a 100 years in many countries. This has an important consequence for building services. It can be seen from Figures 1 and 2 that the relative availability of different fuels has changed dramatically in the past and is expected to similarly change in the future. The design of services must reflect the likelihood that in the future energy will be a costly and more prized commodity, whose final delivered form may not always be predicted now with certainty. Strategic design must therefore search for flexible and adaptable solutions which will not cause the building in the future to become a costly white elephant.

New and existing buildings clearly require different analysis and different treatments. In existing buildings the time at which to take action to reduce energy consumption is when that action first becomes cost-effective. In new buildings it is necessary to consider action at the design stage because action later can be much more expensive. An example is the extra expense involved in the introduction of an underfloor low temperature heat distribution system compared with a conventional radiator or warm air system. The cost is less at the initial stage than later on and may be worth the extra initial cost as an insurance premium, to make possible the later introduction of an ambient energy device such as a heat pump or solar collector system.

One important point in common to the use of energy conservation measures in both the existing and new buildings is the need for assessing the building and its services as an integrated system. For example adding insulation to an existing building without considering changes to the heating system can lead to temperature redistribution and waste. Thus there is a need to integrate the thermal performance of the building fabric and its services in assessing energy consideration measures.

The availability of cheap microprocessors opens up the possibility of more sophisticated and efficient control of building services, particularly those which consume energy such as the heating and cooling systems, the artificial lighting, the lift services and the heat management systems in complex buildings which may involve heat storage, energy supply at off peak times, solar collectors etc.

A final point before turning to more detailed aspects of building services is that the cause of poor energy performance of many buildings can be traced to what are sometimes called institutional issues, such as an over emphasis of first costs

and inadequate allocation of funds for building service maintenance. Means need to be sought to overcome these institutional barriers, though experience argues that this may take a long time, and in the timescale of depleting possible fuel resources it may be necessary for the designer and research worker to seek energy conserving solutions which are not undermined by existing institutional constraint.

Future building services

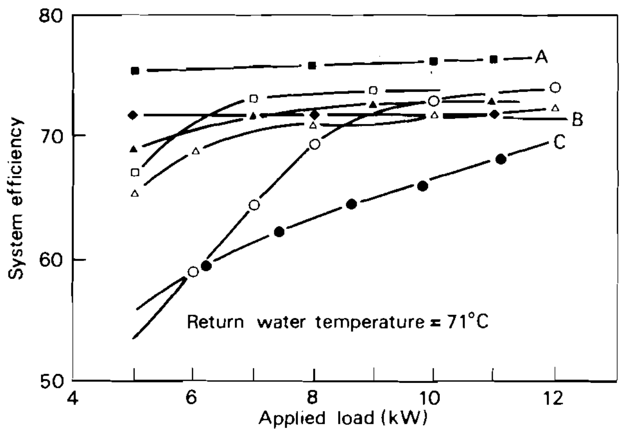
It is clear from figure 2 that there is expected to be a role in the next 75 years for a wide range of fuel supplies, wider even than in the past 75 years. This means that we must not only consider the performance of the newer ideas - solar energy, heat pumps etc but we must not neglect the traditional methods of heating buildings, despite the current tendency to emphasise in research the more glamorous energy supplies and means of conserving energy.

Traditional building services

At one time it was considered sufficient to design heating appliances to have a reasonable efficiency at full load under steady state conditions. Tests of this nature are incorporated in the standards of many countries. This is no longer adequate if the minimum fuel costs are to be achieved. In moving from bench tests to the real situation four factors have now to be taken into account: (i) sizing of the heating appliance and system with respect to the demand; (ii) appliance operation over the full load range; (iii) heating system design and controls and (iv) mode of operation by the user. All these factors have been made more critical and interactive by moves towards high insulation standards and reduced ventilation.

Fig 3 gives the results of some recent (4) laboratory tests on gas boilers on a wide range of commercially available appliances. The full load test showed all the boilers passed the 70% minimum efficiency test (based on gross heat input), but the design of the boiler markedly affects the performance at low loads. The main design features are the thermal mass of the boiler, its water content and its control. The best results were obtained when the effective thermal mass was low as typified by two very compact lightweight appliances A and B. The efficiency of these boilers does not fall until low output levels are reached. With a heavy cast iron boiler, C, with a high water content, the efficiency can fall off significantly. During its normal operation in a dwelling the boiler operating point ranges up and down a set of efficiency curves. The curves shown in Fig 3 will be displaced by the design factors of the system and the dwelling. This is brought about by the constantly changing temperature of the return water observed in practice. During each operational period the frequency and length of firing periods can have an effect even with a constant heat output. If a boiler is oversized for a particular application the implication is that it operates on the lower part of the performance curve for a longer period than the correctly sized boiler.

It is feasible that fossil fuel powered boilers will in future operate with much higher efficiencies, more than 90% efficiency is possible with condensation of flue gases and from pulse-fired combustion. Such high efficiency boilers are under investigation in several laboratories around the World and may reach the market place soon if costs do not turn out to be prohibitive.



	Output (kW)	Bench efficiency	Mode of operation
—■——■—	8·24	75·6%	On/off
—◆——◆—	14·7 – 4·7	76%–76%	Modulating
—▲——▲—	14·7–5·0	77%–75%	Modulating
—□——□—	14·7	77%	On/off
—△——△—	14·7	74·7%	On/off
—○——○—	16·0–10·0	79%–73%	On/off
—●——●—	11·72–8·8	74% – 71·5%	On/off

Fig 3 System efficiency v. boiler output.

Heat pumps

Applications of heat pumps in buildings can be divided into two categories. First, there are those in which the heat pump extracts energy from an ambient source and provides useful heat to the building thereby requiring a smaller consumption of processed energy (e.g. electricity) than comparable conventional heating systems. The energy supply to these ambient sources is the sun since the contribution from geothermal heat is usually negligible. In the second category, heat pumps are needed to upgrade heat within the building envelope in heat recovery applications.

The sources of ambient energy normally used are the ground, running water and the air. The only one of these widely available which could supply the energy demands of large numbers of domestic heat pumps is the outside air. For this reason, most research effort is being concentrated on improving the performance of this type of heat pump, in particular on the efficiency with which energy is extracted from the air. In the USA such machines have been sold in large numbers because, with a reversal of the refrigerant cycle, one device can provide either heating or cooling of the building. This dual function is not required in most potential applications in Western Europe and many experimental prototype machines and new products are being evaluated and beginning to be sold, with rapid market growth apparently beginning in Germany and in Scandinavia, noteably in Denmark.

Present domestic heat pumps can produce between two and three times as much energy for heating as is required to drive them, the ratio depending upon the temperature of the source medium. Heat transfer is normally accomplished by warm air since this allows the lowest output temperatures and best performance. Water-heating heat pumps are being developed since these allow a greater flexibility in installation and heat pump systems using radiators could then be installed in existing buildings which would be more difficult to convert to warm-air central heating. The water temperature will necessarily be lower than in a conventional radiator so extended surfaces or fan convection will be employed. In purpose-built houses, underfloor heating would allow an even lower water temperature to be used. This aspect has already been mentioned as a general aspect of new building design opening up the possibilities of retrofitting heat pumps if and when their cost falls sufficiently to justify their installation in comparison with the currently cheapest alternatives.

As in most refrigeration appliances, the heat pumps in use today are based on the reversed Rankine cycle. Future developments will see moves made towards other thermodynamic cycles, especially the absorption cycle (employed in gas refrigerators) and also towards Rankine, Brayton or Stirling cycle heat pumps driven by combustion engines. These have the advantage that the utilisation of primary energy is better than in an electrically driven Rankine cycle machine.

However, the scope for heat pump applications is by no means limited to their use for space and water heating and examples of other potential uses for heat pumps are to be seen in three experimental low energy houses that have been built at the Building Research Establishment (Fig 4). All the experimental houses have greatly improved thermal insulation, accounting for much of the energy saving. Each will incorporate a different energy handling system and are designed individually around concepts utilising 'heat recovery', 'solar energy' and 'heat pumps'. They are now being instrumented and their performance measured under controlled conditions and simulated occupancy. Their calculated energy savings are of major significance (5).

Fig 4 View of the south face of the BRE low energy house laboratories.

Figures 5, 6 and 7 show respectively the services systems of the "heat recovery", "solar energy" and "heat pump" houses and it can be seen that heat pumps feature in all of them. The application of heat pumps range from heat recovery from waste water (fig 5) and ventilation (fig 6) to heat management of a store of solar heated water collected in summer and used in winter (fig 7).

Thus the scope for heat pump applications is immense and the world wide research activity reflects this. CIB is playing a part in keeping research workers up to date in this field through Working Commission, W 67 'Energy Conservation in the Built Environment' which has a Technical Sub Group on Heat Pumps.

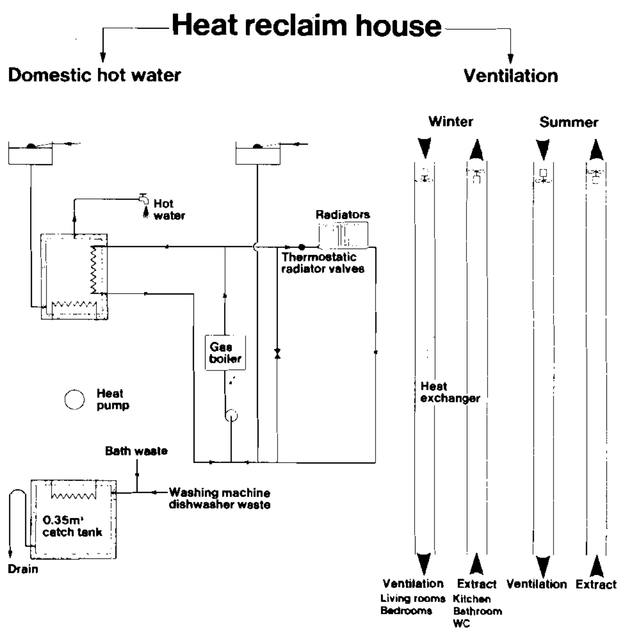


Fig 5 "Heat Reclaim" house laboratory.

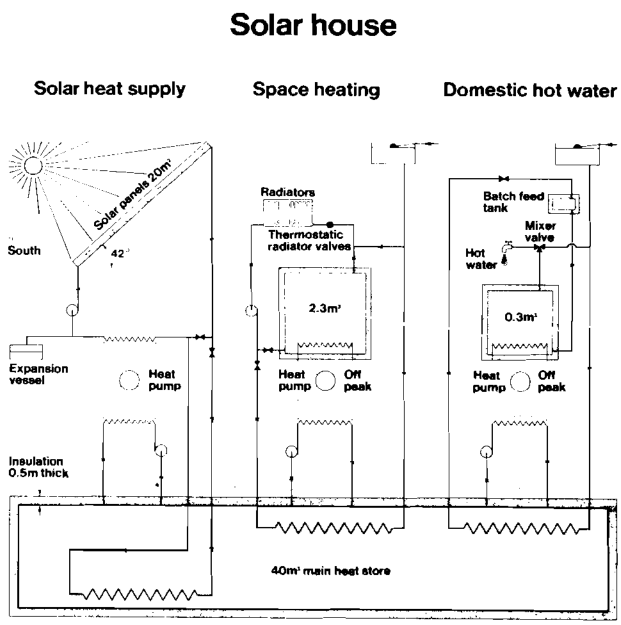


Fig 6 "Solar House" laboratory.

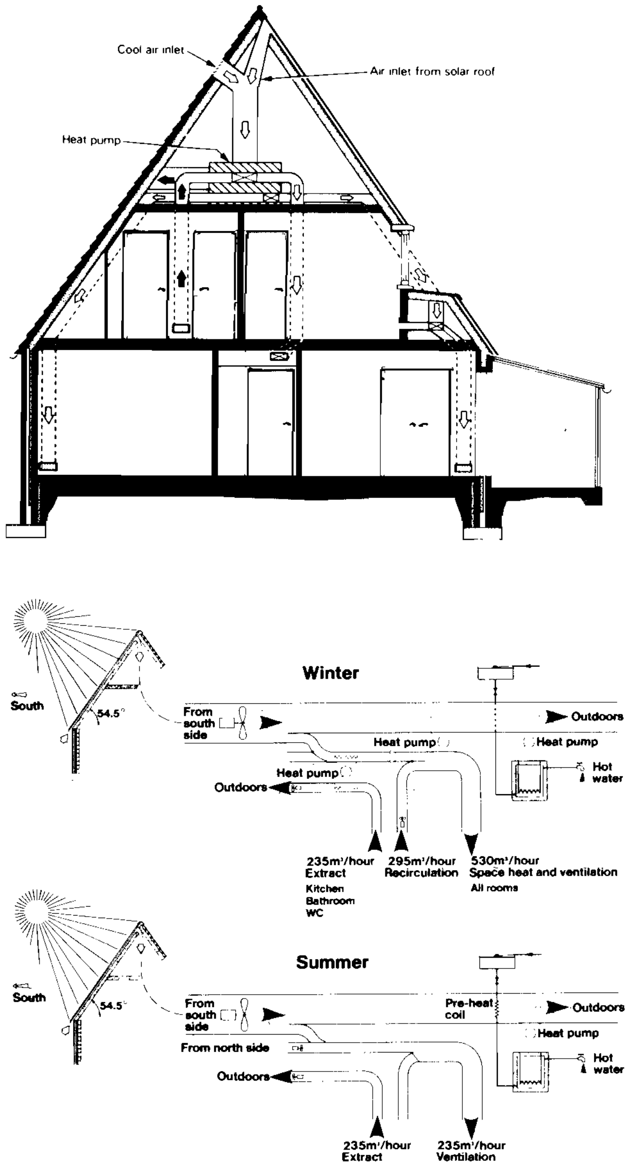


Fig 7 "Heat Pump" laboratory.

Solar Energy

Solar energy applications to buildings have perhaps received the greatest attention of any of the possible ways of saving energy in buildings since the 1973 energy crisis. There is no doubt that the amount of solar energy reaching the earth's surface exceeds the needs for energy in building services by a large factor - about 10,000 times the current requirement (6). But it is diffuse, rarely exceeding 1 kW/m^2 and averaging much less. Sir William Hawthorne (7) at a recent Royal Society meeting has illustrated the diffuse nature of solar radiation by comparison with other means of providing energy. Flat-plate solar collectors receive heat at an average rate of between 25 and 90 W/m^2. In a modern boiler furnace the heat transfer to the water walls is of the order of 100 kW/m^2. A windmill or aerogenerator can produce up to 50 W/m^2 of disk area in a 8 km/h wind, but of course, this is work and not heat. A single row of blades in the last stage of a modern steam turbine develops some 1 MW/m^2 of disk area. This means that for any significant amount of solar energy to be utilised the collection area must be large for whatever means of application - solar collectors, solar cells, windows etc - is being considered.

Building roofs and walls provide in total a huge area. However, heat storage (except in cooling applications when solar radiation can drive absorption chillers when needed) is always necessary and storage periods from a few hours (e.g. in the building fabric) to months in well insulated tanks are all under investigation. An illustration of the potential importance of storage can be drawn from the case of a single family sized UK house. Taking account of incidental gain from the sun and from the activities of the occupants, the useful energy requirement of a well insulated house for space heating may be as little as 20 GJ per annum. In contrast, about 90 GJ of solar energy is incident annually upon the roof of this house, if it faces south. Most of this insolation occurs during the summer but, even so, an overall collection and storage efficiency as low as about 20% would enable the house to be self sufficient in its requirements for low grade energy. Power from centralised sources would then be required only for lights, TV and the pumps and controls of the solar/storage system. It is feasible that this could be achieved in practice. However, unless storage problems can be solved and storage made cheaper enabling solar energy to be used for space heating, the potential saving from solar energy must remain small. Storage problems may be solved by phase change materials but a cheap, stable, non-corrosive system, readily integratable into the building has not yet been perfected.

The two applications of solar energy which are beginning to be utilised in practice are solar collectors for heating "domestic hot water" (shorthand for hot water for washing in all buildings!) and the design of buildings to maximise the utilisation of solar energy through windows, usually called passive solar design. The latter is particularly appropriate for buildings needing heating for 24 hours a day e.g. old people's homes and less suited to intermittently occupied buildings where a fast response fabric and a well controlled heating system may well use less energy than a "passive" design.

Solar collectors used to provide domestic hot water can typically save 30-50% (the higher figure applying where winter sunshine is frequent) of the hot water heating bill and are now being widely used in some countries where frost protection is rarely necessary and low cost systems can be made, e.g. in Israel and South Africa. In the parts of the USA which receive most sun a market is developing and about 300,000 systems have been installed in the last few years. In Western Europe solar collector system costs do not currently favour wide use but a market may just be emerging anticipating future energy cost increases.

Lighting

In some types of buildings artificial lighting accounts for over 50% of the primary energy consumption of the building. Sometimes even greater consumption arises as a consequence of the artificial lighting when cooling is needed to counter heat from lighting. The possibilities for energy conservation in lighting have recently been reviewed (8) and some of the main conclusions are as follows.

It is a matter of common observation that lights are often fully on in parts of buildings when no, or very few, people are in occupation and also when daylight is providing a high illuminance over at least some part of the working area. This over-use arises in different ways but most frequently by not switching off rather than by switching on unnecessarily. However, if too large an area of lighting is controlled by one switch the requirements for light by one individual may lead to large numbers of luminaires being switched on when only one or two are really required. Such a situation might arise from working in a place which is particularly poorly daylit or from working in a large room when no one else is present.

Controls should at least permit individual rows of luminaires parallel to window walls to be controlled separately, and control systems (both mechanical and electronic) have been installed in some buildings which permit individual luminaires in a large installation to be switched by the occupants most affected.

If the occupation of a building effectively ceases at a fixed hour every working day, it may be worth installing a time control so that most of the lighting is switched off soon after this time. Arrangements may need to be made, however, for individuals working late to override part or all of the switching with subsequent automatic switching off. The building cleaning routine may also need special arrangements; sequential control of lighting may be appropriate when a cleaning gang move from floor to floor. Arrangements must be made however, to ensure that no-one ever has to enter an unlighted space or to be in a space where all the lighting is out of their control.

Failure to switch off lights in areas receiving sufficient daylight has already been mentioned and photo-electric control can ensure that the lighting cannot be turned on or remain on when the daylight provides the required illuminance by itself. In interiors where there is a large range of daylight factors, e.g. a fairly deep interior with two or more rows of luminaires running parallel with the window wall (or walls), it may be advantageous to use a separate controller for each row.

Fig 8 shows an experimental installation in an open plan school which has three separate rows of luminaires running parallel to the windows in three separate areas. The outer row of luminaires (nearest to the windows) is fitted with an on/off photo-electric switch. The innermost row is designed to be on continuously. The middle row - "top-up row" has an automatic dimmer control linked to photo sensors. The automatic dimming system installed is produced commercially but different response rates and delay times specified by BRE were incorporated so that the possibility of an optimum set of control parameters could be investigated. A timeswitch was used to over-ride the daylight-linked controls at the beginning and end of the day.

Over the first six-month period of the experiment a 30 per saving on energy consumption was achieved. Generally the staff seemed more satisfied with the controlled system than the original installation. General conclusions are not yet possible because of the small number of respondents available in this particular experiment, but there was evidence that more adverse comments were associated with switching than dimming - a not unexpected result. It is also important to use the highest efficiency lamps for a task providing that they provide adequate colour rendering. Fluorescent lamps are available in wattages and colours suitable for most commercial and domestic interiors and provide up to five times as much light for the same power consumption as ordinary incandescent lamps. Even higher efficiency lamps are available where good colour rendering properties are not vital.

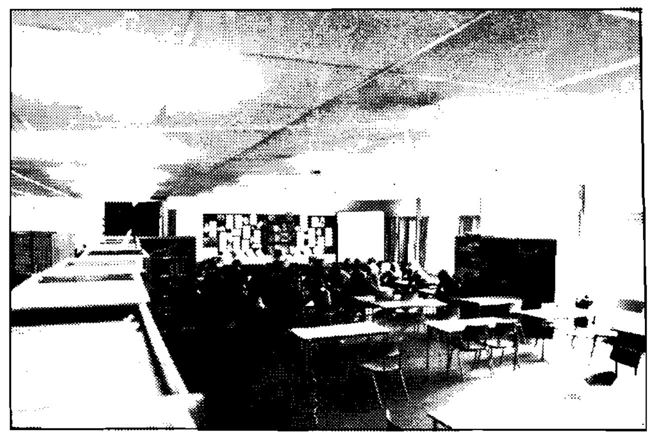


Fig 8 Photo-electrically controlled lighting installation in an open-plan school designed by the Building Research Establishment.

Another possible way of reducing lighting consumption is to provide task illuminance in conjunction with lower ambient illuminance. One office with a rather low density of 15 sq metres per person achieved a reduction of 44 per cent in installed lighting load by using 20 Watt fluorescent lamps in local lights at each side of the desk and in adjustable drawing board lamps. This however, may represent somewhat higher than average savings in relation to the normal density of office occupation.

In the example quoted, measurements of contrast rendering indicated that although the new installation provided only 80 per cent of the horizontal illuminance on the task which the previous installation produced, there should have been a net improvement in task visibility.

The cost of most of the measures discussed is small in relation to the energy saved, even as additions or replacement in an old building. In a new building some of the improvements in manual control can be cheaper than installing the conventional wiring runs for wall switches.

Ventilation and Air Conditioning

For much of Western Europe there is only need to consider using air conditioning in special situations where for example a particular deep plan building shape is essential or where external noise or dirt prevents windows from being opened in summer. In many buildings good environmental standards can be achieved with natural or mechanical ventilation alone. The author is not able to discuss the special and complex aspects of air conditioning systems where they are essential and how these may change in future, recognising that this is a topic worthy of a paper of this length in its own right.

Adequate ventilation is an essential feature of all habitable buildings in order to ensure both the safety, health and comfort of the occupants and to preserve the condition and integrity of the fabric. Ventilation, however, has an important effect on energy consumption. In the heating season energy is expended in raising the temperature of air brought in from outside and energy is consumed by the fans of mechanical ventilation. It is estimated that ventilation is responsible for approximately 15% of the total UK primary energy consumption, i.e. about as much as is consumed by the whole of the transport sector. There is therefore scope for making a substantial contribution to energy conservation by reducing consumption due to ventilation.

It is important to establish the requirements for 'adequate' ventilation. These clearly depend upon use to which a building, or particular spaces within a building are put. Existing requirements are set out in Regulations, Codes and Professional Guides. In many cases, for instance in relation to odour, the research on which requirements are based was carried out many years ago under conditions which no longer pertain. Certain airborne contaminants which, in the past, were not considered important, have been shown by more recent work to have important health effects e.g. radon and allergens. In the period when many of these requirements were set, energy consumption was not a significant factor and it is possible that with no clear upper bound higher requirements than necessary were stipulated. It is therefore important to review ventilation requirements and reassess these where necessary in order to ensure a balance between saving energy and a safe and comfortable environment. The lead is being taken in Scandinavia, particularly Sweden, where requirements are being set in building codes only just above those considered adequate for the occupants.

Having set the requirements for ventilation the next consideration is the way in which these may be provided. Two general methods are available - natural and mechanical ventilation. The latter method can in principle be designed to satisfy requirements exactly. Natural ventilation is much more difficult to deal with, since the factors on which it depends (such as wind and temperature) are highly variable, or difficult to specify, as, for instance, the position and size of openings in the building fabric.

Mechanical ventilation systems provide a further possibility for energy conservation. If heat is recovered from the outgoing warmed air and transferred to the incoming air energy consumption can be substantially reduced. Methods of achieving this range from simple plate heat exchangers to complex systems incorporating heat pumps as has been discussed.

In conclusion it is probably true to say that building ventilation is the area of greatest ignorance when looking at the energy balance and energy consumption of buildings in detail, largely because of the difficulties associated with making measurements in buildings and in developing a mathematical simulation. Without knowledge of real ventilation rates in buildings the application of meaningful energy targets to buildings is not possible nor is it possible to estimate the energy savings from paying more attention to the tightness of the building fabric.

Acknowledgement

This paper is based on work of the Building Research Establishment. The views expressed are those of the author alone.

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A new method on relation between the mean radiant temperature and the aspect ratio of a space

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Summary

Generally, mean radiant temperature is an unfamiliar concept for the architect. However, it is also the most important factor for the energy and comfort conscious design. About 50% of the total energy exchange of human beings with their environment is by way of radiation. Architects generally do not know how to control this very important factor, and it becomes imperative to give a simple tool to their hands to handle this problem, especially at the design stage.

In this paper, a new method is explained and the output of the method, a simple graph is presented as an example. Using this method, if one knows the height and the floor area of a space, one can find optimum aspect ratio for any set of climatic conditions which prevail, with the help of provided graphs. Optimum U values of the building shell for any given aspect ratio of the space can also be obtained through the usage of this new method.

Sommaire

Généralement la température du radiante moyenne est un concept pas très familier pour les architectes. Cependant ce concept joue un rôle primordial dans le domaine de la conservation de l'énérgie et celui du confort.
A peu près 50 % da la l'échange d'énérgie entre l'homme et son milieu s'éffectue par voie du rayonnement. Pourtant la plupart des architectes ne savent comment controler ce facteur très important, et il devient impérative de mettre à leur disposition une simple méthode.

Dans ce communiqué, une nouvelle méthode vient d'être éxposée et les résultats y relatifs vient d'être préséntes, comme example, par un simple graphique àla fin. En utilisant cette méthode et à l'aide de ces graphiques, la superficie du plancher et la hauteur étant connue, on peut aisement trouver la proportion optimal entre la longeur et la largeur du volume donne et cela pour une condition climatique bien déterminée.

La valeur K des murs éxterieurs d'un batiment peut être aisement trouvée pour une quelconque proportion longueur - largeur donnée.

Introduction

The majority of the nations of the world are in erengy straits. Every day, the energy conscious building design and energy conservation methods gain more and more importance. Of course the energy conservation in buildings is utmost importance, but we should not conserve energy by sacrificing the bioclimatic comfort conditions of a building. Otherwise, we may lose much more than the value of the energy conserved.

The bioclimatic comfort of a space is the composition of six physical variables. These are:

- . MRT (Mean radiant temperature)
- . Dry bulb air temperature
- . Relative humidity
- . Relative air velocity
- . Activity level
- . Thermal resistance of clothing

The most important variable among them is the MRT. Because, if we make a comparative analysis of the references (1-18) we should come to the conclusion that, under normal conditions, around 50 % of the total heat exchange of a human being with his environment is by way of radiation.

The relative importance of radiative heat exchange is known by everybody. Everybody knows by his daily experiences that, if a cold room is heated, though the air temperature raises, let us say to 20 °C, the persons living it that space do not feel themselves warm enough to be comfortable. It will take, according to the materials and composition of the walls, from several hours to several days to increase the inside surface temperatures in conventional buildings. We know that, for intermittent heating system, the best way of insulating a wall is by installing the insulation material inside surfaces. But, though it helps a great deal, it is not a complete solution. Especially in summer, overheating problems arise in lightweight structures. To improve the situation, we should try to find other solutions, try to take other measures.

In my attempt, I tried to find an architectural approach to the problem so that, any architect at the initial design stage should be able, as much as possible, to control physical bioclimatic comfort variables. If he succeeds, than the task of heating and ventilating engineers will be much more easier and by taking passive precautions, the energy expenditure of the building will be minimized.

Method

It is accepted that (19), when the mean radiant temperature in the occupied zone differs from the dry bulb temperature, the dry bulb air temperature should be reduced 1 °C for each 1 °C mean radiant temperature elevation above dry bulb air temperature and vice versa. If t_a and t_{mrt} are equal to each other, then:

$$t_{comfort} = \frac{t_{mrt} + t_a}{2}$$

This relationship is correct for the reciprocal increase or decrease of t_a and t_{mrt} values. The above interrelation between mean radiant temperature and dry bulb air temperature is correct only for a 2.7 °C temperature difference. This value is the mean value of the research findings given in references (3-5, 17, 19-23). By applying the above rule, we can write;

$$t_a = t_{mrt} \pm 2.7$$

If we accept the bioclimatic comfort temperature ($t_a = t_{mrt}$) as 24.5 °C (6), it means that the mean radiant temperature and dry bulb air temperature may vary between 21.8 °C - 27.2 °C.

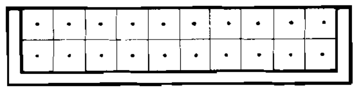
At the beginning, the room height and the room floor area should be known. A suitable room height and room floor area can be selected according to function of the room and/or the modular coordination standards of the country.

The height will stay constant throughout the calculations. We shall vary the width to depth ratio, or in other words the aspect ratio of the room from one extreme to the other extreme.

The most narrow dimension is accepted as 2.00 m. This is about the size of a corridor. And we increased this dimension at 1.00 m. increments such as 3.00, 4.00, 5.00 meters and keeping the floor area constant, the other dimension changed accordingly until around 2.00 m.

For each case, the floor is divided into imaginary square grids. And we supposed a person is sitting at tha center of each grid. The dimensions of these grids are arbitrary. It is possible to accept any dimension, but in our work we have chosen 1.00 m. x 1.00 m. square grids. In architectural standards, a sitting man is supposed to occupy around 87.5 cm. If the persons are sitting 12.5 cm. apart from each other, we thought that this is a resonable distance, and the dimensions of the grids becomes 1.00 m. x 1.00 m. each. We thought that, to analyse a space for the persons sitting 1.00 m. apart from each other and to find their mean value gives a result in conformity with reality at the acceptable range.

If we know the angle factors of the persons sitting at the center of each grid, to the walls, floor and ceiling, or in other words to the surrounding surfaces, and if we know the temperatures of these surfaces, it is easy to calculate the mean radiant temperatures affecting the person.



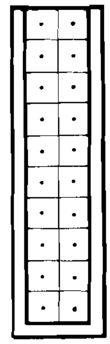


Fig. 1
Extreme aspect ratios of a space.

By different researchers, the angle factors are calculated and published as different diagrams. Some of the researchers represented the person as a sphere, some as a cylinder, some as a point in space etc. But, in my opinion, Dr. FANGER's data should be used for calculations. Because, after a long and time cosuming experimental procedure, he calculated the angle factors for a real person and published the data in graphical form (24).

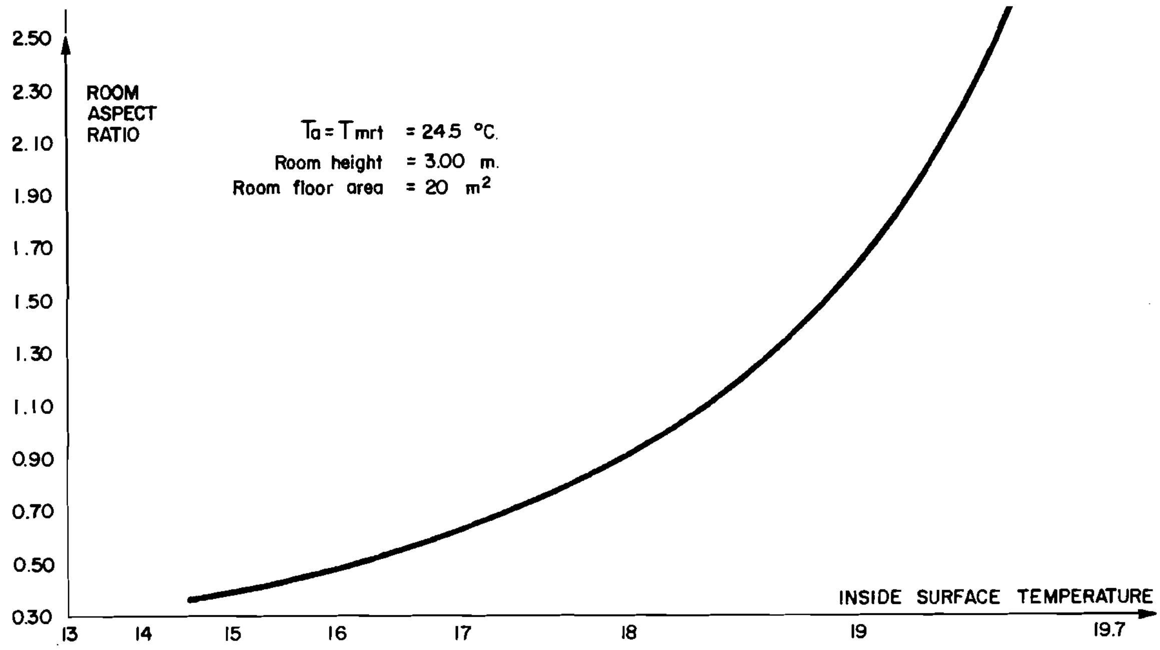
In architectural work, the location of the person in a space is important but his orientation may change. For this reason, the data taken from the above angle factor diagrams for such a person are used throughout our work which gives acceptable results.

For the calculation the formula below may be used;

$$\bar{F}_{P-A} = \frac{1}{2\pi^2} \int_{\frac{x}{y}=0}^{\frac{x}{y}=\frac{a}{c}} \int_{\frac{z}{y}=0}^{\frac{z}{y}=\frac{b}{c}} \int_{\alpha=0}^{\alpha=2\pi} \frac{f_p}{\left[1+\left(\frac{x}{y}\right)^2+\left(\frac{z}{y}\right)^2\right]^{\frac{3}{2}}} \, d\left(\frac{x}{y}\right) d\left(\frac{z}{y}\right) d\alpha$$

The temperatures of all the surrounding surfaces may be accepted as being different from each other. As an example, I will take a most simple case. We can accept all surfaces except one surface have equal surface temperatures. This may represent a room in a multi-story building having one exterior wall and surrounded with other spaces all around.

Whatever the function of the room, whether a living room or an office room, the person inside may be assumed as a sitting person. His orientation is not fixed, he can turn around.



We change the position of man in the room. We assume him sitting at the center of each imaginary 1.00 m. square grid and find his angle factors according to surrounding surfaces for each position. If we take the average value of the angle factors found, we can use this mean value as the representative angle factor of the room.

Then, using the mean angle factor values, we can calculate the MRT for each aspect ratio using the MRT formula below;

$$T^4_{mrt} = F_{1-cl}\, T^4_1 + F_{2-cl}\, T^4_2 + \dots + F_{n-cl}\, T^4_n$$

Of course, for all these calculations, a computer program has been developed. Since the paper is limited, I can not give here the flow-chart and listings of the program. Anyone interested can write to me.

The results are represented as a set of graphs drawn on logarithmic paper. One example is given at the end of the paper.

Conclusion

If we decide on an aspect ratio from architectural or functional point of view, using the graphs we can find the acceptable inside surface temperature of the exterior wall for that aspect ratio and knowing the outside temperature, we can decide on the composition and thermal resestance value of the wall.

Or, if we decide on the composition and thermal resistance value of the exterior wall and if we know or assume the outside temperature, we can calculate inside surface temperature of the exterior wall and using the graph, we can find the optimum aspect ratio corresponding.

The set of graphs is a tool for architects and for engineers. It may be used at the design stage to ensure the bioclimatic comfort of occupants and to conserve energy as well.

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Well Insulated Airtight Buildings, Energy Consumption, Indoor Climate, Ventilation and Air Infiltration

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Background

Previous standard requirements in Sweden with reference to outer structure thermal insulation and airtightness have been influenced by hygiene or comfort. There have been requirements for thermal insulation but, on the other hand, no requirements for building airtightness.

In Swedish Building Code 1975 the requirements for thermal insulation for different building sections have been made considerably more severe. For example the requirements for thermal insulation mean, in the case of mineral-wool insulated wooden walls, that the insulation thickness must be approximately 150-190 mm (depending on the geographical location in Sweden of the house). In loft ceiling structures a mineral wool thickness of 220-260 mm is normally required. These are significant thicknesses which mean more complicated wall and joist structures than those previously used. As a result of the considerable increases in oil prices there is considerable motivation today for insulating to a greater extent than is prescribed by the Swedish Building Code.

Completely new requirements for a building's airtightness have been introduced. The purpose of the new regulations is to prevent too much natural ventilation, as was the case earlier, through the building's external structure. The Code now contains a recommendation for the highest perviousness for the whole building at a pressure difference of 50 Pa in relation to the outdoor air (Table 1).

In order to build airtight houses it is necessary to carefully consider airtightness problems. A well-planned system for how airtightness is to be achieved facilitates practical work. Great importance must be placed on how the different constructional parts are formed and, by no means least, how transitions for installations - electricity, heat, water and ventilation - are to be achieved (see Figure 1).

Objectives

The way in which indoor climate - primarily air quality - and how energy consumption is affected by very good airtightness, as well as good thermal insulation, has been studied in a number of houses in a group housing area. During pressure testing all of these houses had an air change rate of 1 change/h at a pressure difference of 50 Pa immediately after erection. For the sake of comparison the climate has also been studied in a number of houses which, during pressure testing, have had an air change rate of approx 3 changes/h at a pressure difference of 50 Pa. Furthermore the change in the airtightness of the house has been determined during the course of the first few years.

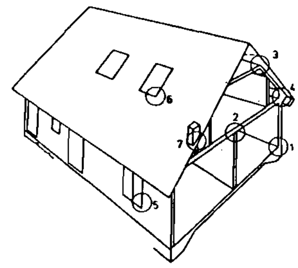

Figure 1. Connection and joint details to which a great deal of attention must be paid in order to achieve satisfactory airtightness.

1 External wall - ground floor
2 Loadbearing partition - gable wall/attic floor
3 Attic roof - sloping roof
4 Eaves
5 Joints around windows
6 Joints around windows in the roof
7 Penetrations for services

Table 1. Maximum permitted number of air changes in a completed building

	1 July 77 - 30 June 78 change/h	After 1 July 78 change/h
Detached house or linked house	4,5	3,0
Other building of at least 2 storeys	3,0	2,0
Building of 3 or more storeys	1,5	1,0

Type A Houses

These houses are built on site, designed and erected by Byggnads AB Folkhem, Stockholm (figure 2). The houses are all of the same type and are situated in a group housing area approximately 40 km east of Stockholm.

During the planning stage of these houses considerable effort has been made to achieve good building engineering solutions. A carefully considered system to achieve airtightness has been produced. Furthermore high demands have been placed on work procedures, particularly thermal insulation and airtightness work on the building site. All the houses were pressure tested before occupation and all had an air leakage less than 1.0 changes/h at 50 Pa gauge and negative pressure in the house. The Institution for Building Technology at the Royal Institute of Technology, Stockholm has carefully followed the whole building process and has documented the procedure well (Elmroth A: 1978). Thus the houses are very airtight.

The ventilation system is of an exhaust air type and is fan controlled. Supply air is delivered through special air supply devices (slot air valves) in window frame heads. The slot air valves can be regulated but cannot be closed completely.

The houses are built on ground slabs and are of a dormer design.

Pressure difference between outdoor air and indoor air

To check whether the fan in the house could create a negative pressure in the whole house, the pressure difference in relation to the outdoor air at different facades has been measured.

Measurements were carried out with the fan set at basic speed, 50% of full fan capacity and 100% full fan capacity. When the fan is set at basic speed an air change rate of approx 0.25 changes/h is obtained in the whole house. At full fan capacity there is an air change rate of 0.9 - 1.0 changes/h. Full fan capacity is designed primarily for use during food preparation. Measurements were carried out on two different occasions with different wind speeds. In the first case the wind speed was high (approx 10-12 m/s, southerly) and on the second occasion moderate (approx 3-6 m/s south-easterly). On both occasions the external temperature was approximately $0^{o}C$ and the indoor temperature approx $20^{o}C$.

Examples of measurement results in a type A house are shown in Tables 2 and 3.

Table 2. Results from air pressure measurements in type A houses, trial 1 (slot air valves).
All values indicate that the air pressure is lower indoors than outdoors. Wind speed 10-12 m/s (S)

Facade	Pressure difference Pa with fan set at		
	basic speed	50% of full capacity	100% of full capacity
Longside living room north facing (leeward side)	1-2, 5	4-6	10-11
Longside external door south facing (windward side)	5-6	9-11	19-22

Table 3. Results from air pressure measurements in type A house, trial 2 (slot air valves).
All values indicate that the air pressure is lower indoors than outdoors. Wind speed 3-6 m/s (SE)

Facade	Pressure difference Pa with fan set at		
	basic speed	50% of full capacity	100% of full capacity
Longside living room north facing (leeward side)	2-4	4-6	8-12
Longside external door south facing (windward side)	4-5	4-6	12-14
Upper floor west facing	1-2	4	8-12
Upper floor east facing	0-1	1-2	5-6

All measurements indicated that there was a negative pressure in the houses. The pressure difference changed immediately when the fan's speed was increased or decreased. No significant pressure difference was measured between upper and lower floors in the test houses. An interesting observation is that, with a wind speed as high as 10-12 m/s, there was a negative pressure on both the windward and leeward sides in type A houses with the fan set at basic speed. (These pressures were 5 and 2 Pa respectively). See Tables 2 and 3.

The result of the pressure difference measurements gives a clear indication that the ventilation is controlled to a significant degree by the setting of the exhaust air fan. The external climate has only a marginal effect on ventilation in airtight houses.

Energy consumption

Energy consumption during a normal year has been estimated by registering air consumption, air change rate, temperature difference between outdoors and indoors and possible solar radiation during a few, relatively short measurements periods (16-19 hours). On the basis of these short-term registrations, transmission and ventilation losses can be approximated for longer periods. Such calculations can be made providing that the houses are unoccupied and that the external climate is stable both during the trial and for a certain period prior to commencement.

Energy consumption for hot water and household electricity in occupied houses has been extracted from a paper by Munter (1974) as have estimated values of the proportion of energy usage constituted by direct losses.

Energy gains from solar radiation to the houses has been approximated as 3200 kWh/year.

The total number of degree hours for Stockholm is shown in Table 4 for different indoor temperatures.

Table 4. Calculated degree hours for Stockholm using normal outdoor climate figures for different indoor temperatures during the heating season. This is assumed to begin when the mean diurnal temperature goes below $+12^{o}C$ and ends when it again exceeds $+10^{o}C$.

Indoor temperature ^{o}C	Degree hours ^{o}C h
20	110 000
19	103 000
18	97 000

When calculating the energy consumption for ventilation during one year, the air change rates have been assumed as 0.25 changes/h and 0.5 changes/h respectively. The reason for this is that many householders normally set the fan to approx 0.25 changes/h. According to the Swedish Building Code however the air change rate should be 0.5 changes/h.

Theoretical determination of transmission losses

Calculation of k-values have been carried out in accordance with Swedish Building Code 75. Calculations have been carried out so that the total area of framework members, nogging pieces, rest timbers, cross ties etc. is included. See Table 5.

Table 5. Calculated k-values, areas and transmission losses per °C through different building sections in type A houses.

Building Section	k-value $W/m^2\ ^oC$	Area m^2	k x A $W/^oC$
Floor over crawl space	0.29	77.2	22.39
External walls	0.28	206.0	29.68
Roof	0.16	35.0	5.53
Sloping roof areas	0.19	57.1	10.68
Windows	1.90	20.4	38.76
Doors	0,95	5,0	4.75
		Σ k x A =	111.71

The total transmission losses during the year and for 110 000 degree hours amounts to 12 288 kWh. The calculated transmission losses, based on short-term measurement, amount to 13 100 kWh. Thus the difference is only 812 kWh.

The values show good correlation which indicates that, in airtight houses where the air change rate can be expected to be relatively constant during the year, short-term measurements for calculating energy consumption provide good results.

Table 6 shows the calculated energy balance during a normal year for a type A house. The indoor temperature has been assumed to be +20°C and the average ventilation rate 0.5 changes/h. The transmission losses have been calculated using the results from short-term measurements. How the energy consumption changes if the indoor temperature and ventilation are changed is indicated in Table 7.

Table 6. Energy balance for type A house for a normal year in Stockholm´s climate with an indoor temperature of +20 °C and an average ventilation rate of 0.5 changes/h

Energy losses		
	transmission	13 100 kWh
	ventilation	6 700
	household electricity	1 000
	drainage water (hot water drainage)	3 500
Total energy losses		24 300 kWh
Energy gains		
	heating plant	11 000 kWh
	hot water production	5 000
	household electricity	3 500
	solar radiation	3 200 } "free energy"
	body heat	1 500 }
Total energy supplied		24 300 kWh
Total purchased energy		19 500 kWh

Table 7. Tabulation of expected demand for purchased energy supply for different indoor temperatures and ventilation rates

Indoor temperature °C	Ventilation change/h	"Purchased"energy kWh
20	0.5	19 600
	0.25	16 200
19	0.5	18 400
	0.25	15 200
18	0.5	17 200
	0.25	14 200

Comparison between calculated and measured energy consumption

The total energy consumption in five houses was read off from the respective houses´ electricity meters. The indoor temperature was checked a number of times during the year. The householders gave an assurance that no changes were made to the thermostat settings on the electric radiators.

The quantity of exhaust air was measured at each reading opportunity from the electricity meter and has been assumed to be constant during the year.

Tables 8a and 8b indicate the true energy consumption over a period of two years in relation to the calculated energy consumption. Calculation of the energy consumption has been carried out in the same way as that which formed the basis for Table 6, wherein the measured values of temperatures and ventilation were used for calculating transmission and ventilation losses.

Table 8a. Tabulation of calculated and measured energy consumption between February 1978 - February 1979

House	Measured indoor temperature °C	Measured air change rate changes/h	Energy consumption kWh/year calculated	measured
A1	19-20	0.35	17 100-18 000	17 900
A2	20-21	0.50	19 600-20 500	19 450
A3	17-18	0.50	16 100-17 100	16 000
A4	20-21	0.50	19 600-20 500	20 500
A5	19-20	0.50	18 400-19 600	18 900
			Average	18 500

Table 8b. Tabulation of calculated and measured energy consumption between February 1979 - February 1980

House	Measured indoor temperature °C	Measured air change rate changes/h	Energy consumption kWh/year calculated	measured
A1	19-20	0.45	18 600-19 400	20 800
A2	19-20	0.35	17 100-18 000	18 500
A3	18-19	0.50	17 200-18 600	16 900
A4	20-21	0.50	19 600-20 500	20 400
A5	18-19	0.50	17 200-18 600	17 400
			Average	18 800

Tables 8a and 8b indicate that the measured energy consumptions agree favourably with those calculated. When the indoor temperature and the ventilation rate are known, it is possible to calculate the annual energy consumption with reasonable accuracy and in quite a simple manner. Different living patterns (hot water consumption, household electricity) can explain the differences which are evident between measured and calculated energy consumption.

In well-insulated, airtight houses there is no evidence of dramatic changes in energy consumption unless the mean annual temperature during the year is significantly greater or less than the normal value. Furthermore, the results indicate that natural ventilation is low and varies insignificantly in relation to the outdoor climate.

Monitoring the houses´ airtightness

The Swedish Building Code recommends that free-standing single-family dwellings shall have an airtightness of 3.0 changes/h at a gauge or negative pressure of 50 Pa. The five houses described above all had an airtightness of less than 1.0 when the houses were completed.

One constructional requirement is that the houses´ airtightness shall remain unchanged. At the Institution for Building Technology, The Royal Institute of Technology, Stockholm, pressure measurements have therefore been carried out to discover whether the houses´ airtightness change significantly with time. Table 9 shows the results of airtightness tests carried out both at completion and when the houses had been occupied for one and two years respectively.

Table 9. Results of pressure tests over a three year period

House	Air change rate, changes/h, with a pressure difference of 50 Pa when pressure testing		
	October 1977	February 1979	February 1980
A1	0.8	1.6	1.5
A2	0.7	1.1	1.2
A3	0.7	1.5	1.4
A4	0.7	1.0	1.1
A5	0.8	1.2	1.3

The table indicates that a relatively high increase in air leakage is evident after the houses have been occupied for a year. During the latest measurements, no further change has occurred (the values lie within the measuring equipment´s accuracy range.)

The reason for the considerable increase during 1979 is probably the fact that the house dried out during the first year wherein small cracks can have arisen primarily between external walls and intermediate joist structures.

The moisture content of wooden joists adjacent to external walls was very low (6.5-7%) when measured during February 1979 and 1980, which shows that there had been a considerable drying out of the timber since erection. One of the reasons for this satisfactory drying out is probably the fact that there is always a certain amount of negative pressure in the house which means that warm moist air cannot escape through the external structure.

The result from pressure tests gives a clear indication that airtightness remains constant for a long period after drying out.

Indoor climate

During an investigation of the indoor climate it was shown that two type B houses, as well as type A houses, had an air leakage, when completed, of 3.0 changes/h at 50 Pa negative and gauge pressure respectively. (Compare with type A houses < 1.0 changes/h).

These houses are factory built as two volume elements and eight roof elements. They also have accessible foundations. These houses are also designed as dormer houses (see figure 3). Compare with type A houses.

The exhaust air ventilation system is fan-controlled. Supply air is supplied through special air supply devices (slot air valves) in the window frame heads. The slot air valves can be adjusted but cannot be closed completely.

Air change rate

Tracer gas measurements have been carried out to monitor air change rates in individual rooms occupied by people over long periods (e.g. bedrooms).

In houses ventilated with an exhaust air systems there are usually no exhaust air devices in bedrooms, workrooms etc, whereas such devices are fitted to wet rooms (bathrooms, toilets etc) and kitchens. "Tainted air" is extracted via exhaust air devices in these areas wherein outdoor air is drawn into the house through supply air devices (slot air valves) usually positioned above windows in the rooms where exhaust air devices are not fitted. A certain amount of air also comes through leakage sources in the house.

The exhaust air flow is often regulated with a centrally-positioned control device on the cooker hood. The exhaust air fan is normally positioned in a ventilation flue above the roof.

The fan is set so that its basic flow corresponds to the air change rate (l/s) given in the Swedish Building Code for each individual wet room and kitchen. The minimum air change rate for the whole house must however not be less than 0.35 l/s m^2. This value corresponds to approximately 0.5 changes/h for the whole house. There is no indication of a minimum change rate for individual rooms in the Swedish Code, it merely states that "hygienic discomfort must not arise".

From a hygienic point of view an air change rate of 4 m^3/person and hour, at 18 °C and a relative moisture content of 60%, is the minimum change rate to ensure that the air shall not contain more than 0.5% CO_2 (the maximum value allowed at a place of work by the National Swedish Board of Occupational Safety and Health). There is no corresponding value for dwellings. Bearing in mind comfort requirements such as smell, a relative humidity value in the room which is not too high, and consideration of material-conditioned evaporation including radon, an air change rate of 10 m^3/person an hour is a more suitable limiting value, (see Ubisch 1977). This means that in the master bedroom a ventilation rate of approx (10+10+5)=25 m^3/hour is necessary if two adults and one child sleep in the room.

In all the houses which were investigated it was very easy for the individual householder to adjust the fan - and therefore the total air change rate in the house. In type A houses, the fan´s basic setting - or basic speed - (lowest fan setting) has been adjusted so that the total air change rate in the house was approximately 0.5 changes/h including natural ventilation. The average air change rate at the basic speed in type B houses was 0.23-0.26 changes/h. for the whole house including natural ventilation. The reason for having a "basic speed" which gave approximately 0.25 changes/h in type B houses was said to be that, during the daytime or during a longer absence from the house, it should be possible to reduce the ventilation and thus the energy consumption. There is no position which indicates when the houses have an air change rate of approximately 0.5 changes/h in type B houses.

It has been shown that most householders nearly always had the fan set to its lowest value in order to save energy.

The greatest risk of being subjected to an unacceptable indoor climate occurs in bedrooms since these are occupied for longer periods and since these rooms do not have exhaust air devices. The measurement results shown in Table 2 indicate the air change rate in type A and B houses with the fan set at basic speed and in accordance with the Swedish Building Code´s recommendation (approx 0.5 changes/h). Measurements were carried out with the slot air valve both open and closed. The measurements shown relate to a master bedroom of approximately 13 m^2. The doors to the respective bedrooms were kept closed.

Table 10. Air change rates for different fan settings in master bedrooms with open and closed slot air valves respectively. Bedrooms doors were closed.

Fan setting	House A	B1	B2	Recommended Value
Basic speed approx 0.25 changes/h in the whole house (slot air valve closed)	-	4.7	5	25
Basic speed approx 0.5 changes/h in the whole house (slot air valve open)	-	9.7	12.2	25
As per Swedish Building Code approx 0.5 changes/h in the whole house (slot air valve closed)	21.6	9.4	8.4	25
As per Swedish Building Code approx 0.5 changes/h in the whole house (slot air valve open)	29.5	18.5	19.6	25

The table shows that only type A houses have an air change rate which corresponds to the recommended value of 25 m^3/hour. In type B houses, with the fan set at basic speed, the value was as low as approximately 5.0 m^3/h with the slot air valve closed. The value is totally unacceptable from a hygienic point of view and causes an increase in relative humidity and CO_2 content.

The results also show that the slot air valves have a decisive effect on the air change rate in the rooms. For this reason it should not be possible to close the slot air valve completely.

Even when the fan was set to correspond to the values quoted in the Swedish Building Code, very low values (9.4-14.1 changes/h) were obtained in type B houses (with the slot air valve closed). This value is approximately the same as at basic speed with the slot air valve open.

<u>Determination of CO_2 content</u>

In type B houses, very low air change rates were measured in bedrooms. The lowest value measured is 5 m^3/h. 5 m^3/h in type B houses corresponds to an air change rate of 0.15 changes/h and this agrees favourably with the measured amount of natural ventilation in the house.

In order to illustrate the increase of the CO_2 content an example below shoes the increase of the CO_2 content in house B2. The CO_2 content is calculated using the following equation

$$c = \frac{q}{nv}\,(1-e^{nt})+c_o e^{-nt}$$

where c = CO_2 concentration at time t

n = air change rate (changes/h)

t = time (h)

q = exhaled CO_2 content in m^3/h

v = room volume (m^3)

c_o = background concentration of CO_2 in the room

Table 11. Air change rate for different fan settings in masters bedroom

House	Fan Setting	Air change rate measured in bedroom m^3/h	changes/h
A	Fan setting according to Swedish Building Code (0.35 l/s m^2) approx 0.5 changes/h in the whole house, slot air valve open	29.5	1.0
	Fan setting according to Swedish Building Code(0.35 l/s m^2) approx 0.5 changes/h in the whole house, slot air valve closed	21.6	0.73
	Note. The slot air valve in type A cannot be closed completely whereas it can in house B		
B2	Fan set at base speed approx 0.25 changes/h in the whole house, slot air valve closed	5	0.15
	Fan set according to Swedish Building Code(0.35 l/s m^2) approx 0.5 changes/h in the whole house, slot air valve closed	8.4	0.26
	Fan set at base speed approx 0.25 changes/h in the whole house, slot air valve open	12.2	0.37
	Fan set according to Swedish Building Code(0.35 l/s m^2) approx 0.5 changes/h in the whole house, slot air valve open	19.6	0.66

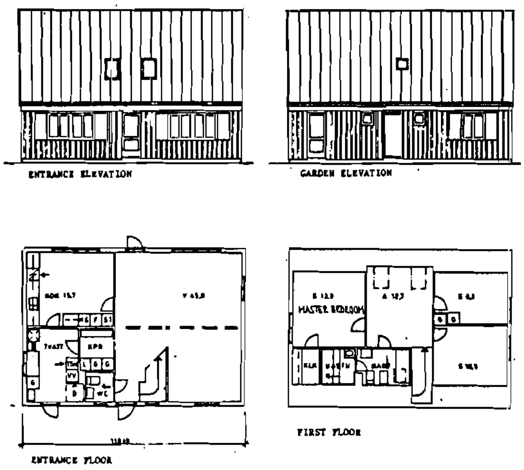

FIGURE 2. HOUSETYPE A

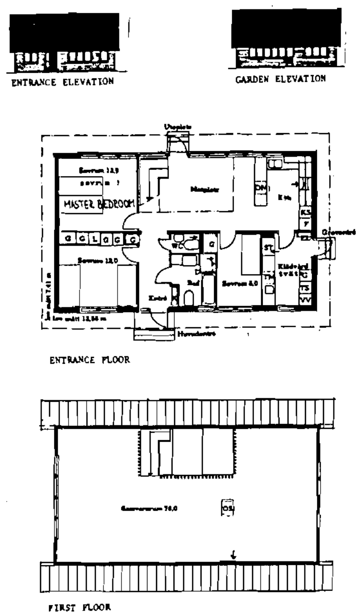

FIGURE 3. HOUSETYPE B

The calculations assume that the room is occupied by two adults and one child, that the door is closed and that a person at rest exhales 20 l CO_2/h at rest. The corresponding figure for a child at rest is 10 l/CO_2/h.

Figure 4-5. CO_2 content variation with time in type A and B2 houses for different air change rates in the master bedroom with closed door occupied by two sleeping adults and one child.

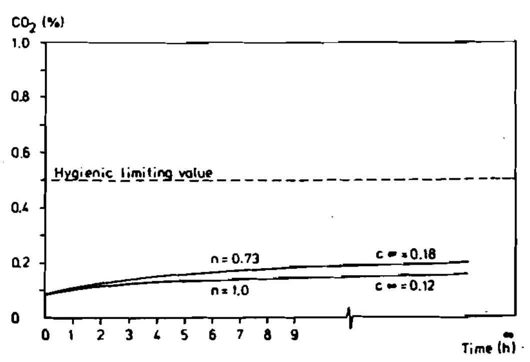

Figure 4 Type A houses
From the figure it can be seen that the hygienic limiting value is not exceeded in type A houses

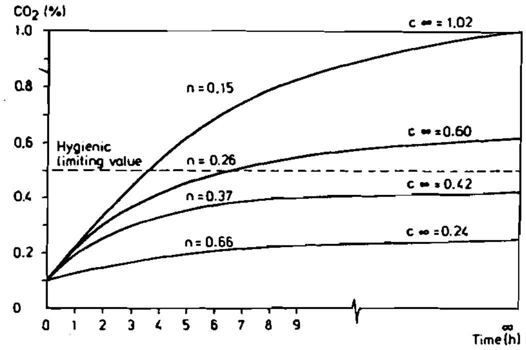

Figure 5 Type B house
From the figure it can be seen that if the slot air valve is closed in the bedroom the hygienic limiting value is exceeded in house B2 at both basic speed and at air change rate values which correspond to the requirements in the Swedish Building Code. With an air change rate of 0,15 the CO_2 content becomes as high as 1,02%. From a hygienic point of view this value is totally unacceptable. An initial value of 0,18% CO_2 is assumed in house B2 during the day.

Determination of moisture content increase in the air

A person gives off approcimately 40 g of water vapour per hour at rest. If we assume that two adults and a child sleep in the master bedroom, the vapour gain will be approximately 100 g/h (40+40+20). There may be other moisture sources which can increase moisture emission even further. These will be considered in the text that follows since they are considered to be minor.

The increase in the moisture content in the room is dependent on how well the room is ventilated. Figure 6-7 show how the moisture content increases according to time for type A and B2 houses where the outdoor temperature is 0 °C and where the outdoor humidity is 80%. The calculations have been made using the same method as for calculating the CO_2 content above.

The values indicate the upper limit for moisture content in the bedroom. The presence of absorbant material in the room reduces the calculated value somewhat. All the calculations are based on the values shown in table 11. The initial values in figures 6-7 indicate the moisture content at steady state conditions with an average moisture gain in the whole house of 3.0 g/m^3 with an air change rate of 0.5 changes/h.

Figures 6-7 indicate that the moisture content of the air in the master bedroom in house B2 becomes unacceptable high with the slot air valve closed. When the slot air is open the values become acceptable however in the master bedrooms of both type A and B houses.

Since most of the slot air valves available on the market today fitted to single family dwellings can be closed completely, it is quite probable that many people close the valves during the winter period in the hope of saving energy or to cut down "draughts". However by closing the valves the indoor climate deteriorates. Raising the moisture content over long periods can give rise to rust damage on windows and mould growth behind cupboards up against external walls etc.

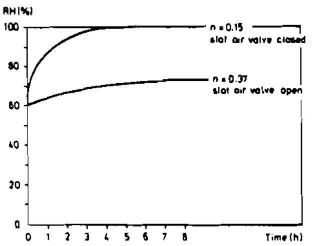

Figure 6

Increase in moisture content in master bedroom (house B2) with slot air valves closed and open respectively. Fan set at approx 0,25 changes/h (basic speed). Indoor temperature 19 °C and outdoor temperature 0 °C (RH 80%)

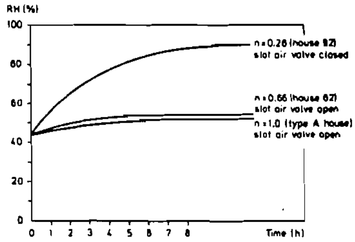

Figure 7

Moisture increase rate in master bedroom (type B2 and A houses) with slot air valve closed and open respectively. Fan setting approx 0,5 changes/h (0,35 l/s m²). Indoor temperature 19 °C and outdoor temperature 0 °C (RH 80%)

Summary

Previous standard requirements in Sweden with reference to outer structure thermal insulation and airtightness have been influenced by hygiene or comfort. There have previously been requirements for thermal insulation but, on the other hand, no requirements for building airtightness.

In Swedish Building Code 1975 the requirements for thermal insulation for different building sections have been tightened up considerably and completely new requirements for a building´s airtightness have been introduced. The purpose of these new requirements is partly to reduce transmission losses through the house and partly to prevent too much natural ventilation through the building´s outer structure.

The indoor climate - primarily air quality - and energy consumption have been studied in a number of free-standing houses in a group housing area. All these houses were very tight and, when pressure-tested, had an air change rate less than 1 change/h at 50 Pa.

Energy consumption

The annual energy consumption has been calculated theoretically and then compared with the true consumption over a two year period. From the results it can be seen that the measured energy consumption agrees quite favourably with that calculated. The mean consumption for the five houses was, during a period of one year, 18.700 kWh. The corresponding value for a similar house (dormer house with approximately 140 m^2 living area), built before the new requirements for airtightness and insulation were introduced, is approximately 28.000 kWh. Thus the energy consumption as a result of improved thermal insulation and tightness has decreased considerably.

Checking the airtightness of the houses

Measurements of the airtightness of the houses was carried out during the period 1977-1980 (pressure testing at 50 Pa) in order to discover whether this had changed significantly with time. From the results it can be seen that a relatively large increase in air leakage was measured after the houses had been occupied for approximately one year. Later measurements indicated that no changes had taken place. The cause of the increase in air leakage during the first year is probably the drying out of the timber in the house giving rise to cracks. The measured values after two years are below approximately 1.5 changes/h at 50 Pa - considerably lower than the limiting values recommended by the Swedish Building Code for new-built houses. Thus the houses are still very airtight.

Indoor climate

Apart from the five houses noted above (type A house), two houses (type B house), which when completed had an air leakage of approximately 3.0 changes/h at 50 Pa gauge and negative pressure, were investigated when studying indoor climate. Both types of houses are fitted with mechanical exhaust air systems. From the results it can be seen that the air change rate in the master bedroom in type B houses was very low (5 m^3/h) if the fan was set to its lowest value and the supply air valve (slot air valve) in the room was closed. From a hygienic point of view the air change rate should be at least 25 m^3/h. In the tighter houses (type A houses) a significantly better air change rate was obtained. The measurements carried out indicate clearly that an acceptable indoor climate in all areas can only be achieved if the houses are tight, the slot air valves open and the fan set at a position which corresponds to an air change rate in the whole house of approcimately 0.5 changes/h. In houses which have exhaust air ventilation and which were not sufficiently tight, there is a risk of the air supply being concentrated to the gaps in the outer structure. These are often unevenly distributed which means that an uneven air flow is obtained resulting in certain rooms not being ventilated sufficiently neither from hygiene nor technical points of view.

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SUBJECT
SUJET **4B**

Composting Latrines.
A cultural, social and technical problem.

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Composting Latrines. A cultural, social and technical problem

The dominating polluter of water is the human being and in developing countries it is in the main a question of faeces from man and his cattle. Nitrogen from night-soil and manure pollutes surface- and groundwaters. This pollution is more serious under arid circumstances with its higher concentration of pollutants. To separate the nitrogen from the hydrological cycle would give good effects. The separated nitrogen should then be supplied to the ecological system in a proper way - to get better harvests on cultivated land.

Cultural patterns

Areas, which for a ling time have had a high density of population and an old farming experience have also usually had a good tradition in handling night-soil. In China for example a good chain of handling is common. Night-soil is collected in buckets and containers and transported to composting sites or biogas plants. The residues are then reused as fertilizers for plant growth.

On the contrary a nomadizing family has little practice in night-soil handling. The excreta is disposed of in the open bush. This does not usually bring about any sanitary complications and the fertilizers are mobilised in the natural ecosystem.

When a rural nomadizing family or people from low density population areas migrate to more or less uncontrolled densely built-up areas a lot of problems will turn up. The habit of not using a fixed place for disposing excreta easily produces a sanitary collapse. The problem is usually complicated by limited economical resources to construct appropriate technical devices.

Religious rules can also have a rather unexpected influence on handling schemes and technical solutions. It may for example be forbidden to handel night-soil with some equipment by special people or it may be impossible to dispose of it in some areas or to go to extremes it may not be possible to handle night-soil on the whole.

The localisation of the latrine can also be important. Some locations are impossible in spite of suitability for technical reasons. The use of different anal cleaning materials can also obstruct different microbial processes. Much cleaning water will disturb a compost privy, a lot of stones will give a W-C with conventional sewerage problems.

Technical conditions

Composting is a relatively fast process of aerobic decomposition of organic matter. It achieves a relatively high temperature in the early stages of the process.

To get a composting process work satisfactorily, some factors must be fulfuilled. The mixture of night-soil (nitrogen) and organic material (carbon) must be in the order of 1:30 to produce enough energy for a temperature rise. The moisture content must be favourable for the microorganisms. Too dry conditions gives only preservation, too much water obstructs the oxygen exchange. Air must be present in generous amounts, good ventilation through the compost mass is essential, oxygen shortage gives fermentation with a low energy exchange and a bad smell. The surrounding temperature must be in the order of 15-20^{o}C to get o good temperature rise. The processes in the the compost privy is thus controlled by the user and his understanding of the process.

Water pollution

As long as night-soil is disposed of and spread in the nature as fertilizer it will not do much harm. When the material becomes concentrated it will be more hazardous. The leachate can not be absorbed in the ecosystem but will pollute surface- and groundwaters. If the night-soil is disposed of in pit-latrines things will tend to be more serious. Thus practically all the nitrogen will tend to leach to the ground water.

Table 1. Nitrogen content in wells in Tunis.

	mg/l		
	NO_3	NO_2	NH_4
Rohia 1)	3,2	0,019	0,48
Mornaghia 2)	13,2	0,032	0,28
Harisa 3)	130,0	-	0,28
Bir M Zara 4)	523,8	-	0,32

1) Solitary farm no pit-latrines
2) Farm, cattle, gardens, no pit-latrines
3) Dense farming area, pit-latrines
4) Dense village, pit-latrines and leaching trenches.

The nitrogen content in well water gives a good indication of the amount of night-soil deposition under the ground surface. Whether the nitrogen is harmful of not for the human being is questionable. For example in Botswana high levels have been recorded with alarming implications for the health of very young children. Nitrosoamines are suspected to be cancerogenous. A high nitrogen content also indicates a faecal bacterial pollution of ground water.

A compost latrine prevents the nitrogen leaking to the ground water. It produces instead a sanitary acceptable material with a good fertilizing effect.

Project Tunis

The Swedish International Development Authority (SIDA) decided in 1977 to investigate the possibilities of starting applied experimental work in Tunis. The first visit made it plain that the technical conditions were not unfavourable. It was possible in the area to find sites with differences in temperature and air humidity to investigate the influence on the moisture content of the compost.

The cultural and social conditions seemed favourable, but to avoid mistakes as above a special sociological study was suggested. This was done during 1978.

The study was done by students interviewing families in recognized areas. The main points in the form were:

1. The structure of the family
2. Economical structure
3. Hygienic standard of the house
   a) order of precedence of requirements
   b) latrine habits of to-day
   c) sanitary habits and water
   d) sanitary habits and refuse
   e) attitudes to compost latrines.

Some questijns were penetrated in more detail, e g:

3b. construction of latrine, habits of different members of the family, use of night-soil as fertilizer,

3c. amounts of water used in family, water for washing up, water for cleaning-bathing elderly and babies, water use in connection with prayers, water use by latrine visits, effluent disposal,

3d. refuse handing, amounts and constituents of refuse, organic and inorganic materials, occurence of plastics, bottles and cans.

Analysis of the essembled data gave interesting information for example.

In one of the areas the community stimulated to home-construction of latrines, the problems being of financial character ranging from consideration of space requirements and the use of the night-soil as fertilizer.

The water-use made by prayers on religious occasions was moderately,and usually the waste water was disposed via the latrine.

The refuse was usually collected and fermentated and thus not mixed with plastics, glass and cans which of course is a good habit benefiting the compost-latrine.

In another area there was a big demand for a separate latrine for each plot, both for convenience and sanitary reasons.

The psycho-social conditions of creating compost-latrines

To accept a technological innovation it must correspond to a requirement. This requirement can be clearly pronounced or it can also be of latent character in which case it must be awakaned and formulated.

The innovation can lead to a situation when the user must change his habits to get the compost latrine working well. This must be in agreement with the demand to reach a way of living which is in line with the desired modernized way of living.

Some kind of orientation and education is thus essential to get new latrine facility models developed for the families involved. These models will undoubtely produce new cultural patterns which for a long time will control future living habits.

Thus a programme has been established, not only to follow the technical function of the compost latrines, but also to give an understanding of the involvement of the facility to the users. Essential changes in the social patterns will be followed by social workers, so that it will be possible to vary different technical conditions to get the process to work well.

Thus we hope, not only, to have the technical conditions under control but also the cultural and social aspects.

Summary

Pit latrines involve a hazard of leakage to the ground water where nitrogen is the dominating polluter and tracer. A high nitrogencontent also indicates a risk for patogen contamination. One way to prevent the leakage is to install composting type latrines.

To introduce a technical innovation is not only a question of creating an awareness of the conditions given by nature such as geological, hydrological, climatological and ecological conditions, but also a question of considering social and cultural implications. A succesful experiment with composting latrines must therefore be founded not only on technically sound principles but also on the user´s cultural attitudes. An investigation has been started that hopefully will make as many consitions as possible favourable for a successful sanitary solution at experiment sites in Tunis.

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Appropriate technologies for water supply and waste disposal

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This paper is written on request from the 8th CIB congress. It is giving a brief review of the World Bank research project on water supply and waste disposal.

Improvements in water supply and sanitation are fundamental to any strategy to raise the living standards of poor households. On current estimates, it would cost at least US$60 billion to provide conventional sewerage facilities. Low cost methods of providing adequate services are urgently needed.

The Bank undertook this two year research project with the broad objective of improving its ability to direct the benefits of its water supply and sanitation loans to the poor. The project studied the technical and economic feasibility of options for water supply and waste disposal, and analyzed the economic, environmental and sociological effects of using various technologies for conserving water and disposing and reclaiming wastes. It also reviewed the scope for improving existing intermediate technologies, to make them acceptable to consumers and more easily transferable for use in other areas. Field investigations were made in fourteen countries. In evaluating technologies, emphasis was given to the ability and willingness of consumers to pay for the system, real or perceived improvements in health and living conditions, and any obstacles to adaptation for use in other communities. The project found that eight distinct technologies could be recommended, under specified conditions, for developing countries. Improved designs have been prepared for several of these technologies, and protype "sanitation sequences" developed, according to which a community begins with a low cost system and upgrades it as its income levels and service demands increase.

Early in the project a comprehensive bibliography on Low Cost Technology Options for Sanitation: A State of the Art Review and Annotated Bibliography was prepared by the Internation Development Research Centre (Ottawa). The Ross Institute of Tropical Medicine also took part in the project, preparing a comprehensive reference work on Health Aspects of Excreta and Waste-Water Management, shortly to be published by the Johns Hopkins University Press. The classification of excreta-related diseases in this manual should make it possible for project engineers to translate the results of a community health profile into the design of sanitation measures which can break the transmission processes of the locally important diseases. The other major reports of the study, Appropriate Sanitation Alternatives: A Technical and Economic Appraisal and Appropriate Sanitation Alternatives: A Field Manual, will also shortly be published by Johns Hopkins University Press.

Because the research had such immediate relevance to operations, vigorours efforts were made to disseminate the results as they became available. The design of the project emphasized the participation of nationals of developing countries; each of the main case studies relied heavily on local engineers, economists or behavioral scientists for the collection and analyses of data. This facilitated the early transfer og knowledge and techniques. The project results have been presented at numerous seminars for Bank staff, and also at conferences of professional associations, so as to reach the international consulting profession, whose members are still responsible for the design of most externally financed water and sanitation projects in developing countries. Efforts to reach developing country practitioners directly have included a four day workshop in Egypt for top officials of national and state health ministries; participation by Bank staff in the Government of India/World Health Organization Workshop on the International Drinking Water Supply and Sanitation Decade; a seminar for the Philippine Local Water Utilities Administration Staff, and a one day workshop following the Symposium on Engineering, Science and Medicine in the Prevention of Tropical Water-Related Disease held in London, which attracted a wide range of participants from developing countries. Funding was approved in October 1979 for the production of training materials based on the results of the project (see notes on "Dissemination Activities" in this issue).

Governments and the development community appear to have reacted very favourably to the results of the research. Follow-up work is now in progress, whereby a core team of sanitary engineers, health specialists and behavioral scientists is helping to develop low cost water and sanitation programs in twelve countries, with funding from the UN Development Program. Various other agencies, including the World Bank, Canadian International Development Agency, and UNICEF, are contributing to the implementation of demonstration projects and sanitation programs. Several of the consultants who participated in the research are now involved in these projects.

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SUBJECT
SUJET **5B**

L'informatique dans l'entreprise de construction.
Quelques informations avant de se décider ....

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Introduction

The price of data-processing equipment has been falling steadily, and it is now becoming possible for an increasing number of construction firms to consider acquiring such equipment.

However before action is taken careful reflection should be made to ensure that two requirements are fulfilled :
- the firm must be sufficiently well organized to be able to make effective use of the computer,
- the equipment must suit the needs of the firm.

We shall make an attempt to clarify these points.

1. Introduction

Les prix des équipements informatiques baissant de façon régulière, il devient possible pour un nombre croissant d'entreprises de construction d'envisager leur acquisition.

Toutefois, une telle opération doit être mûrement réfléchie pour répondre à deux exigences :
- l'entreprise doit être suffisamment organisée pour utiliser l'ordinateur efficacement,
- l'équipement doit être adapté aux besoins de l'entreprise.

Nous allons tenter de préciser ces aspects.

2. Organisation de l'entreprise

2.1 Fonctionnement actuel

La première chose à faire est d'identifier et de décrire les circuits d'organisation et de renseignements qui fonctionnent correctement dans l'entreprise. En effet, il ne sert à rien de chercher à introduire de nouvelles procédures ou habitudes de travail si ce qui est en place est satisfaisant. Ainsi, toutes les méthodes utilisées dans l'entreprise doivent être examinées, celles qui sont satisfaisantes seront maintenues (l'ordinateur devra les assurer sans perturbation).

Parmi ces méthodes de travail, citons :
- les soumissions
- les commandes de matériaux, leur facturation
- le contrôle des coûts
- le calcul des salaires
- la comptabilité générale.

Une liste plus complète en sera donnée au point 3.

On examine pour chaque aspect (soumission par exemple) les différentes étapes nécessaires, notamment :
- vérification du métré
- découpe en postes de travail
- estimation des rendements et consommations
- évaluation des prix ou demande de prix
- estimation du prix sec
- .....

Pour chaque étape identifiée, on note les personnes responsables et les documents ou renseignements sur lesquels on s'appuie. Grâce à cette analyse, on a une description très claire des circuits de renseignements; on mesure également l'utilité des documents existants dans l'entreprise en voyant à quoi ils servent.

Rappelons qu'il n'est utile de mener une telle analyse que pour les procédures qui sont satisfaisantes en vue de les expliquer ultérieurement au programmeur.

2.2 Souhaits d'organisation

La direction peut profiter de l'événement pour améliorer certaines méthodes d'organisation. En réunissant les responsables, on peut définir une nouvelle manière de procéder et la compléter par les documents nécessaires. L'idéal serait de tester cette nouvelle procédure manuellement, ce qui n'est pas toujours possible.

2.3 Préparation à une informatisation éventuelle

Il convient d'être bien conscient que l'ordinateur ne pourra fournir des états utiles que si les renseignements nécessaires sont collectés. Il y a là un problème d'éducation du personnel.

A l'inverse, il est néfaste d'exiger des renseignements qui ne peuvent être fournis correctement par le personnel (p.ex. un pointage avec des postes trop fouillés). Là encore, l'analyse effectuée permet de mieux réaliser le volume et la facilité d'obtenir les données.

Un second point est de préciser la forme de présentation des résultats ou rapports souhaités. Ceci est une aide appréciable lors de la programmation et évite de nombreuses déconvenues.

Enfin, pour les problèmes où l'entreprise envisage le recours à l'informatique, un ordre chronologique ou une priorité est des plus utiles. En effet, il sera prudent de procéder par étapes. Ici encore, ces priorités seront fixées a priori selon les besoins de l'entreprise et non en fonction des possibilités de l'équipement (ou les programmes disponibles).

3. Applications possibles

Nous allons citer les principales applications possibles en nous référant aux priorités fixées par un groupe d'entrepreneurs.

3.1 Contrôle des coûts de chantiers

Ceci va impliquer principalement :
- l'enregistrement des heures prestées par les ouvriers, par poste, la comparaison aux budgets

- la concordance des factures de matériaux et sous-traitants avec les livraisons et les conditions de commande
- l'enregistrement des prestations du matériel et le contrôle du tarif.

3.2 Le calcul des salaires et appointements

Ceci implique l'enregistrement journalier des heures prestées par ouvrier.

3.3 Les états d'avancement et les factures aux clients

3.4 Les soumissions

Ceci avec la possibilité
- de se référer à des postes internes de l'entreprise
- d'obtenir les budgets d'exécution pour le contrôle.

3.5 La comptabilité générale

Ceci avec tous les contrôles des pièces comptables, le suivi des comptes clients et fournisseurs.

3.6 La gestion financière

On peut aborder les aspects suivants :
- prévision mensuelle de trésorerie
- contrôle de rentabilité d'entreprise
- prévision annuelle et décisions de ressources financières, objectifs de marché.

3.7 La comptabilité analytique

Ce qui implique la ventilation des recettes et débours par chantier et service, le contrôle des frais généraux d'entreprise et leur couverture.

3.8 Planification des chantiers

- Analyse des travaux
- Affectation possible du personnel et du matériel de l'entreprise
- Calcul possible des dates de fournitures et d'intervention des sous-traitants
- Planification à court terme et réactualisation du planning
- Planning d'occupation de la main-d'oeuvre et du matériel au niveau de l'entreprise.

3.9 La gestion des stocks

La faible priorité de cette application provient du fait que peu d'entreprises constituent des stocks de matériaux ou de pièces de rechange. Les aspects suivants peuvent être abordés :
- inventaire permanent
- livraisons aux chantiers
- calcul du prix unitaire.

En vue de déterminer l'ordre d'implantation souhaité dans l'entreprise, on s'inspirera des deux arguments suivants :
- considérer les travaux obligatoires (salaires, TVA, états d'avancement, ...)
- augmenter l'efficacité de l'entreprise, en particulier en fixant des objectifs plus précis (budgets heures d'exécution, planification, trésorerie, commandes dans les délais, ...)

L'état d'organisation de l'entreprise et ses possibilités d'évolution fixeront en fait cet ordre d'implantation.

4. L'ordinateur

En dehors des prouesses techniques auxquelles les constructeurs font volontiers référence, une série de points sont à considérer en vue d'orienter le choix.

4.1. Le hardware ou ce que les Français appellent la quincaillerie. Actuellement, il y a peu d'inquiétudes à avoir à ce sujet, la fiabilité étant bonne. Ce dont il faut se préoccuper est la possibilité d'extension. En effet, en vue d'être concurrentiels, les constructeurs proposeront l'équipement qui suffira strictement aux exigences de départ. Il est certain qu'après quelques années, vos besoins vont croître et des extensions seront nécessaires. Dès lors, il convient au départ de se préoccuper des extensions maximales possibles de l'équipement présenté (nombre d'écrans, mémoire centrale, disques). Si cet équipement est saturé, certains constructeurs peuvent proposer un autre équipement de la même série qui soit entièrement compatible quant aux programmes de l'utilisateur.

4.2. La plupart des équipements permettent le traitement en temps réel, c'est-à-dire d'une manière interactive avec l'utilisateur. Ce dialogue s'effectue le plus souvent à l'aide d'un écran. Il y a deux avantages principaux à ce mode interactif :
- l'utilisateur a une réponse au moment où il est confronté à la question. Auparavant, il fallait remplir des formulaires et attendre le lendemain pour avoir une réponse. De plus, en cas d'erreur des données, la réponse était postposée d'une nouvelle journée. Grâce à ce dialogue, l'entrée des données est grandement facilitée et une série d'erreurs est immédiatement détectée.
- on évite le passage par une perforatrice qui ignore ce qu'elle encode et ne peut donc corriger des erreurs d'écriture.

Il reste toujours possible pour de gros volumes d'avoir recours à une dactylo entraînée à cet effet (par exemple, pour enregistrer les intitulés des postes d'un métré).

4.3 Les programmes du système

Le constructeur accompagne son équipement d'une série de programmes de base du système, qui vont faciliter le travail de l'utilisateur. Parmi ceux-ci citons :
- les langages évolués mis à disposition de l'utilisateur : Cobol, Basic, RPG, ...
- la gestion du formattage d'entrée
- la gestion des fichiers: définition, accès, modification d'enregistrements. Sur ce point surtout, de grandes différences existent.
- la possibilité d'interrogation d'un fichier (query) qui permet de sélectionner un groupe d'enregistrements selon des critères non fixés d'avance
- des programmes d'élaboration de rapports (facilite la mise en page d'éditions souhaitées)
- des programmes de traitement de textes, en vue de faciliter des corrections ou modifications (peut servir à l'envoi de lettres types)
- la possibilité de se connecter à d'autres équipements (en vue d'utiliser des programmes peu courants ou d'avoir accès à des fichiers).

Les trois premiers points sont d'une importance capitale pour la facilité d'emploi et de programmation du système.

4.4 Bibliothèque de programmes

Certains constructeurs proposent également des programmes pour des applications précises (réponses au point 3). Il convient de ne pas s'arrêter au titre du programme mais de s'interroger sur son contenu et s'assurer qu'il répond bien aux souhaits de votre entreprise.

4.5. Parmi les applications souhaitées par l'entrepreneur, un certain nombre resteront à programmer. Quelle est la solution offerte par le constructeur ? Accepte-t-il de prendre une part de responsabilité dans leur élaboration ? L'offre faite, l'est-elle à un prix forfaitaire ? Le constructeur se contente-t-il de vous proposer des cours de formation en vous laissant le soin de développer vos programmes ?

Il convient ici d'être très prudent et de ne pas sous-estimer la charge de travail d'une telle mise au point. Certains constructeurs ont des "Clubs d'utilisateurs" qui permettent d'échanger des expériences et parfois des programmes. A moins de disposer de services informatiques puissants à l'intérieur de l'entreprise, il est préférable de pouvoir s'appuyer sur un groupe professionnel qui vous permettra de progresser plus rapidement et vous évitera des mises à jour pénibles (taux de charges sociales, réglementation comptable, ...).

En tout état de cause, il est recommandé de passer un contrat global pour l'équipement et les programmes, ce qui vous donne un prix du service effectif avec des garanties.

4.6 La maintenance de l'équipement

Un équipement ordinateur nécessite une maintenance régulière et, malgré cela, n'est pas à l'abri d'une panne. Quelle est la durée avant l'intervention de l'équipe de dépannage ? Quelle est la sécurité proposée par le constructeur en cas de panne prolongée de deux ou trois jours par exemple ? Ceci peut conduire à de graves problèmes en cas de paiement de salaires en particulier.

4.7. Le coût

Le prix d'investissement est le plus évident, toutefois, le coût total est de deux à trois fois plus élevé. Le coût total comporte :

- la maintenance (de 8 à 10 % de l'investissement par an)
- le local
- la programmation
- le software du système.

4.8 Le délai de fourniture

Enfin, dans certains cas, le délai de fourniture peut être un handicap pour l'entreprise en retardant son évolution. Des délais de 3 à 5 mois peuvent être considérés comme normaux.

5. Le choix

Plusieurs approches sont possibles en vue d'aboutir à un choix. La plus simple est de procéder par éliminations successives. On se fixe quelques critères essentiels concernant

- l'équipement
- les programmes

et on examine les offres. Celles qui ne répondent pas sont éliminées. Pour les équipements retenus, on élabore un tableau comparatif qui permet d'avoir une vue d'ensemble de tous les critères. A ce moment, on complète par l'aspect commercial en formulant le prix de la même manière pour tous les concurrents.

6. Conclusion

Le but du recours à l'ordinateur doit être de limiter le personnel administratif et l'encadrement technique tout en ayant une meilleure gestion. Ceci est possible car une série de tâches d'intendance sont assurées par l'ordinateur et l'efficacité du personnel en est accrue. Une amélioration de l'organisation est le fondement d'une meilleure rentabilité de l'entreprise. Et l'organisation passe par les hommes avant de pouvoir s'aider de l'informatique.

Les Services d'Agrément chez les Pays en Développement pour les Nouveautés dans la Construction
et
leur Union Régional à Vocation Commercial

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Résumé

Dans l'exposé, en partant des mouvements de l'innovation et l'exportation dans la construction, on fait une justification du service de l'agrément pour les nouveautés technique chez les pays en développement aux situations économiques différentes correspondant plus ou moin à l'agrément européen. On propose aussi un modèl d'un système d'agrément convenable pour la Turquie. Et on le prévoit dans une union régional d'agrément ayant le but de promotion du service d'entreprise à l'étranger.

Summary

This paper, moving from the development of innovation and exportation in construction, justifies the system of "Agrément" for technical novelties in developing countries of different economical situations, corresponding more or less to the West European "Agrément"s. Here is also proposed a convenient model for Turkey, and this model is foreseen in regional union for "Agrément", vocative of promotion of enterprise in foreign countries.

O. Introduction

A l'entré du 3ème dixaine de développement mondial, en tenant compte la faiblesse du moyen de croissance économique en 1978 et 79 (4% et 3% réciproquement), faisons l'attention des objectifs de développement pdincipaux surlesquelles accentuent les organisations internationaux ou régionaux comme Banque Mondial, EOCD[x], la Conférence Islamique, GATT, UNCTAD, UNEP, UNICEF, UNDP-surtout par l'intermédiaire de Conférence de la Coopération Technique entre les Pays en Développement (TCDC) et Conférence de Science et Technologie pour le Développement (UNSTCD)- et UNIDO dans la cadre de la Nouvelle Ordre Economique International (1974) et de la Nouvelle Stratégie International pour Développement (1979), signalant l'augmentation de l'interdépendance entre le Sud et Nord:

a) transfére des sources et moyens substentiels du Nord au Sud ,

b) aide et coopération scientifique et technique pour Sud,

c) aide pour l'industrialisation du Sud

d) Développement de commercialisation international.

Les objectifs consistent à augmenter la place de produits industrialisés à l'origine de Sud dans le total mondial du 9% au 25% jusqu'à 2000 et le niveau de commercialisation dans le même sujet et cadance, de 4% au 16%. Et on vise même un balance commercial même dans le secteur industrialisé entre le Sud et Nord en 2000.

D'autre part on cite les autres objectifs de développement spécialement pour les pays industrialisés:

i. transformation tec hnologique

ii. élevation de production (manque de main d' œuvre)

iii. efficacité dans l'utilisation de ressources

Dans touts ces objectifs, les nouveaux facteurs de croissance économique KOT (Knowledge, Organisation, Technologie) sont dominants par rapport aux facteurs physiques LCR (Labour, Capital, Ressource). La participation du KOT au croissance représente 65 - 75%, tandis que LCR 25 - 35%.

Parmis les mesures ou recommanelations de réalisation de ces objectifs on peut citer le fond mondial de l' UNIDO qui a de vocation d'industrialiser le Sud, le fond de l'UNSTCD qui supporte les instituts aux cooperation technologique et industriel entre les pays en developpement, l'institut International de Technologie Industriel conçu de la part UNIDO et les recommandation de la Plan d'Action de TCDC:

R11. Encourrager Coopération Technique entre les pays en developpement par les organisations professionelles et techniques.

R15. Renforcer les instituts et organisations régional pour les activités du TCDC.

Tout ces tâches se répercutent évidement dans le secteur du construction qui s'industrialise et commercialise plus en plus. La construction prend un place importante dans l'économie avec le 10-20% du PNB et plus la moitié de totalité des investissements. Elle emploie aussi le 15% de l'effectif total de la main-d' œuvre. L'enjeu est du taille aux répercussions économique considérables.

Dans et exposé on propose une organisation spécialisée pour le pays en développement et son union régional intergouvernemental que ont des missions en voie de réalisation des objectifs et se fait des mesures citées cidessus.

1. Deux évennements dans la secteur du construction: innovation - exportation

Le deuxième moitié de 20ème siede est devenu l'ère du innovation dans la construction. Le motifs sout cidessous:

a) l'obligence de l'augmentation de productivité: le croissance de demande dû au Deuxième Guère Mondial, puis au préoccupation avec les problèmes de Sud, qui augmente avec l'interdepandance exité entre le Sud et le Nord par

[x] l'abréviation est tenu en englais

la valorisation du matière première ainsi que le source et au croissance démografique de Sud. D'après un recherche de Peter Adamson, pour NU, de groupe de l'université pour 3ème monde, le besoines primordiaux pour le monde sont la nourriture, l'eau, le soigne sanitaire, le logement, l'education et le'travail. Le logement prend place entre eux, c'est à dire la construction. D'après un programme de UNICEF dans 15ans (à partir '76) on a prévu procurer les besoins primordiaux d'un millard de gens qui en sont présque dépourvus. Seullement pour les habiter on doit construire 200 millions de logement dans 15 ans, en tenant compte du moyen de dimention de famille de Sud à cinque personnes. C'est à dire construire 14,5 millions par ans. En constatant l'empleur de demande il faut trouver les nouveaux procédés.

b) Répondre aux exigences de l'utilisateur: Aujourd'hui l'homme veut trouver les conditions de confort qui ne changent pas dans tout le monde, dans le milieu bâti. C'est à dire nous devont construire en assurant les performances exigés chez les éléments du bâtiment. Cela invite aussi des nouveautés.

c) Economiser et rendre efficace les utilisation des sources pour atténuer la pressions inflationistes. C'est vu réaliser à la fois par les conceptions et procédés nouveaux.

d) Les efforts de promotione de l'exportation dans la construction. Exporter le savoire-faire, des services de project, d'entreprise et des produits pour construire dans le milieu différent et l'obligence des transportation à long distance provoquent les nouveautés. Tous ces nouveautés entrainent généralement la construction à l'industrialisation. Il y a aussi les freins à l'innovation, puis à l'industrialisation: la règlementation et l'insuffisance de série de production.

Retournons à l'exportation qui n'a pas vu un épanuissement désiré. Il y a deux entraves principaux qui interresent le milieu de construction: (1) la faiblesse de la valeur au poids des produits, qui s'appaise plus en plus avec les problèmes afférant l'énergie et (2) la differance entre les règlementations nationaux et même locaux. D'autre part il y a des barrières commerciaux tarifaires et non-tarifaires qui comptent quelques certaines. Mais aujourd'hui il y a certaines motifs principaux qui poussent la construction à l'exportation: L'un est la récession de secteur au nord dû à la satisfaction de marché et la hausse de prix matière première; l'autre est les tâches qui consiste à développement de Sud et l'attraction de marchés du pays riches du petrol qui leur manquent généralement de savoir-faire. Bien que les motifs moteurs, le commerce international des produit de construction n'entre que pour une faible part-généralement inférieure à 5%- dans le volume total du commerce international de la plupart des pays européens. Même en tenant compte des recettes provenant de la vente des brevets, des services professionnels et des activités des entrepreneurs en dehors de leur propre pays, la contribution du secteur de la construction au commerce exterieur demeure proportionnellement beaucoup plus faible que sa contribution au produit national brut (10 - 20%).

La hausse très marquée des coûts relatifs de l'énergie a provoqué l'augmentation des coûts des transports, tout particulièrement des transports routiers et ferroviaires. Cette hausse tend à diminuer le commerce des matériaux de construction qui ont une faible valeur au poids et à renforcer en revanche la tendance au developpement du commerce des matériaux fabriqués, des machines et des équipements qui ont une forte valeur au poids. L'attrait economique d'un commerce portant sur la technique plutôt que sur les matériaux ainsi que les avantages des investissements directs ou de la prise de participation dans la production locale des matériaux de construction s'en trouveront beaucoup renforcés. Malgré tous cela les activités des entrepreneurs importants (voir le Tableau V) à l'étranger ne représantent que 5% dans le volume total du commerce international. Tandis que les produits les produits industriels y représantent plus 50%.

Pour surmonter l'entrave de règlementation, on s'efforce les rendre internationaux, au moin régionaux par la voie de la nouvelle conception de règlement au base fonctionnel ou bien "au base de performence" au lieu de "descriptive". Au milieu de NU-CEE, NKB, CAEM et dernièment dans la cadre de CCE on a déja accompli beaucoup progré. Mais cela n'est pas facil à aboutir et les appliquer. Parce que tout d'abord la vérification des règlements fonctionel exigent un niveau de connaisance assez élevé chez les technissiens de la construction et des épuipements d'essais importants.

Alors, que faire pour la promotion de commerce? Il y a mille des chauses à surmonter tant financiel et administratifs que techniques. En tant que techniciens, on propose le systéme d'agrément(x) technique pour favoriser les nouveautés dans la construction vis à vis de la règlemantation traditionelle et l'union de l'agrément régional pour promouvoire l'exportation en rendant valable les nouveautés au moin dans le niveau régional.

2. Proposition sur les modalités de "l'agrément" converable pour les pays en developpements

C'était just à lendemain du commencement de l'industrialisation dans le bâtiment, le besoine de l'appréciation et l'approbation des procédés et produits non-traditionnel entraîne les plusparts des pays d'Europe occidental -et dernièrrement l'Afrique de Sud- à organiser son service d'"Agrément" technique dans la construction. D'après le Système en France qui est précurseur dans ce domaine, "l'agrément" est un jugement formulé par un commission constitué de la part de tous représantant de la construction, en matière de l'aptitude à l'emploi des procédés, matériaux, éléments ou équipements utilisés dans la construction lorsque leur nouveauté ou celle de l'emploi qui en est fait, n'en permet pas encore la normalisation, réglementation. Les plus-part entre elles s'exercent au

(x) Dans ce texte le mot d'"agrément" n'a pas le sans strict, il couvre touts les sens où on l'utilise en Europe de l'Ouest en matière de nouveautés dans a construction ainsi que l'Avis Technique en France.

sein des institute de recherche sur la construction. Ces institutions ont fait la coopération en 1960, afin de creér leur union régional: UEA_{tc}

Elles ont vue ou voient des modifications. Par exemple en France l'agrément technique" qui était plus imposant dans la secteur autrefois. s'est converti à "l'avis technique" depuis 1971. Il traitait les sujet seulement non-traditionnel mais maintenant les nouveautés. D'autre part en Grande-Bretagne, un groupe d'étude spécial vient de demander que le Comité d'Agrément soit absorbé par un autre organisme plus important comme le BRE, La National Building Agency on British Standard Institution. Même on cherche la mesure dans la quelle "l'agrément"s pourraient ou devraient fair partie intégrante des code ou règlements nationaux. Et Malgré de récession dans la construction, le développement d'agrément ne cesse pas; en France certificats d'agrément atteint vers 1900.

En tant qu'un la certification ou bien un avis, l'agrément a un coté de l'application référentielle: les normes, les règlements,des exigences les directifs communs servent la base pour accorder un agrément. Un autre coté de l'agrément, comme les autres certificats, est processus de jestion de qualité: control et assurance de qualité (l'agrément suivi et marqué).

Avant d'aborder la question de l'agrément pour les pays en développement, cela vaut noter ce que l'agrément européen préoccupe de l'efficacité de technologie et du qualité de produit nouvel plustôt que la technologie ou bien le produit approprié à l'economie. Seulement dans l'arrêté de l'agrément ancien (1958) en France on parlait de "l'utilisation rationnelle de la main-d'œuvre et matière premierès. Puis, chez les pays industrialisés l'évolution d'agrément doit à l'abondance de procédé et produit non-traditionelle et son mission primordialle consiste à les identifier et évaluer au profit de producteur, entrepreneur, le promoteur et l'utilisateur.

"L'agrément" pour les pays en developpement aussi doit avoir la même mission premièrement, mais il y a les autres, dues à certaine situation économique, que l'agrément assume. Dans le tableau I on récapitule la corrélation entre les pays par catégorie économique et leurs situations dominantes d'où sortent les mission d'agrément et on arrive quelque type de l'agrément par exemple ABCD. C'est une sorte de justification d'agrément par catégorie de pays en développement, une résumée de sa mission principaux . Prencns de l'agrément dans un système A/qui donne les situation principaux de la Turquie, le Tableau II récapitule les origines de réquisition de l'agrément ou bien seulement l'avis et les milieux qui sont susceptible d'en exiger.

Quand son champ d'application, générallement pour, tous les pays en developpement, on prévoit qu'il ne couvre pas seulement le bâtiment, qu'il s'occupe de l'environnement bâtis et de l'infrastructure. Les nouveautés chez ces secteurs s'influencent. On a besoin transfére de connaissance entre eux. L'exigence de l'homme se déborde de l'intérieur à l'extérieur. L'autrefois la nature peut arriver à satisfaire l'homme à l'extèrieur,mais maintenant les hommes doivent arranger l'environnement.

Tableau I- Les types de service d'Agrément pour la construction par rapport à la situation économique du Pays.

Dispositions dominantes relatif à la construction qui exitent établissement d'un système d'agrément \ Catégories des pays en développements	à l'économie libéral semi-industrialisé	riches de ressources naturels	sous-développé soutenu avec les invessetisements étrangères	à l'économie centralisé-industrialisé ou semi-industrialisé
Encourrager les nouveautés les rendre acceptable dans le marché et sauvgarder les consommateurs	x			
transfert de la technologie appropriée	x	x	x	x
Mesures de protectionisme pour l'exportation	x			x
Mesures de protectionisme pour substition aux importations	x			x
l'aide de l'état et les crédit organisés	x	x	x	x
Exportation de savoir-faire des produits et des services de project et d'entreprise	x			x
Importation de savoir-faire des produits et des services de project et d'entreprise		x	x	
Privation ou lacune de réglemantation		x	x	
Type de de système de l'agrément pour les pays en développement	A	B	C	D

D'autre par toutes les dispositions qui ne sont pas devenus le sujet de réglementation en vigeur, peuvent être le sujet de l'agrément avant le démarche de lui réglementer qui risque ou bien peut être long. Comme nous avons déja indiqué, le propriété le plus accentué de sujet de l'agrément est de nouveauté. Le Tableau III présente le domaines de nouveauté dans le bâtiment, constitués pas seulement des procédés et produits de construction, mais de méthodes de conception ou calcule aussi. Enfin les procédés traditionels évalués aussi so t comptés comme le sujet d'agrément pas seulement les procédés industrialisés. Donc la champs d'application, peut être entourée dans un domain beaucoup plus large que celui de l'agrément européen.

Nous citons les missions indirectes et latéraux que l'agrément sera accompli ou devra accomplir.

. Stimuler et encourrager les nouveautés

. Définir des axes technologiques dans la construction pour l'avenir et d'après eux organiser les concourts afin de les réaliser.

. Concrétiser les resultats de recherche

. Devenir un centre d'information et documentation qui fait la collection, collation et classification des nouvautés dans la construction.

. Donner l'information pour l'enseignement et pour le milieu de recherche dans le bâtiment

. Donner le document pour les agence de technologie

. Promouvoir l'effort pour établissement de réglementation sur la base du fonetionnement.

. Servir comme règlement de construction dans le pays où il n'y a prèsque pas règlementation traditionnele.

Il faut accentuer sur certains natures de l'agrément pour les pays en developpement: L'agrément doit devenir un instrument comme support de l'état. Il doit financer par l'état. On discute si ce qu'il soit facultatif ou obligatoire, et si ce qu'il doit étre indicatif ou imposant.

Tableau II-Corrélation entre les demandeurs de l'agrément ou l'avis et les milieus relatifs à la construction pour lesquelles ils disposent, chez le système d'agrément(A).

Le demendeur de l'agrément ou l'avis / le milieu de la construction exigeant l'agrément national, régional ou l'avis pour les nouveautés	Etablisseur de métodes nouveaux relatifs à la conception et à la calcul	détendeur de nouvel procédé	fabriquant des nouveaux produits	entrepreneur travaillant avec le procédé nouvel	entrepreneur travaillant à l'étranger
Commerce extérieur et intérieur pour les produits			x		
Promoteur (indigène ou étranger)		x	x	x	x
Maître d'œuvre	x	x	x	x	x
Bureau d'étude technique		x	x	x	
Maître d'ouvrage		x	x.	x	
Entreprise travaillant avec le procédé d'autrui (à l'intérieur et l'extérieur)	x	x	x	x	x
Société d'assurance	x		x	x	x
Institution de crédit			x	x	x
(x)Etablissement de politique et de planification		x	x	x	x
(x)Mécanisme de protectionisme			x	x	x
(x) Mécanisme de trasfert de la technologie appropriée		x	x	x	

(x) le milieu où peut se contenter d'avis.

Les critère d'évaluation de l'agrément pour les pays en développement se groupe en quatre:

i) L'aptitude à l'emploi par rapport les exigences utilisateurs (voir "ISO Rles exigences humaines et Guide de Performance dans le Bâtiment de CSTC)

ii) Les exigences contructives: le simplicité, l'interchangeabilité, le flexibilité, la prévention d'accident etc.

iii) La protection d'environnement: le bruit, l'élimination de déchets, la déstruction, la réutilisation, le recyclage, la déterioration microbiologique, la radioactivité etc.

iv) Les objectifs économique de développement régional ou national: L'agrément n'est pas un évaluation de project d'invessement mais on doit prendre en compte sa conformité à certaines facteurs économique. Par ex., l'optimisation de l'utilisation de ressource naturel (coût d'opportunité), l'échèle optimume de réalisation en site, le quantité à capital intansif ou à main-d'œvrue intensif, le type de source d'énergie et l'économie d'énergie (Dans le bâtiment on consomme 35-40% de l'énergie total consommé dans le monde et en 2000, on vise que 50% de l'énergie économisée dans le monde, se réalisera dans secteur bâtiment et ses services relatives.

Tableau III- Mémo-matrix pour les domaines des nouveautés susceptibles de se réveler dans la construction

les sujets / le processus	A matériaux	B matériel	C composants ou	D équipements	E batiments ou pieces de bâtiments
(1) métode de conception métode de calculation métode de l'apréciation rapide du coût et métode de l'établissement de devis					x
(2) métode de vérification et d'essai de spécification	x	x	x	x	x
(3) production en usine	x	x	x	x	x
(4) transportation (matériels amballages)	x		x	x	x
(5) réalisation en site			x	x	x
(6) exploitation et entretient				x	x
(7) rénovation				x	x
(8) élimination des déchets, déstruction, réutilisation, recyclage pour (3),(5),(6)	x		x	x	x

Tableau IV représente un système d'agrément au type (A) par exemple pour la Turquie. On trouve qu'il vaut mieux le nommer par la service de l'"Identification & Evaluation" (I & E) pour les nouveauté dans la construction.(x) Les ministère et l'institution de recherche qui s'occupent de la construction initiéera son établissement. Il décerne la certificat (ou bien document) de l'"I&E" national ou régional ou bien seulement l'avis, à l'intérest pour certaine service, qui ne seront pas publié. Le controle et l'assurance ne sont pas prévu dans le service de l'"I &E".

Comme justification de l'"I&E" pour la Turquie quelques chiffres méritent d'être cités: On a constaté 73 firmes de construction qui s'intéressent aux procédés nou veaux (industrialisé). Parmi eux 40 ont construisent actuellement, avec les procédé étrangers, ayant profiter

(x) L'auteur travaille sur ce sujet à l'Institue du Recherche du Bâtiment.

des mesur de protectionisme. Et de'54 à '78 on compte 20 contrats de licconces pour les matériaux nouveaux. C'est à dire l'"I & E", généralement l'agrément pour les pays en développement doit accentuer sur la mission d'être la comités consultatifs dans la sec teur de la construction pour la mécanisme de transfert de la technologie.

D'autre part notons comme justification d'agrément qu' il y a quelque pression en Turquie afin de règlementer ou bien normaliser des nouveautés même avant leur application.

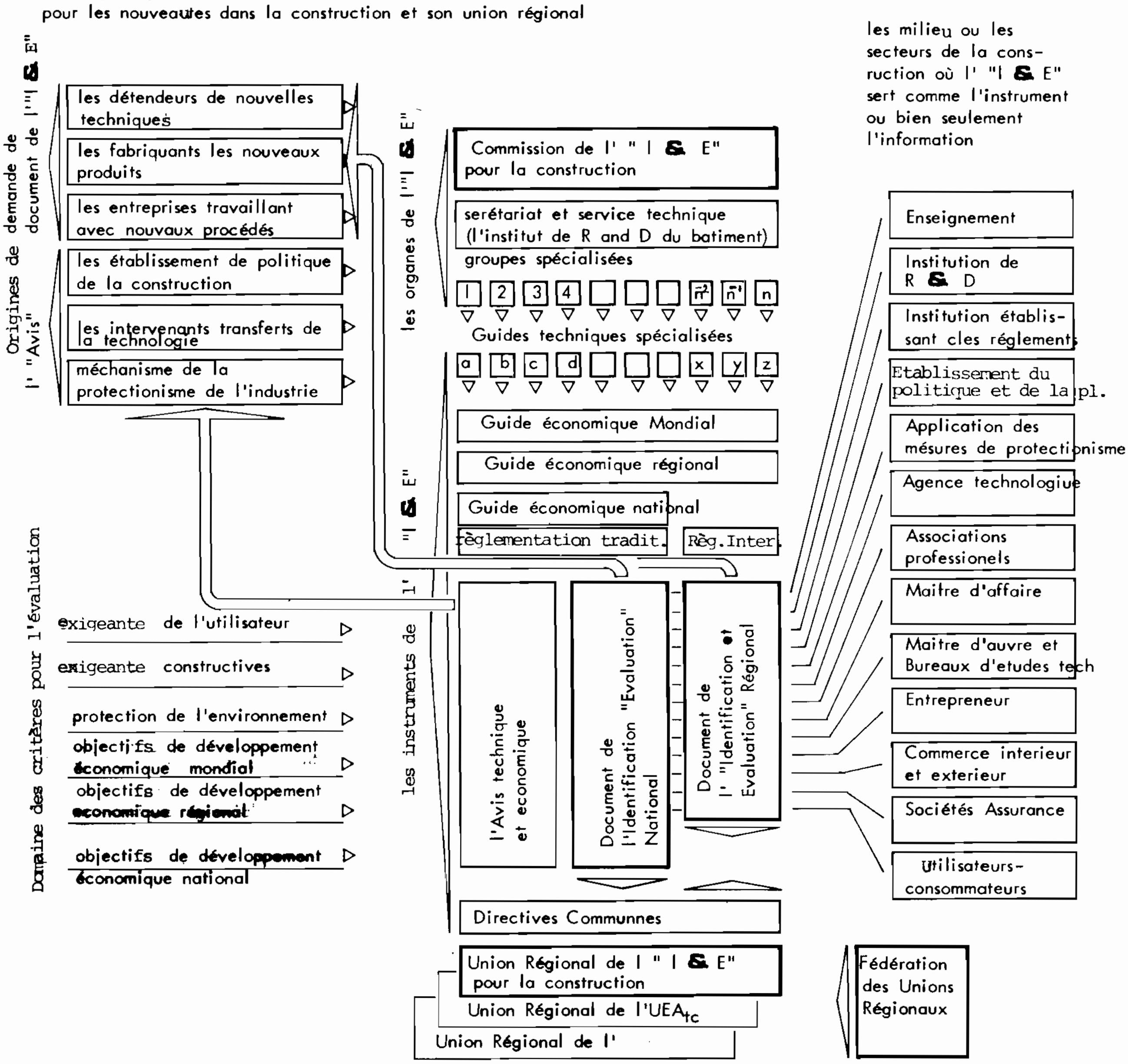
3. Union régional de l'agrément ayant le but de promouvoir de commerce dans la secteur du construction ainsi que de faire l'échange de connaissance

Les pays situé dans une région limitée (la distance compte beaucoup dans la construction) peuvent coopérer pour former une union par l'intermediaire de l'institution d'agrément, faute de l'agrément, un autre institution impartiale, non but lucratif, qui s'occupe de la construction. D'après la stratégie de région, les vocation des unions change un peu l'un à l'autre. Mais ses vocations primordial seront inévitablement la commerce ou bien l'échange relatif à la construction entre les membres. Aujourd'hui, UEA_{tc} qui est le seule union d' agrément, a la même mission.

Prenons la Turquie qui est situé tout à la proximité d'une région où on construit beaucoup par l'étranger: La péninsule arabique, et Afrique du Nord (voire le tableau V). La Turquie a des autre facteur qui favorisent la construction à l'étranger: un certain niveaux de connaissance, la main-d'œuvre disponible et en plus la réligion. Mais la Turquie, et certaines autres pays en développement dans cette région sont mal lotis dans ce marché. Par exemple la somme totale de contrats 1978 des entreprises, bulgares, égyptiens, grècs, isrealiens, lebanes, pakistaniens, roumains, turcs, yougoslavs a un part seulement 8% de tout la somme totale de contrats relatifs cette région (voir le tableau V). Tandis que

Tableau IV

La morphologie du service de l'Identification and Evaluation" (" I & E ") pour les nouveautes dans la construction et son union régional



la somme de la population de ces nations atteint 18% de population totale de tous les nations qui construisent dans ces région. D'autre par les pays riches de pètrole dont le niveau de connaissance dont la construction ne sont pas élevés, n'ont pas un organe assez compétant qui défence leur intérest technologique. Les deux genres des pays même les pays assez favorisés (comme la Grèce) peuvent réunir dans une "union régional d'agrément" gouvernemantale pour promouvoir leur situation technologique. L'union se fait un conseil importial surtout pour les pays où on construit. Les nouveautés de construction, mêmes les plusieurs procédés et produits traditionel qui sont nouveaux pour les pays arabes, seront agréés par un par dans la niveau régional à l'aide de directifs communes qui visent satisfaire les exigeances des pays en construction. Un fois l'entrepris qui travaille avec ces nouveauté ou le fabriquant qui en produit, a un agrément régional agréé par union, il aura bien favorisés pour les contrats internationaux, et dans les marché de région. Cette union sera l'instrument pour réaliser les objectifs de développement cités au paragraphe (O). Elle sera évidement encourragé ou même aidé de la part plusieurs organismes internationaux ou bien régionaux ainsi que UNIDO, CIB, UNEP, Conférence Islamique etc.

La Turquie après avoire établir son service de l'"I&E" invite les pays de cette région instituer un "union d'agrément régional". Cette union aura des relation avec UEA_{tc} afin d'utiliser de son expérience et son niveau de connaissance, ainsi que CEE.

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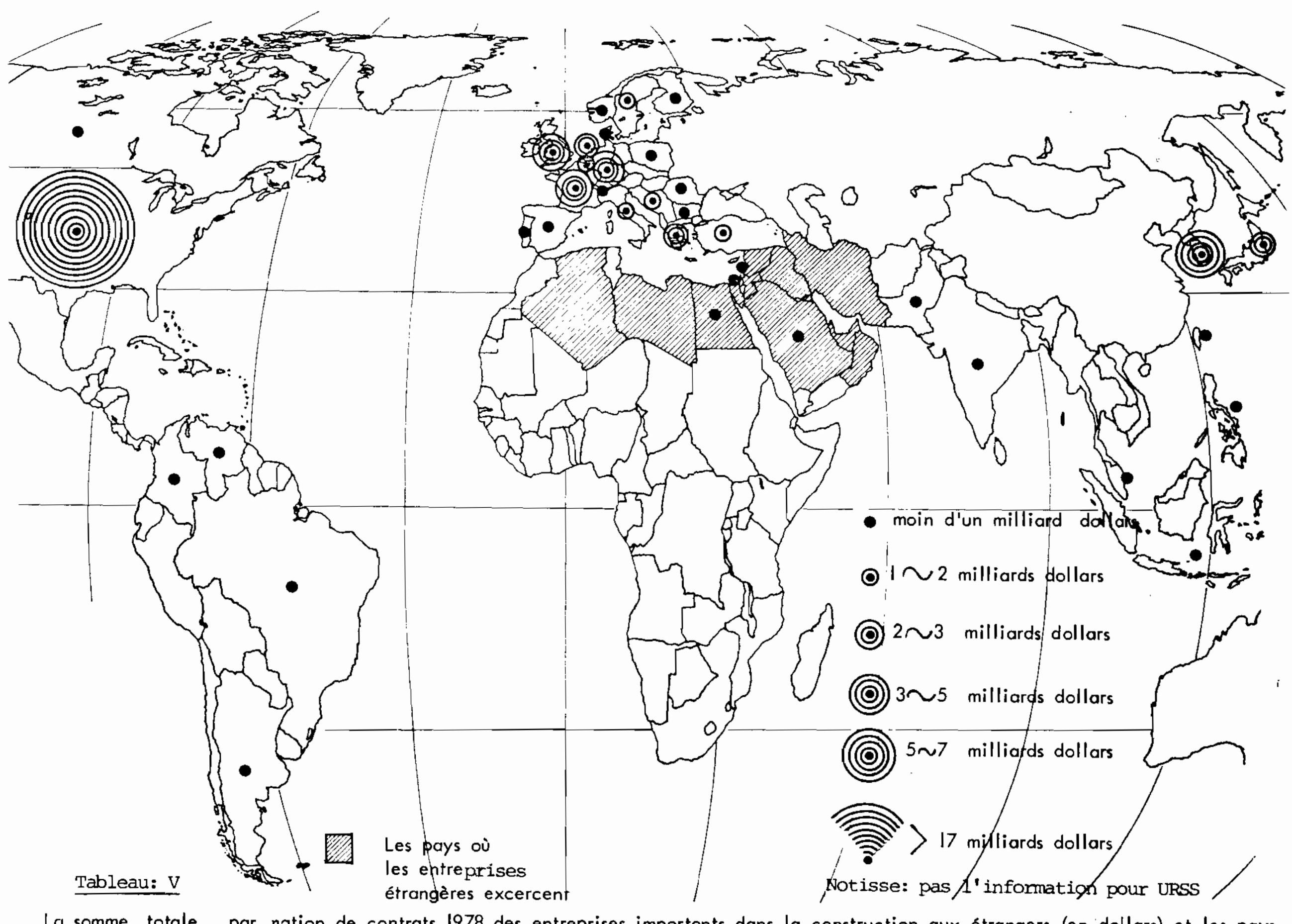

Tableau: V

La somme totale , par nation de contrats 1978 des entreprises importonts dans la construction aux étrangers (en dollars) et les pays de réalisation (d'aprés les informations tirées de "International Construction Week and Engineering New-Record - 1979"

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Objectives and Activities of the NCCL
An example from Iraq

Presented by Dr. Mufid Abdulwahab Samarai
Director General of NCCL

The National Centre for Construction Laboratories was established in November, 1976 - its Head office is situated in Baghdad and it is attached to the Ministry of Housing & Construction and consists of four main laboratories (Baghdad, Arbil, Babylon & Basrah) and of branch & field Labs. distributed throughout the country as shown in fig. (1).

The prime specialization of the Centre is as follows:

1- Carry out laboratory tests for all types of construction materials, soil investigations and all necessary tests on construction works carried out by the Ministry's subsidiary Organizations & Directorates and by the Ministries & Organizations of the general sector against fees.

2- Endeavour to enchance the standard of technical performance of engineers & technicians in this respect and to arrange special courses in respect of qualifications and training.

3- To carry out applied research on construction materials and works in order to determine & realize the best methods in construction of roads & structures in coordination with the organizations of the respective research..

4- To compile the research which are issued by universities and by scientific, National and Foreign organizations related to the specialization of the Centre in order to prepare them and place them before the establishments and those spezialized.

5- Undertake to carry out any other activities which enable the Centre to realize its objectives.

The Centre undertakes to collaborate and contract with Government Departments, National Organizations, universities, Foreign Establishments, specialized persons and the consultants' offices related to its line of specialization.

N.C.C.L. is considered the largest Centre for Quality Control in the Middle East and was diverted from a Centre which conduct routine testings to one responsible for Quality Control for the Ministry's works and has participated in all modern scientific development in its line of specialization by arranging research works, studies and scientific training courses which were carried out to raise the ability of the technicians to the required standard, and by also conducting many experiments which were proved successful by finding replacements for the presently utilized construction materials and include Non-destructive tests as a developed scientific measure which, if applied, it realizes a large income to the public economy.

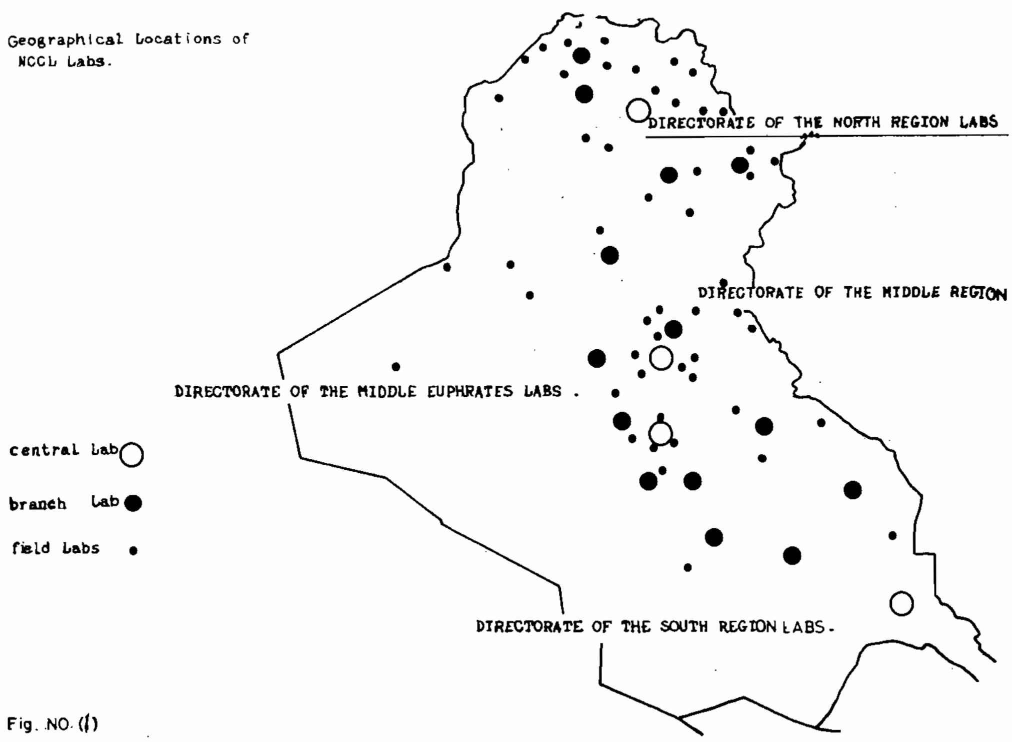

Fig. NO. (1)

The activities of the Centre are the following:

1) Soil:-

Soil investigations.

Drilling parties:-

The Centre has over 20 drilling parties distributed all over the country's governorates.

The Centre, since its establishment, endeavoured to increase the number of these parties as it was previously one drilling party only as shown in fig. No. (2).

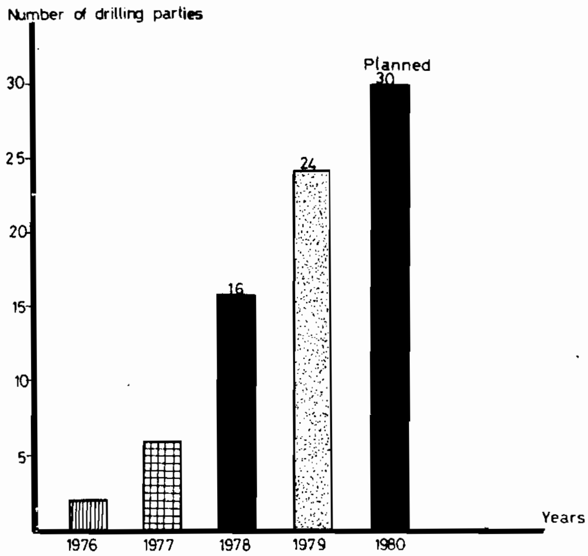

Fig. No(2) Number of drilling parties

The Centre purchased different types of machines in order to perform its duties in different conditions as in Iraq the nature of soil differs from one area to another - and as these machines can operate in the following conditions;-

- Rotary drilling in clay - usually used in southern areas.
- Swival wet drilling in gravel.
- Core drilling in stone and conglomerated materials.
- Down-the-hole hammer in conglomerated materials.

Shall be introduced by the Centre in the near future for hard soil as the soil is analysed and tested in order to determine its properties and issue reports and recommendations in respect of types of foundations necessary for different types of installations. Among these are Bridges, Airports, Habitational buildings, Hospitals and Hotels ... etc.

2) Construction Materials tests:-

The Centre undertakes to carry out laboratory tests for most of the construction materials in the country which include the following:-

- Reinforcement test.
- Tiles and flags.
- Curbes.
- Concrete pipes.
- Gravel, sand, soil, bricks, stone, cement, water, asphalt, mastic, concrete cubes, cylinders and cores.
- Non-destructive tests.
- Field tests.

3) Road Tests:-

Road tests include all site & laboratory tests of road compaction, sub-base and surface courses for asphaltic concrete, water-proof materials, and also airport runways and their load classification number (L.C.N.).

4) Chemical Tests:-

Our laboratories conduct testing of sulphates in sand & in soil, but our Central Labs. can carry out most of the advanced chemical tests for the different types of construction materials - 30.000 tests are carried our every year.

5) Studies & Research:-

Upon cooperation basis the Centre collaborates with the organizations & companies which belong to the Ministry of Housing & Construction to carry out tests, studies and Quality Control which the Centre endeavours to expand during 1980 - 1982.

The Centre has also expanded basis of cooperation with the Estate Company for Construction contracts, State Organization for Tourism, and is about to sign cooperation agreement with the department responsible for the project of Main Fall.

The Centre is carrying out a research for the utilization of sulphur as a binder in construction with the cooperation of the French National Centre for Applied Sciences and the Centre is also carrying out with the cooperation of the Building Establishment of the United Kingdom, a research work on a trial embankment at Marshy Areas plus many research works & studies by collaboration with the country's universities and organizations. We state below some of these studies & research which were executed or which have already been studied:-

A) No - fines concrete:-

No - fines concrete (fire aggregates) is considered a type of light - weight concrete and the fact of not containing sand will very much reduce the problems which the engineers face today as sand contains a light percentage of sulphates especially in most quarries in the Central & Southern Areas. Results have proved that the strength of concrete which does not contain fine aggregates is less than the strength of ordinary concrete. This is considered suitable for many construction purposes as in walls, partitions and floors.

B) Utilization of crushed stones in replacement of sand & gravel:-

The subject of utilization of crushed stones, which is available in the country, in concrete works is being studied and it was found that it complies with the British standards or the American standards from chemical & physical point of view for the purpose of utilization in concrete as another replacement for natural gravel & sand and it was found that the bearing of concrete made by using this kind of aggregates is not less than, if not better, than the concrete made from gravel and sand besides the fact that its expansion coefficient is less.

C) Adjusting tables of concrete mix design to suit available local aggregates:-

This subject is still under study as it was found that the tables mentioned in the American or in the British standards for the concrete mix design are not applicable when using local materials due to the fact that the properties of local materials, gravel, sand or crushed stones differ from that of other countries. Therefore, the main purpose of this study is to modify these tables to suit the materials which are available in the country.

The Centre has performed the following studies during 1977 - 1978:-

a) Sulphur as a part - substitute for asphalt in pavement:-

The N.C.C.L. have, with the collaboration of the State organization of Minerals & the State Organization of Roads & Bridges, paved 2 kilometers of road in the Northern area & 1 kilometer in the central area by using sulphur/asphalt mixture of different ratios. The physical properties of this pavement were studied and it was found that mixing sulphur & asphalt improves the stability of road and similar to asphalt, it is not affected very much by the change in temperature beside it provides larger boundaries for the binder without affecting the properties of the road.

b) Effect of sulphates on concrete:-

The country suffered from contamination of sand used in concrete by sulphates which appears mostly in the form of calsium sulphates which is considered less effective from sodium and magnesium sulphates in effecting the concrete strength, which deemed necessary to study this subject in order to find a higher limit for the sulphates allowed in concrete which comply with the requirements of the contamination present in sand and not to depend on the available international standards due to the difference in geological conditions. The effect of these sulphates were studied for a period of (10 - 15) years and the allowed limits were fixed accordingly.

c) Non-Destructive Testings:-

The methods of the possibility of utilizing the non-destructive testings were studied especially the ultrasonic method for evaluation of the installations. It was found that this method could be used to determine the concrete bearing strength and the locations of voids & cracks in the concrete of the installations in a very precise manner and this method could also be used to determine the effect of sulphates and how much it reduces the concrete strength.

d) Minard's Unit - Comparing it with Iraqi Soil:-

The above study was carried out to assess the scope of activity of this method in Iraqi soil and compare the results with the traditional methods in order to evaluate the laboratory testings and to depend more on field testings.

6) International conventions:-

The Centre has, since its establishment, followed the practice of carrying out scientific symposiums of high standard and in which foreign experts & professors from all over the world participated in order to take part in developing and raise the capabilities of the technical Cadre and be informed of the advanced knowledge from technical point of view - nothing that the Centre has carried out two international conventions:-

1. Non-destructive testings convened in 1978 in respect of concrete structures.
2. Quality Control on construction materials convened in 1979.

The Centre shall issue "Call for papers" in order to carry out symposium on the subject of "Temperature Effect on Concrete & Asphaltic Concrete" which shall be held in Baghdad during the period 16th-18th March 1981, lectures shall be delivered by a number of experts and specialists upon evaluation by those who are experienced in the subject of the symposium.

7) Training Courses:-

The need for following the scientific & technology development and to persue the new theories is being increased from day-to-day with the increase in depending on modern technology and the importance of same is being increased due to the scientific accomplishments in various fields and domains. It has now become apparent that depending on scientific knowledge gained by the Cadre during their academic studies does not suit the development in different specialization domains the Centre has therefore undertook, since its establishment, to raise the scientific standard of its Cadre and acquaint them with the scientific development and advancement and follow - up technical matters and undertake to raise the performance capabilities of other engineering & technical Cadre and endeavoured to carry out training courses and make available some lectures either from its staff or from outside the Centre, and in addition to that it undertakes to train other Dept.'s staff and students of colleges & of other technical institutes. We append below clarification of these courses:-

- Twenty training courses were carried out in 1979 in different specializations in which 450 trainees participated.
- Eight training courses were carried out for the staff of other departments in addition to the 20 courses.
- Training of the students of technical institutes and colleges - (11) courses were arranged. (3 of the Center's staff were granted (Leave Study) outside Iraq (2 of them in the United Kingdom to obtain Ph.D. and MSc. degrees) and another one in France to obtain Ph.D. degree. Some of the staff were delegated to participate and to be trained in different conventions - as (4) engineers were delegated to Sweden to

participate in the conference of Quality Control on concrete and were trained for approximately (70) days, two of our engineers were delegated to Sweden to be trained in field soil for a period of (4) months.
A larger number of our staff have participated in international conventions in different parts of the world;among them were:-

- 7th European scientific symposium in Brazil.
- Rilem scientific symposium in Brazil.
- International symposium for concrete in the U.K. and other conventions for scientific activities.

(4 engineers will be delegated to Sweden to be trained on field testings of roads & soils during the first half of the current year and for a period from (1 - 3) months.)

8) Participation of the Centre in Direct Execution:-
The Centre undertakes to carry out direct execution for the laboratory buildings and many committees were formed in the different parts of the country to follow-up the direct execution of laboratory buildings as ;among these committees are the following:-

1- Extension of Construction Laboratory Baghdad Building.
2- Extension of Northern Area Laboratory at Arbil.
3- Extension of Southern Area Laboratory at Basrah.
4- Extension of Laboratory Building at Forat-Al-Ausatt.
5- Extension of Laboratory Building at Misan Governorates.
6- Extension of Laboratory Building at Sulaimaniyah Governorates.

The Cebtre undertakes to study the requirements of the laboratories, which belong to it, for Units & Laboratory Equipment & undertakes to send an invitation to Foreign Companies to forward their offers - the Centre will then study these offers & select the most developed ones after taking into consideration the technical specifications and economical aspects. These Units & Equipment consist of different types of Units to be used in all developed laboratory tests (Units for non-destructive testings, for testing of concrete strength and tensile strength of steel, mobile Units to measure concrete strength, numerous laboratory equipment and Units for soil investigation in addition to the mobile laboratories.

9) Consultation Committee:-
A main consultation committee was formed in the Centre in order to study the engineering problems which are hard to solve. The committee has carried out the following activities:

- Extend consultations for important and non-routine engineering problems.
- Controlling laboratory charges and amend it whenever necessary
- Participate in technical committees responsible for the study problems of construction materials and their specifications - among these committees is the higher committee for the study of problems in sand.
- The study of technical specifications in respect of construction materials & works and their testings and submit the necessary recommendations for their development.
- Planning the Centre's different technical divisions in order to raise their performance standards.
- The Centre's responsible departments to follow-up the execution and recommendations made by the consulting commttee.

The most important works carried out by the committee are as follows:

1- Foundations of the council of Minister's building.
2- Diversion of the steel railway of Himreen Dam.
3- Diana buildings.
4- Office & home of member of the revolutionary command at Basrah.
5- Two buildings for the Baath Party branches in Thawra and Mahmoodiyah.
6- Mosul's third bridge.
7- Negotiating the acceptance of Fatha Bridge.
8- Setting acceptance limits and remedies for the deviation in the properties of asphaltic concrete for roads & airports.
9- Setting specifications for the use of sulphate resisting cement and the quantity of sulphates allowed for in sand & soil.
10- Negotiating acceptance of the building of Harthiyah Wireless Station.

10) Quality Control:-
The Quality Control is considered a recently applied method in the country and a prime objective of N.C.C.L. the Centre is, therefore, doing its best to develop this fact and is authorised to carry out tests for the Ministry's works and for some other departments. Tests are carried out on materials or on works which are under construction or direct on completed works without contacting those responsible for the execution of the subject works and then submit his recommendations to the Central committees of the department concerned.
The Centre's care is apparent from the number of Quality Control tests on the projects carried out by the Ministry's subsidiary departments & organizations especially which are under direct execution. (50,00) tests were conducted during 1979
whereas (2380) tests were conducted in 1978.

11) The Centre is planning to adopt plastic paint testing, analysing hard concrete, flintcoat testing, testing of hydraulic pressure in pipes, fixing developed units to study the resistance of bridges as time passes, commence using developed units to measure the thermal properties in walls, expanding research works, and expanding the central committee's works by forming branch consulting committees in all the Centre's departments.

Erratum

Dr. Esher Berkoz and dr. Zerrin Yilmaz
the authors of the paper
"Building Facade Design from the Standpoint of Solar Radiation and Air Temperature Control"
have informed us that figure 2 in the paper should be replaced by the following figure.

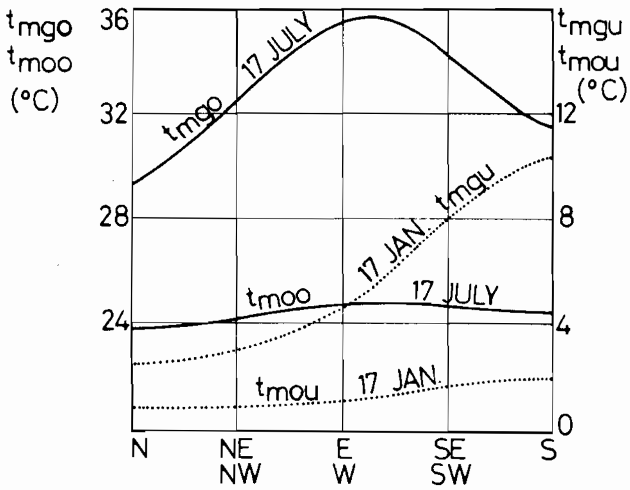

Figure 2: Variation of daily average sol-air temperatures for opaque and transparent components with orientation.