OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

05865

Distr.
LIMITED

ID/WG.181/12
19 September 1974

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Expert Group Meeting on Building and Facilities, Design and Lay-out for Industrial Research and Development Centres

Innsbruck, Austria, 23 - 27 September 1974

TECHNICAL CONSIDERATIONS FOR CONSTRUCTION AND DECORATION [1/]

by

J.E. Breeze*

* Manager of Systems Planning, British Columbia Research Council, Vancouver, Canada.

1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

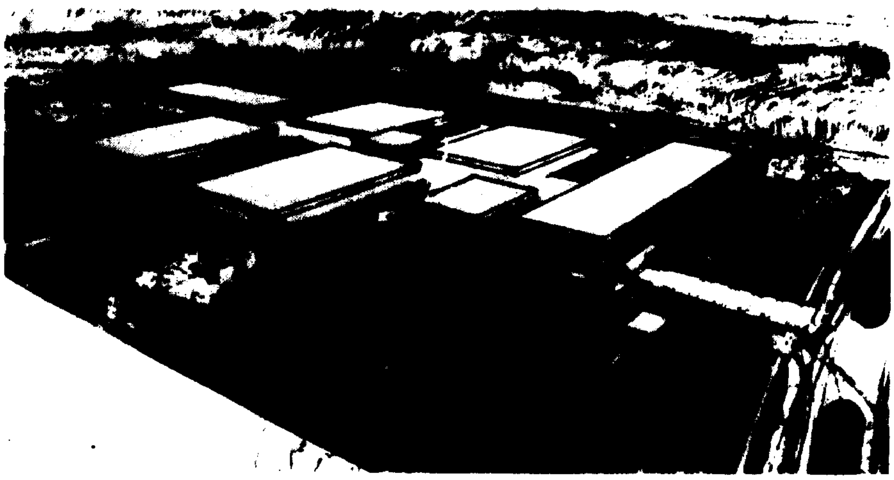
id.74-6584

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

INTRODUCTION

This paper has two sections. The first deals with Technical considerations for the construction of a building to house an industrial R & D activity, and the second section with the decoration of such a building. It will not be possible to cover every possible topic under these headings, but those that are discussed have been selected to illustrate the importance of these factors to the design and construction of a laboratory building in respect to its fulfilling its intended function and in minimizing initial capital and subsequent maintenance costs.

As a focus for these comments the text and accompanying illustrations will refer to the laboratory complex of B.C. Research in Vancouver, Canada, which was completed in 1969, (Figure 1). While this structure will be used to illustrate the various points raised it is not intended to present either the construction methods employed nor the materials used as recommended examples. Rather, they are offered to highlight the points considered important and one example of an attempt to optimize the selection of construction materials and methods. The final design of any building will often involve a number of compromises because of the various relationships between many components. Its development on a systematic and rational basis, however, enables better prediction of performance and provides the best approach to an optimum solution.



AERIAL PERSPECTIVE LOOKING SOUTH-EAST FROM WESBROOK BOULEVARD . THIS IS INCLUDED TO SHOW THE RELATIONSHIP OF THE WHOLE COMPLEX FROM ONE VIEWPOINT . THE ENTIRE PROJECT CANNOT BE SEEN FROM ANY ONE POINT AT EYE LEVEL . OVERALL VISUAL UNITY WAS THEREFORE NOT ESSENTIAL . UNFORSEEN FUTURE ADDITIONS WILL CHANGE THE BUILDING PERIMETERS . ALL BUILDING ELEMENTS ARE ARRANGED SO THAT ADDITIONS DO NOT DESTROY THE ORIGINAL DESIGN . THE INTERPLAY OF BUILDING ELEMENTS GIVES VARIETY AND INTEREST AS ONE MOVES PAST THE BUILDING AT EYE LEVEL .

Figure 1

Artist's perspective of B. C. Research Building

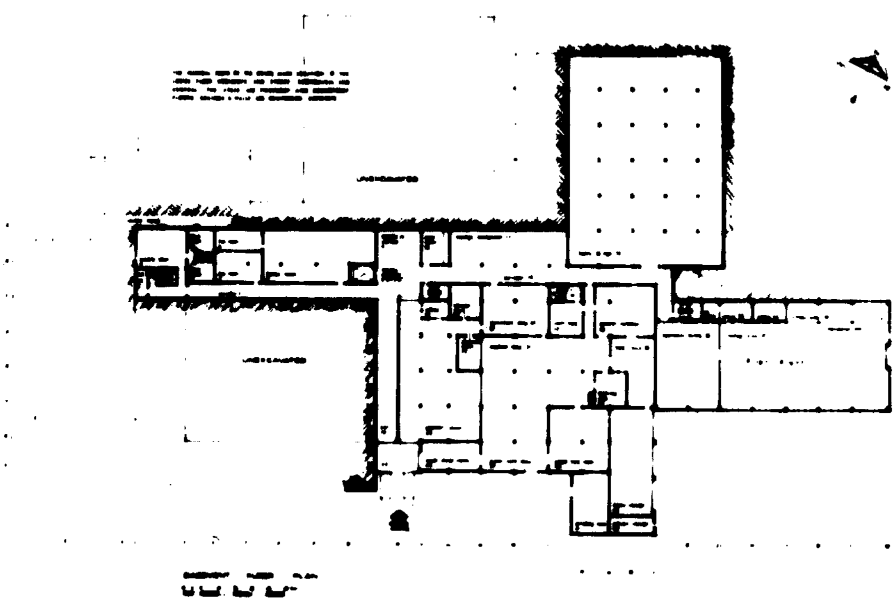


Figure 2

Modular Design

A. TECHNICAL CONSIDERATIONS FOR CONSTRUCTION

The comments to follow are grouped under selected headings and they amphasize some of the technical requirements related to the construction of a laboratory building as distinct from architectural design factors. Frequently these two are interdependent but the emphasis here will be on the latter. It will be necessary to limit comment only to the highlights or main technical points under each heading. A more exhaustive treatment of particular technical requirements is laft for separate discussion.

1. MODULAR CONCEPTS

One is never too clear today about just what the term "Modular" means in connection with building design. To some it will mean tha adoption of a dimensional program wherein all principal spacial dimensions in a building are multiples or sub multiples of a selected modular dimension. Others will consider a module as an element of the building which may be used repeatedly to makeup substantial sections of the whole structure.

Both views, however, embody the notion of some form of design standardization, (Figure 2). The use of a modular approach leads not only to efficient design but also to cost saving through the resulting use of common components. In the structure itself many components can have standard dimensions which are repeated many times throughout the building, and whether these components be beams or columns or other elements, the fact that they are repeated identically time after time can lead to cost economy either for on-site construction or factory built components. In poured concrete construction, for example, it can lead to the repetitive use of high quality forms at a resulting cost saving. In the interior of the building the repeated modular dimensions will lead to common sizes and spacings for partitions, millwork and furnishings.

Probably one of the richest benefits from the adoption of a modular concept for laboratory buildings is its impact on the flexibility available for future adaption and modification of the building. Removal or addition of interior partitions would normally be in accord with the building basic module and would therefore lead to the possibility of re-use of essential building components.

2. TYPES OF STRUCTURES

Many types of structure will be found to be satisfactory for laboratory buildings. Much will depend upon the projected activities of the particular institute, space availability and site requirements. The simplest would be a rectangular building having one or more stories. Such a structure could be extended by the addition of wings at the end or the centre or, alternatively, the type of structure utilized by B.C. Research wherein a central spine is used to connect wings that might otherwise be separate rectangular building, (Figure 3). Probably the most significant criteria in establishing the type of building would be requirements for expansion. In the simple rectangular building, expansion is by means of addition of floors or the extension of the building as a whole by the addition of wings. If independent expansion of various sections of the laboratory is seen as a necessity, then a structure adopting the principles followed by B.C. Research would be more suitable. Generally maximum flexibility for change and expansion is obtained through the use of a one or two story building.

3. THE BUILDING ENCLOSURE

The most important technical requirement for a building to house an R & D Laboratory relates to its design as an enclosure. The overall function of the wall, roof and windows taken together as an enclosure is to provide a barrier between indoor and outdoor environments such that the indoor

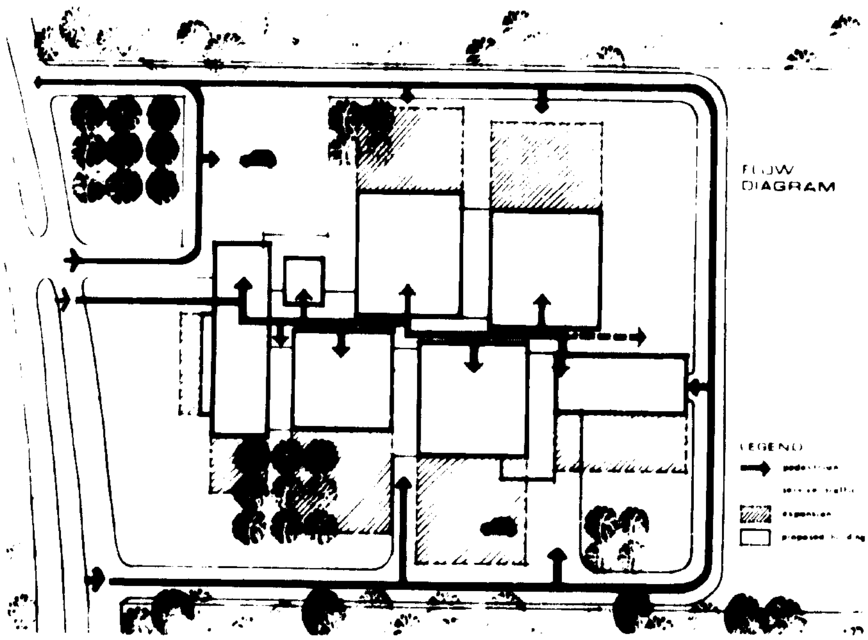


Figure 3

Spine and wing layout of B. C. Research Building

environment can be adjusted and maintained with acceptable limits. Since it is not possible for an R & D Institute to predict what its programs of activities will be throughout the life of any laboratory building, one of the most important requirements for the design of the building is that it should not interfere with the adaption of the enclosed space for uses other than those initially conceived.

Just as program and project planning must at all times be flexible and responsive to changing circumstances so should the use of laboratory space be adaptable with equal flexibility. In its simplest form therefore a given laboratory space could be a large single room within which space layout was arranged as required. Structural walls and columns would be so located as to impose the minimum of limitations to changes in space use, (Figure 4).

(a) Walls

External and internal walls are important elements of all buildings. While a chief function of external walls is to serve as a protection from the weather and as a thermal barrier, they may also function as structural elements of the building. They are therefore a complex assembly of selected components arranged such that the wall will meet all these performance requirements while at the same time satisfying the additional requirements of appearance, durability and acceptable maintenance factors.

As a barrier between the internal and external environment of the building the wall will be composed of four principal elements: a structural air barrier, a membrane to control water-vapour flow through the wall, an insulation layer to control heat flow through the wall and an exterior cladding to shed the rain, (Figure 5). Such a wall employing the well known "rain screen" principal can be assembled from many combinations of materials and so long as the basic principals are followed the wall will perform satisfactorily. It is important to observe that the greater the difference

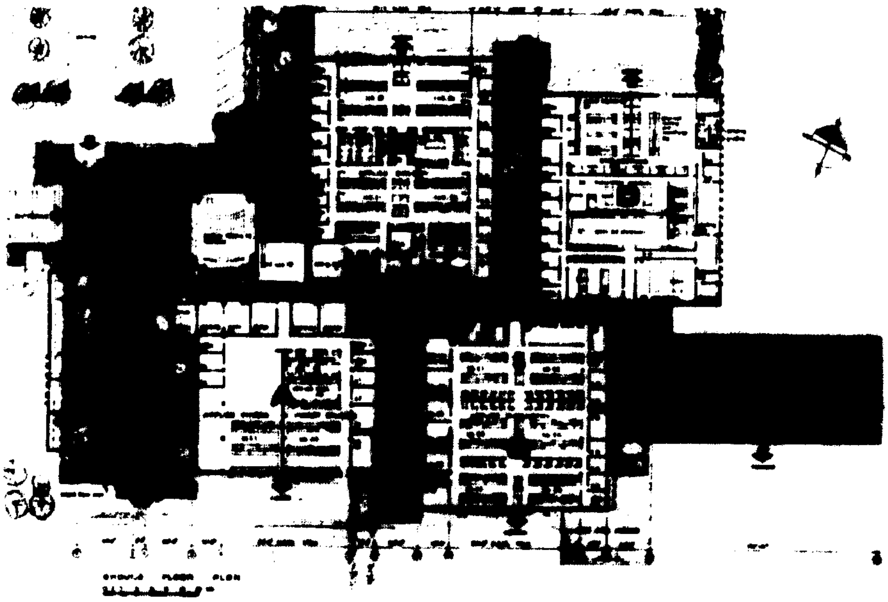


Figure 4

Four large open laboratories, B. C. Research Building

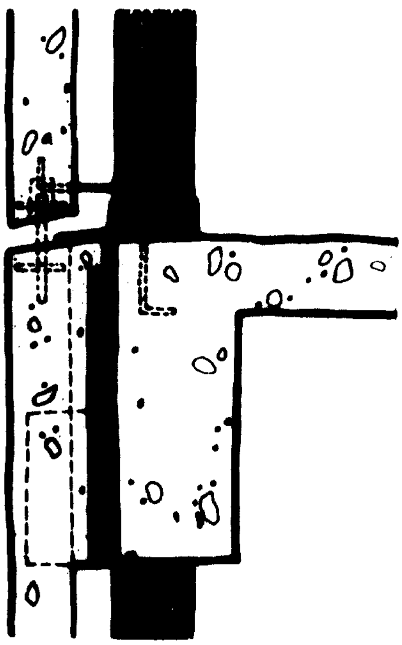


Figure 5

Rainscreen wall

between inside and outside environment or the greater the control required over the inside environment the more care will be needed in designing and constructing the exterior wall system, (Figures 6 and 7).

Internal partitions serve a different function than exterior walls and they therefore have very different requirements. The chief of these in most laboratory buildings will be the requirement for flexible adaptation to future space changes in the building. Interior partitions should therefore be designed having a minimum of services built within the wall cavity. In laboratory areas surface mounting of all electrical, water and other services is to be preferred. A wide variety of internal partition systems and materials is available today. These range from walls assembled from conventional materials such as wood and plaster or masonry blocks (Figure 8) all the way to pre-manufactured panels which can be joined together and then separated at a later date for rearrangement. In the B.C. Research building the use of concrete or pumice block having a thickness of about 4 inches was selected to meet the combined criterial of cost and flexibility. Such walls can readily be dismantled and new walls built.

Special flexibility within a laboratory can be achieved to a much greater extent if internal walls are all non-load bearing. Such a requirement would have a significant effect on the structure of the building itself. The solution to this problem in the B.C. Research building allowed the use of lighter materials, simplified heating and ventilation and permitted the future allocation of space in almost any required way independent of the means for supporting the roof or ceilings.

(b) Roofs

The roof of a building shares with the exterior walls the function of separating the interior and exterior environments, (Figure 9). Because of its normally horizontal position the requirements on a roof system for shedding water are very much more severe than those for exterior walls. The

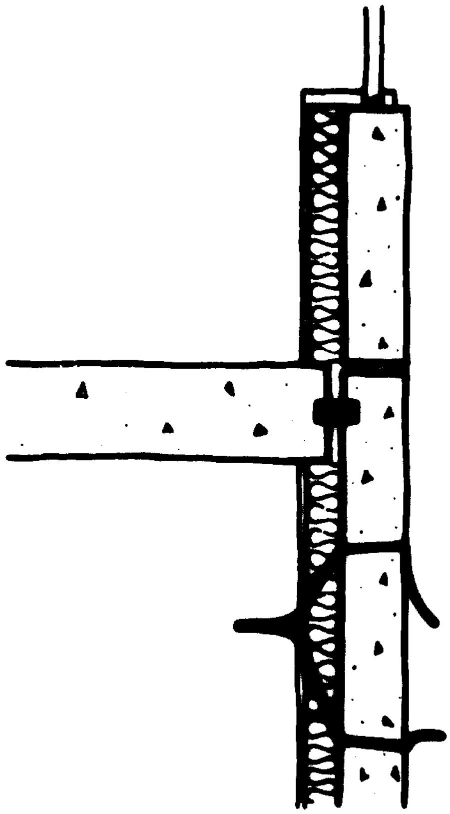


Figure 6

Diagram of Wall Assembly
with insulation layer
on interior face

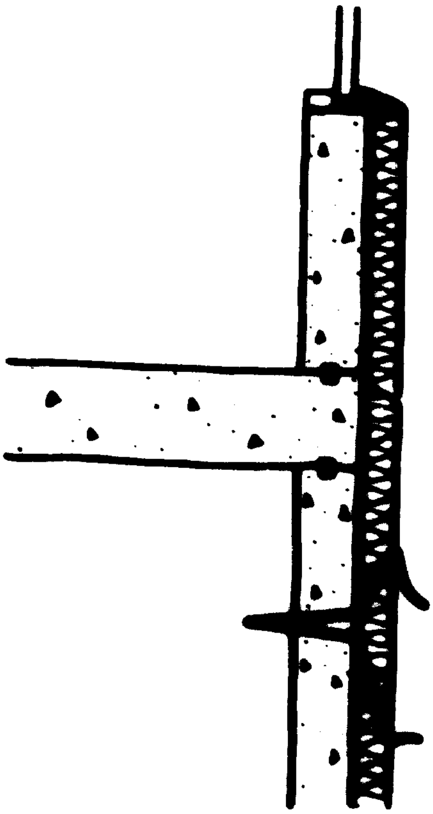


Figure 7

Diagram of Wall Assembly
with insulation layer
on exterior face

Figure 8

Interior Partitions, B. C. Research Building

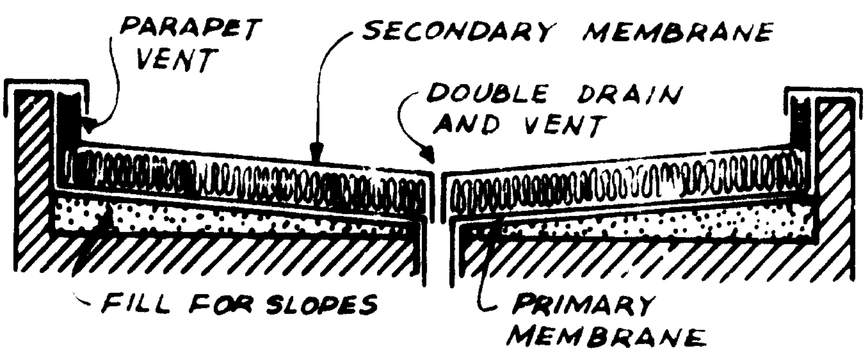


Figure 9

Diagram of Roof assembly, B. C. Research Building requirements for air and water vapour flow control and for thermal flow are similar. A variety of roof systems have been found satisfactory in various climates but all can be violated and found unsatisfactory through faulty construction or faulty understanding of the principals involved.

Most laboratory buildings would have flat roofs and the conventional "built-up" roof would normally be used. A variation of this system, the double membrane roof has been found very successful in cold climates such as Canada's.

Apart from the design of the roof system itself probably the most important factor in achieving a successful low maintenance cost roof lies in the care and supervision given during the construction of the roof membrane and the installation and caulking of the flashings. A roof should not be a matter of constant maintenance and care.

(c) Windows and Doors

All buildings normally have windows and doors and these can give rise to a wide variety of maintenance and in-use problems. If doors to the exterior and window frames are of wood they can be a constant maintenance problem arising from their position as a thin membrane seperating the outside environment from the inside of the building. Under such circumstances the temperature gradient and water vapour gradient across this membrane accentuate the problems of dimensional stability of wood products and the problems of the maintenance of surface finishes in the presence of changing water vapour gradients. Metal or metal clad doors and metal window frames and sashes therefore are favoured for improved finish maintenance and dimensional stability. Glazing on the interior of the building can be done very simply and doors of wood are normal. Generally there is no environmental difference between the occupancies on either side of an interior partition and consequently problems with respect to the maintenance of surface finishes and dimensional stability do not develop.

Doors for special purpose rooms, such as environmentally controlled rooms, cold rooms and refrigerators, must be considered as special cases, however, and these may have to be increasingly elaborate depending upon the environmental differences from inside and outside.

(d) Interior and Exterior Finishings

By the term finishings we mean not only the materials used for exposed surfaces such as plaster, brick, plastic tiles and wood but also the final surface treatment of these materials including paint, stain etc. In the selection of finishes for a building there are therefore a host of technical requirements to be considered. Again for a laboratory building materials and finishes must be selected having the lowest maintenance factors commensurate with acceptable appearance and cost.

The maintenance of surface finishes for any building can be one of the most time consuming and costly elements of overall maintenance. Exterior finishes must be selected for their durability to the weather, for their resistance to the effects of water and water vapour, to the effects of fading from sunlight and to the effects of temperature cycling. Normally natural materials, such as fired brick, concrete, and corrosion resistant metals have excellent durability to exposure while unprotected wood and synthetic materials such as plastics are poor, (Figures 10 and 11).

Materials for interior finishes must be selected considering the service conditions in each particular area. The quality of finish for an office area or a public area can be higher than that required for a laboratory or workshop area. At B.C. Research three levels of finish quality were employed. The highest level of finishes with concealed services and suspended ceilings, painted gypsum board walls, plywood panelling etc. was specified for the library and administrative office wing. The laboratories were the next level down having pumice block wall construction for all partitions, with exposed services and having all exposed masonry and poured

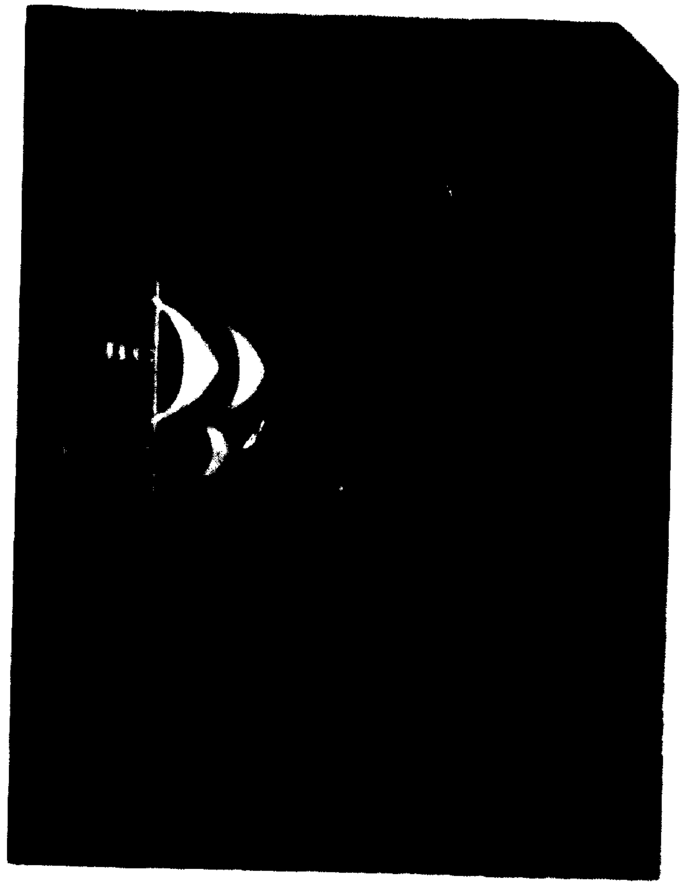


Figure 10

Exterior finishes at Building Entrance

concrete surfaces of walls columns beams and ceilings painted. Vinyl asbestos floor tile was used throughout most of the administrative and laboratory areas, (Figure 12). The stores, workshop and pilot areas had the lowest level of finish were concrete blocks were used as wall partitions and floor was of concrete. Initially all walls and ceilings were painted, while the floor was left unpainted. For improved dust control, the floors in all corridors and working areas in the stores and shop sections of the building are gradually being painted with an epoxy floor paint, (Figure 13).

Materials for interior finishes may be selected not only for serviceability and for appearance factors such as colour and texture but also because of environmental factors including acoustical control and light reflectance. Thus floor tile and carpeting are used on floors while ceilings and walls may be painted in light colours for good light reflectance or the surface material such as acoustical plaster or tile may provide required sound absorption, (Figure 14).

Finishing materials whether for the interior or the exterior of a building should not be considered as subject to selection once the building is well under way. Rather their technical properties must be considered as components of the wall ceiling and floor systems at the earliest stages of design. In this way the advantages of finishes compatable with building systems, providing adequate environmental control and requiring minimum maintenance and up-keep can be obtained at lowest cost.

(e) Staircases and Elevators

Staircases will be placed within a building both for convenience of access between adjacent areas and as exit means required by fire codes. For buildings of two or three stories only, it should normally be expected that stairs will be used by the staff as a normal means of moving from floor to floor. Under such circumstances stairways should be well lighted and should have suitable non-skid stair treads of high durability. Where

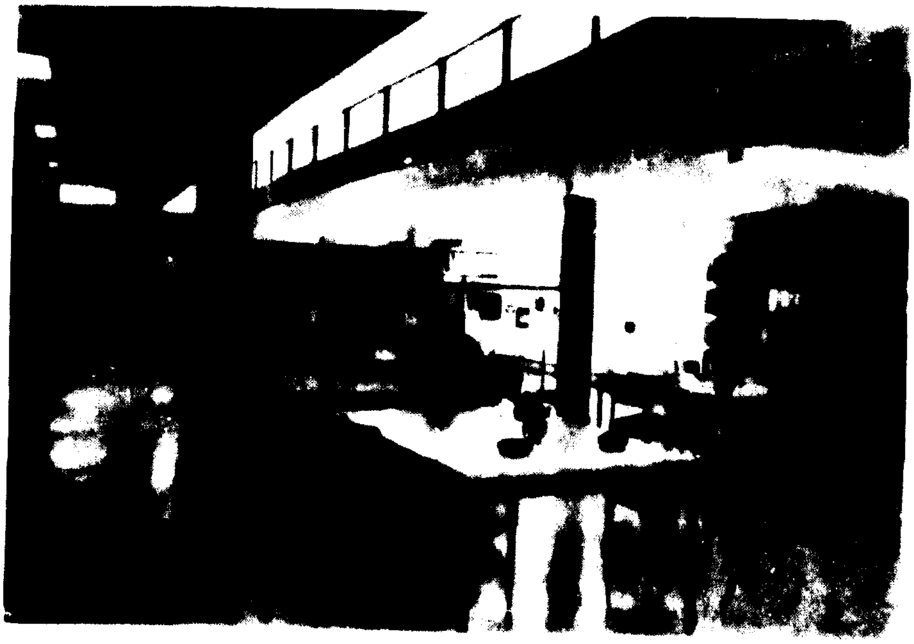


Figure 12

Interior Finishes - Library of B.C. Research Building

Figure 13

Interior Finishes Shipping and Shop Areas

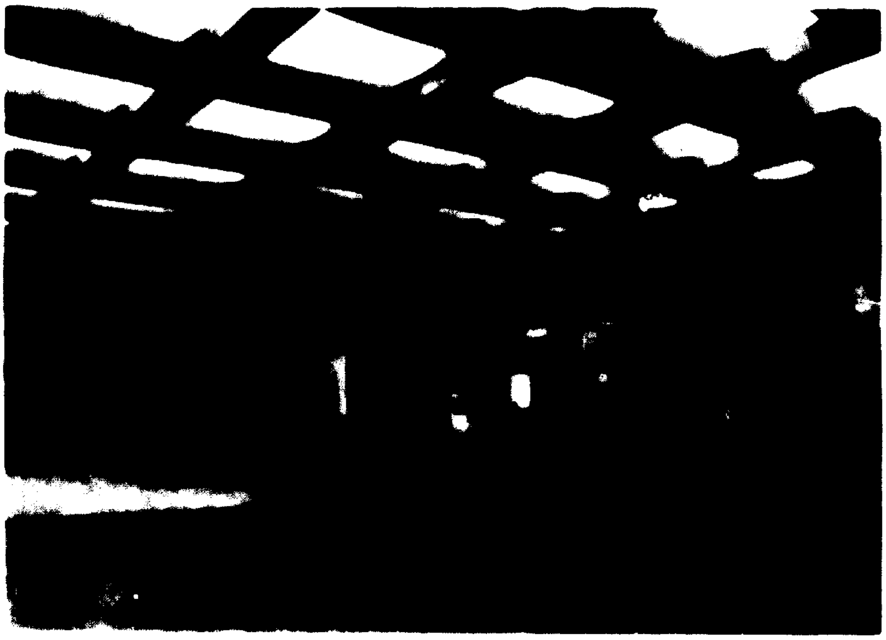


Figure 14

Interior Finishes Entrance Foyer
B. C. Research Building

a laboratory occupies more than one floor, there will inevitably be a need for moving equipment between floors and a simple freight elevator is a requirement.

SAFETY CONSIDERATIONS

Laboratory activities for industrial research and development can have many hazards which may reflect on the technical considerations for the construction of the building. Fire is the most obvious nazard, and most building codes contain requirements to provide for the protection of both personnel and the building structure. Some areas, therefore, will be required to be sprinklered and other areas to have hose standpipes or hose cabinets or portable fire extinguishers. In laboratories utilizing flammable chemicals, it is normal to have portable fire extinguishers located at frequent intervals throughout the laboratory. Some araas having a high potential fire hazard such as the boiler room and transformer vault would be required to be separated from the rest of the building by a suitable fire separation or fire wall.

In designing the B.C. Research building it was concluded that it would not be practical to try to anticipate all hazards and to design the building so that it would respond favourably in the presence of any such hazard whether it be fire, explosion, dust, poisonous gas, etc. Further, it was thought to be undesirable to allow the idea to become accepted that the building provided a wide protection against such hazards. Rather it was felt important that project supervisors should realize that it was they who were parincipally responsible for assessing the degree of hazard of a particular activity and for judging just what steps were appropriate to protect both personnel and property. For this reason, explosion blow-out walls for example, were not included as part of the design of the building and it was anticipated that activities requiring such protection should not be done within the present building without special provision having been made. An external working area outside the pilot area of the laboratory has been provided where the more hazardous experiments can be set up and conducted.

Normally in the construction of a building the usual emergency provisions for the protection of personnel in the event of hazards are installed, such as fire exits, showers, eye washes, fire blankets, first aid rooms, etc. The storage of bulk quantities of flammable chemicals is always a problem and this should be provided for by means of an external solvent stores and by regulations within the laboratory to allow only limited quantities of any one solvent to be removed from the solvent stores for use in any particular working area.

Generally speaking to provide for protection against all possible hazards in the design of a laboratory building could be excessively expensive and generally unwarranted. It will be found more practical to consider hazards as they occur and to provide separately for the special hazards of explosion, radio-activity, pathological organisms, etc.

B. DECORATION

Internal and external decoration of a building, including landscaping, can have a great influence on its working environment. This is particularly important in laboratories where favourable surroundings serve to assist in promoting the creative output of research and development groups, (Figure 15). Externally the appearance of the building can be affected by the choice of materials, textures and colours, together with properly designed landscaping which will lead ones eye to the entrance to the building and suppress such necessary service features as parking areas and shipping and receiving docks, (Figures 16 and 17). With its location on the campus of the University of British Columbia, B.C. Research had probably a better than average opportunity to develop a favourable

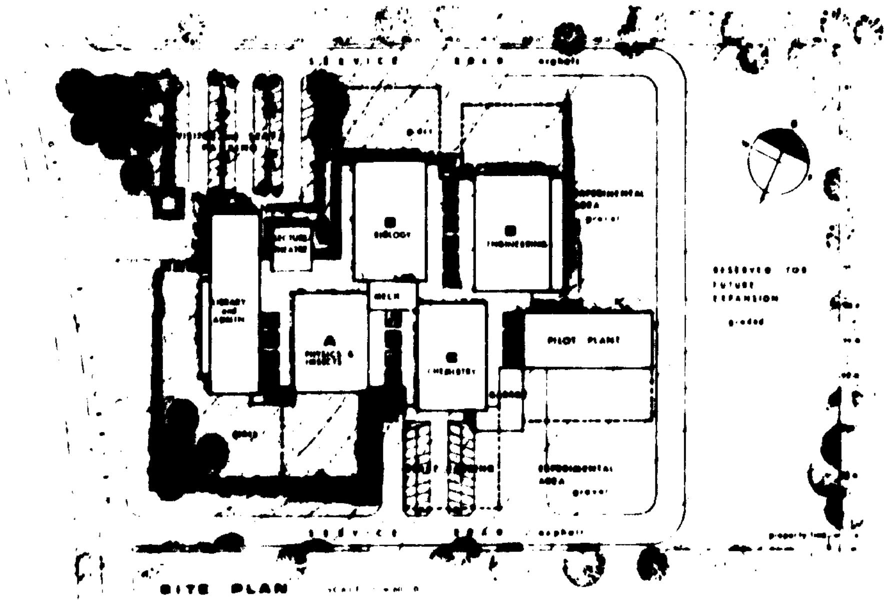


Figure 15

Landscape Layout sketch B.C. Research Building

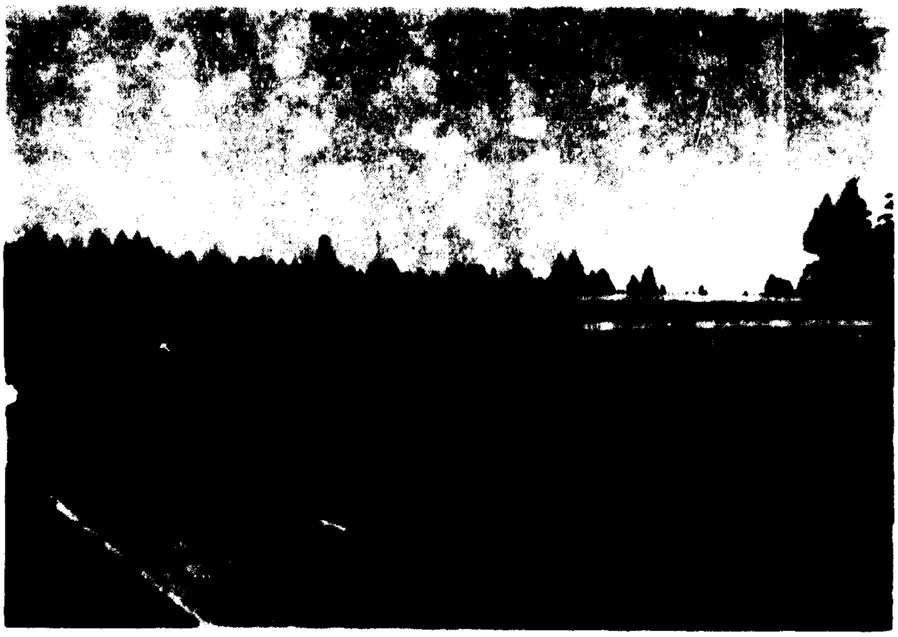


Figure 16

Landscaping at Entrance B. C. Research Building

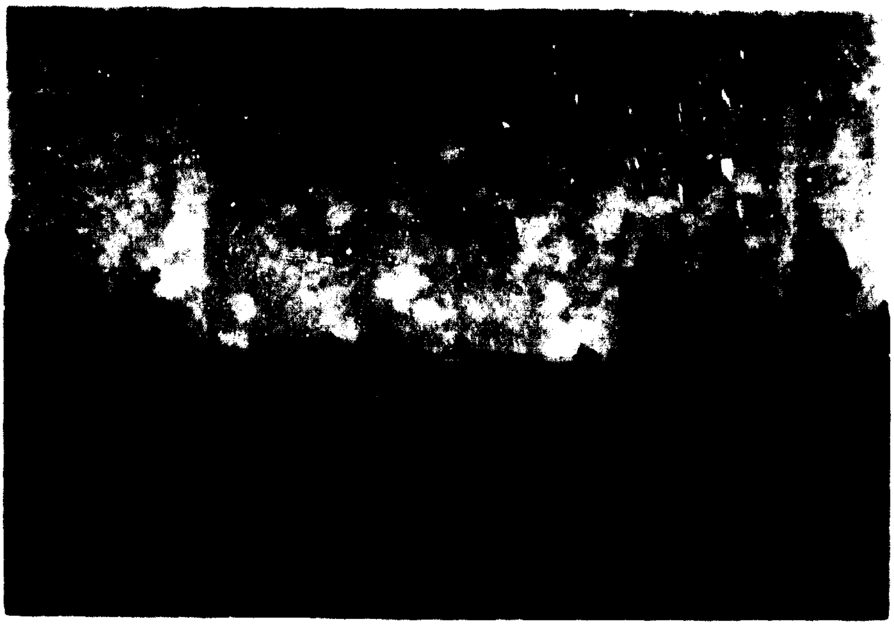


Figure 17

Landscaping and Suppressed Parking Areas appearance to the building through the uee of these devices. The lend-scaping shown in the illustretions has now bsen growing for approximatsly four years and its effectivsnass in framing the building and in suppressing parking areas is alreading epperent, (Figures 18, 19 and 20).

Interior decoration is also an important factor in developing a good working environment. Generally, working erees should be bright and cheerful, but non working areas such as hells, steff rooms, end public areas need not be so bright and thus can provide a change of mood es one moves about the building. The technical requirements for interior dscoration include appearance factors such as colour and texture, housekeeping factors such as cleanability and dust control, end environmental factors such es light reflectivity and acoustical properties. Where netural materials such as fired masonry or bricks are employed, both the colour end texture ere permanent features. For simple intsrior partitions, such materiels ars usually very economical since once erected both feces of the wall require no further finishing. At B.C. Research it was decided that all non-firad masonry and concrete surfaces should be peintsd primarily for dust control but also for colour or to improve light reflectivity, (Figures 12 and 21). In the laboratory areas, the basic colour for all walls and ceilings was an off-white with a similarly coloured floor tile to assist in the gensral brightnesa of these areas. This general overall white colour wes broken up by a coloured high-light strip and small patch areas of the same colour in each laboratory and all millwork and benches were a pele green base with black moulded epoxy bench tops. A different colour for the highlight strips and patch areas was ueed in eech leboretory wing to give some variation throughout the building. The floors throughout most of the building utilized a vinyl esbestos tils of an off-white colour for good light reflectivity. This has besn generally setisfectory and by using acrylic floor waxes, housekeeping generally by wet mopping has been no problem. To give a quieter and more subdued atmosphere, carpeting has been used on the floors of the staff room, the board room the public foyer and in the typing erea.

Figure 18

Landscaping to suppress parking area B. C. Research Building

Figure 19

View of Figure 18 from inside the Building

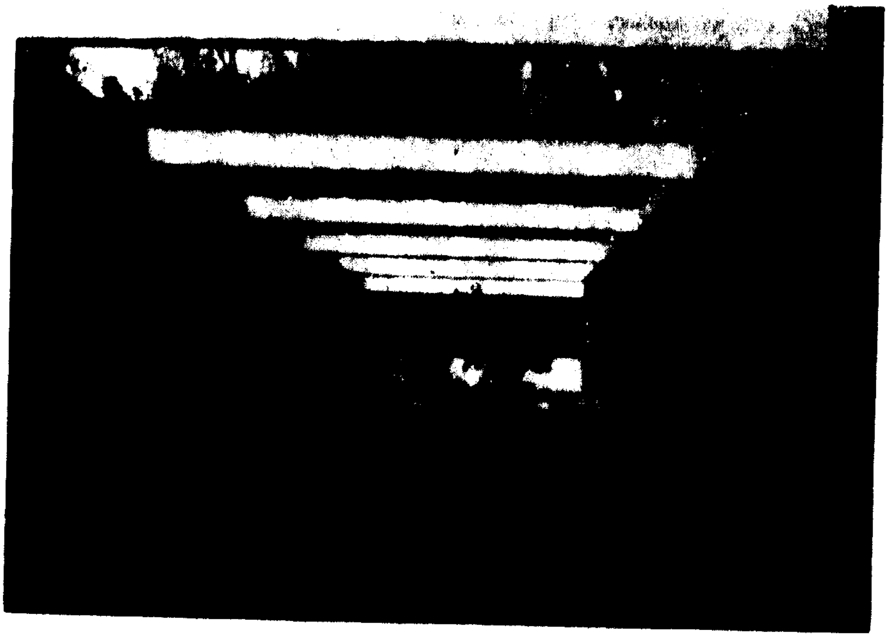


Figure 20

Landscaping between Building Wings

Figure 21

Wall texture decoration
Entrance Foyer
B. C. Research

In choosing the lighting design, a light level of about 50-ft candles was obtained in the laboratory working areas and warm white flourescent tubes were employed to provide a soft light and normal colour rendition. Light levels in the corridors and non-working areas were set at much lower values and the brick walls in these areas served to provide a soft warm appearance in contrast to the brighter working areas. This change of mood in the decoration as one moves through the building was considered to be an important and desirable feature in avoiding the monotony of a single decoration scheme throughout the building.

C. CONCLUSION

It is concluded that the special functional requirements of R & D laboratories can have an important influence on the technical requirements for construction and for the decoration of laboratory buildings. It is important, therefore, that these special requirements be recognized early in the design in the selection of materials and construction methods. The importance of a favourable working environment for all workers is being increasingly appreciated and this requirement is no less important for R & D laboratories.

Of particular importance is the recognition that most R & D laboratories simply cannot know what activities they will be engaged in five or ten years in the future, and the ability to adapt building spaces to new requirements is paramount. A well conceived building plant at the functional program stage embodying the structural system, the selection of materials and the overall decoration and appearance plan can assist considerably in keeping capital costs to a minimum whatever the budget, and in keeping down on-going maintenance costs during the life of the building.

75.06.06