TYPOLOGICAL AND TECHNOLOGICAL MODELS FOR ACCEPTABLE INDOOR AIR QUALITY

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ABSTRACT

This intervention examines in detail those technological and distributional solutions which ensure acceptable air quality inside buildings. The separation of living spaces from those areas which support living activities is advised, as well as a layout which permits maximum ventilation. Then, criteria for making choices about materials and design criteria for the parts of the construction are then indicated.

INTRODUCTION

The formulation of new design standards , whose reference is the protection from indoor air pollution, relates to different aspects, i.e. the geographical location of buildings, the daylight factor, the space distribution criteria, the products and materials employed (1,2,3).
For that it is necessary to define new typological and technological models, best suited to match health requirements. As to internal space distribution, we propose important changes as cooking-cabinets, large ventilated passages, skylight passages.
As to technological quality, it is necessary to re-consider the choice of every single building material and element, with special attention to their possible contaminant effect as well as to the pollutants emitted, to their maintenance, cleaning and durability.
In actual fact, the maintenance and cleaning have to be taken into consideration from the first design of the building in order to reject any solution that can not garantee any lenght in time, nor make cleaning, surveying and substitution of building elements or systems far easier.
As to buildings located in hot climates, it is necessary to verify some solutions proposed by the bio-climatic architecture, using as a standard the indoor air quality.
Hereby some hypotheses on materials , products and typological and technological solutions are suggested.

LAYOUT CRITERIA

The two principles which condition designing from the point of view of distribution are: the separation of areas where a concentrated source of pollution can be found from areas for inhabitation, and ventilation in general.
This is all not quite as simple as it seems when you realize that there

are several sources of pollution and these are not limited just to the better known ones such as combustion devices. We can list (4):

- places where food is cooked where NOx and CO are produced, and places where food is conserved, where the possible deterioration of food is a source of microorganisms; the bath/toilet space where dampness, microbiological pollution and odors are produced;

- machines producing toxic emissions (photocopiers) as well as the electronic equipments which produces ionizing radiation (Computers, microwave ovens);

- combustion devices, especially open gas flame devices, and fireplaces too;

- closets and wardrobes where clothing that has undergone dry cleaning are placed; these release solvents. There is also clothing that has been moth proofed or "scented" with volatile substances which may be toxic to varying degrees;

- cabinets where household cleaning supplies are kept; these may give off toxic fumes in great quantities from cans which have been poorly closed or wet rags.

All of these places or sources of pollution need to be separated from the living areas (an area of the sitting room separated from the rest of the house could be considered in the case of the fireplace).This is in contrast with the principles of internal layout from the fifties, which followed the idea of the complete communication of spaces.
This is the result of open domestic space that was so much admired as a means of ensuring interpersonal communication, although it was mainly looked upon favorably as a way of eliminating any connecting surface thought to be redundant.
Open space has definitely become a thing of the past since it created well founded preoccupations of environmental hygiene apart from its problems of privacy and the identity of the space.
The new criteria for distribution hence place a rigid separation of living spaces which must be used only for main activities which do not pollute, and service and support environments which are highly specialized, equipped with air cleaning devices if necessary, or other protective devices.
These latter areas are places where polluting activities, devices, or equipment can be found. In more detail, there will be:

- cooking cabinets, of less than 5 square meters, exclusively set up for the preparation and cooking of foods, although not for the consumption of food, or as place for people to linger;

- the bathroom's antechamber which avoids direct contact of the bathroom with living spaces;

- wardrobe spaces and pantry spaces, respectively for the storage of clothing, food and household products;

- spaces for tele-work or for the computer station;

- spaces for combustion devices.

Apart from being separated,it is necessary that these specialized areas be ventilated except for those places where ionized radiation is produced, because other forms of protection are needed here.

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The second criterion starts to take on importance here and has an important effect on the layout of the spaces: the ventilation which means:

- arranging accommodations in buildings and organizing the inside the building so that a sufficient draught is obtained (two way);

- creating ventilation possibilities apart from the accommodation's two way exchange, places such as cloisters, galleries, open air passages, so that the service areas which as it has been seen contain the sources of pollution, have the possibility of being constantly ventilated;

- inserting some tubes for continuous exhaust, especially when the two preceding conditions are not possible.

The need for creating constant and consistent ventilation does not just involve choices about distribution. Indeed, correct ventilation does not only depend on the quantity of incoming air, but it also depends on the good circulation of this air, avoiding a layering effect as much as possible. So, the scale decreases and you start to place your attention on the convective forces of air within rooms.
The height of the rooms becomes a topic for discussion once again since the height required by current regulations is too low to allow for good circulation. The position of the windows in comparison to the room's layout and height needs to be carefully studied, as well as the type of window, so that the openings can guarantee constant ventilation of the rooms, although this form of ventilation is somewhat limited.

This convention is dedicated to the need for ventilation in hot countries; this specific type of ventilation needs to be balanced by the need not to bring an excessive amount of heat inside the dwelling place. This does in fact make it necessary to use air conditioning systems and would create all the risks which such systems produce from a hygienic point of view. So, openings should be placed in the direction of any winds that may be present and on the cooler sides of the building. This means protecting them from insolation. Finally, openings onto small courtyards should be preferred to windows on the facade, as well as the chimney effect of vertical air circulation systems.
By using this system, it is discovered that the precautions taken to protect living spaces from internal pollution coincide with the criteria for achieving thermal comfort according to the ancient principles of natural air climatization.
Hence, nothing could be worse in these climates than a building whose perimeter is compact, sealed, and artificially air conditioned, both from a hygienic point of view and a climactic one.
Perhaps the warm countries have not gone through the obsessive imposition of sealing a building's external walls to keep energy consumption down which in turn created a distinct increase in internal pollution. But the opposite problem of not letting heat in, probably makes it necessary to reconsider the shell of a building taking into consideration the quality of air inside it. The issue thence moves to solving details which can be defined in a nutshell as technological choices.

TECHNOLOGICAL CRITERIA

When we try to come up with criteria for constructing "healthy" buildings,

i.e. buildings free of internal pollution, the choice of building materials always comes first: they must have low pollution potential. This criterion is certainly a correct one though it is not exhaustive. The attention placed on the study of construction details and techniques used in execution is of equal importance.
An interesting report presented by H. Levin at the Berlin "Indoor Air '87" convention showed how the time and way that materials are stored prior to construction are as decisive as the choice of the materials itself. For example, if materials with a polymer base characterized by a high degree of emission just after they are produced, are kept in an open, well ventilated, and sunny place before being used for construction, they are given the chance to speed up their emission process, and more importantly the chance to do so far away from the building. Thus, when they are used, they will have already lost most of their toxicity (5,6.).

Getting back to the actual features of construction, it may be noted that intermediary materials used for laying (adhesives and sealers) take on a decisive importance just like the "main" material (covering or floor or insulating layer, etc.). This is because they are often made of substances which have maximum emission and because the operation of sealing and gluing makes the circulation of air around the main material more difficult if not outright impossible. They also prevent it from being substituted, cleaned, or serviced. This is why renovated areas and spaces that have been finished using "do-it-yourself" techniques present the greatest risks. Here intermediary, facilitating materials need to be used in order to carry out the actual laying work without disturbing the inhabitants too much or they are used to make the process easier for the "do-it-yourselfers". Unfortunately however, making things easier is often the opposite of the "way it should be done" the way that the master craftsmen of times gone by used to work. This was also, quite often, the rule of the hygiene of a room (7).

"The way it should be done" which guided old constructions, insisted for example on a few models for protection from the humidity of rain as it struck the building or rose up into it (8). Since humidity was one of the causes of microbiological pollution, we can immediately see how respect for these principles had an immediate effect on the problems we are dealing with too. Furthermore, the steps taken for drainage of the land and the waterproofing of the first floor slab, used to keep dampness out of the construction, might also be useful for keeping radon out.
Another principle in old construction know how was the outside walls' permeability to steam, with correct evaluation of the phenomena of thermal inertia compared to the insulation of the wall. These two issues should be kept in mind at all times when studying the stratification of the outside walls, thus avoiding the sealing of the superficial film (the external covering) and avoiding putting perishable insulating layers along the floor where condensation forms.
Some criteria concerning technical choices can be listed based on the preceding considerations. These directly concern the designer who should never delegate his or her responsibility for studying construction details or choice of materials to the executors of the construction.

The first criterion concerns the choice of materials as was said above. This does not just concern the surfaces which are in direct contact with the living spaces. The choice of materials must be subjected to a series of considerations which do not stop at just evaluating the intrinsically deleterious qualities of the material itself; they should also include all the ways the material can be actually used, issues such as its durability and the possibility of maintaining

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First of all, the composition of the product has to be judged (chemical compounds, the presence of fibers, and the presence of other particles which may be released into the air of the living space); this is then compared to the place where it is going to be used (living space, service space) and the quantitative importance that this product assumes (the extent of the product in the environment). As has already been said, the way that the material is actually used in construction (done dry with just nails, with mortar, or with adhesives), the way it is warehoused, and the finishing touches required, are of equal importance. As to its durability, the risk of the material's eventual perishableness (release of particles or putrescence), any need for protective treatment (wood, the "healthy, natural" material, requires for example, treatment with pentachlorophenol which is toxic), and the ease of cleaning and maintenance in order to avoid the pollution of added dirt, all need to be judged. Therefore, the way the material reacts to different agents is also very important; these different agents may condition its durability: from daily agents (humidity, atmospheric agents) to accidental agents (chemical agents, fire).

Apart from the choice of the material, the durability of an element in construction depends on the study of its configuration, the accessibility of the element and its parts concerning possible substitution, maintenance and cleaning. Research on the causes of internal pollution have emphasized the the importance of carrying out maintenance correctly; this is particularly true for combustion systems and devices but it is true also for surfaces and moldings.
An element which has deteriorated is more likely to release the substances it is made of, or in the case of a protective covering, it is more likely to let those substances it was supposed to keep out, pass through it.
Design of construction details thus, should be such that:

- all parts are easily accessible for maintenance, cleaning, or substitution;

- different elements can show up any of their defects or accumulations of dirt;

- the maintenance, substitution, and cleaning of the elements can easily be carried out by the inhabitants without resorting to the use of poisonous products;

- shapes which are too irregular are avoided.

Maximum attention must be given to the covering of buildings (horizontal and vertical enclosures) because this is like skin for human beings: it is the part most responsible for a correct climactic exchange between the inside and the outside. Correct designing of the covering's consistency along with the correct ventilation system mentioned above may make it possible to avoid the installation of an air conditioning system, thus avoiding the danger of pollution through malfunction of the system.
The parts of the covering which can be opened (the door and window frames) must be equipped with devices with permit the continuous exchange of air (fans or high-low openings) while the layering of opaque parts has to be studied carefully in order to avoid imbalances in the surface temperature, condensation within the rooms or the wall itself, and above all, the filtering of any toxic substances present in the layers, through to the space inside.
For the specific case of warm climates, the most correct solution both from a climactic point of view and the point of view of the quality of internal air, appears to be the ventilated wall. This is made of a real wall, a layer of

insulation, a ventilated air chamber, and an external face.
The air chamber is open above and below to allow the air to circulate; in the summer, it is supposed to decrease the incoming thermal flow caused by the sun's radiation, and in the winter it is supposed to eliminate the phenomenon of condensation of water vapor inside of the insulation.
Furthermore, the ventilation of the air chamber offers the chance to evacuate harmful volatile substances which the inhabitation filters through the wall or outlets in the wall itself to the outside.

CONCLUSIONS

This paper has demonstrated how many internal pollution problems can be avoided just by being more careful during the the designing of a building.
Apart from eliminating the most hazardous materials such as those which contain formaldehyde or asbestos, it is also necessary to compare the aesthetic and space needs with the the needs for hygiene in living.
Even if this means harking back to space and construction criteria that are through of as "passè", or technological solutions which were better known in nineteenth century constructions than in constructions today.

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