Building Shaped for Light

It is our belief that the excessive use of artificial light in modern buildings is inhuman; buildings which displace natural light as the major source of illumination are not fit places to spend the day.

This is an important assertion. It has never been fully investigated, though every expert alludes to it. If it is taken seriously, it has drastic implications for the over-all shape of buildings.

There are two kinds of reasons for believing this assertion.

First: All over the world, people are rebelling against windowless buildings; people complain when they have to work in places without daylight; Rapoport has shown, by content analysis, that people are in a better mood in rooms with windows than in rooms without windows. (*Amos Rapoport, "Some Consumer Comments on a Designed Environment", Arena, January 1967, pp. 176-178.*) Edward Hall tells the story of a man who worked in a windowless office for some time, all the time saying that it was "just fine, just fine", and then finally quit; as Hall says: "The subject was so deep, and so serious, that this man could not even bear to discuss it, since to discuss it would have opened the floodgates".

Second: People's complaints are serious—but they are easy to dismiss. It is much harder to dismiss a growing body of evidence which suggests that man actually *needs* daylight, since the cycle of daylight somehow plays a vital role in the maintenance of the body's circadian rhythms—and that the change of light during the day, though apparently variable, is in this sense a fundamental constant by which the human body maintains its relationship to the environment. (See, for instance, *R. G. Hopkinson, Architectural Physics: Lighting, Department of Scientific & Industrial Research, Building Research Station, HMSO, London, 1963, pp. 116-117.*) If this is true, then too much artificial light actually creates a rift between a person and his surroundings, and upsets the human physiology.

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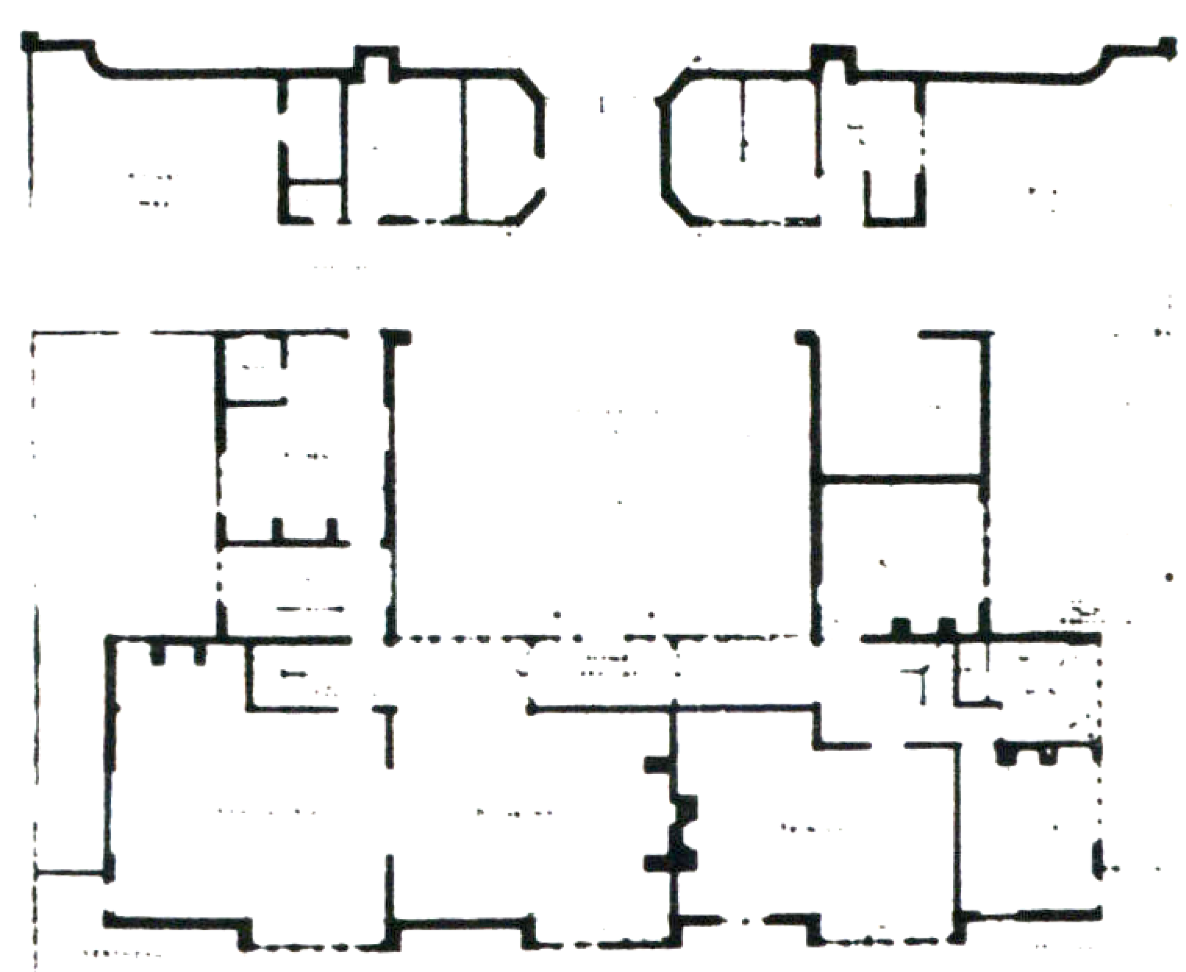
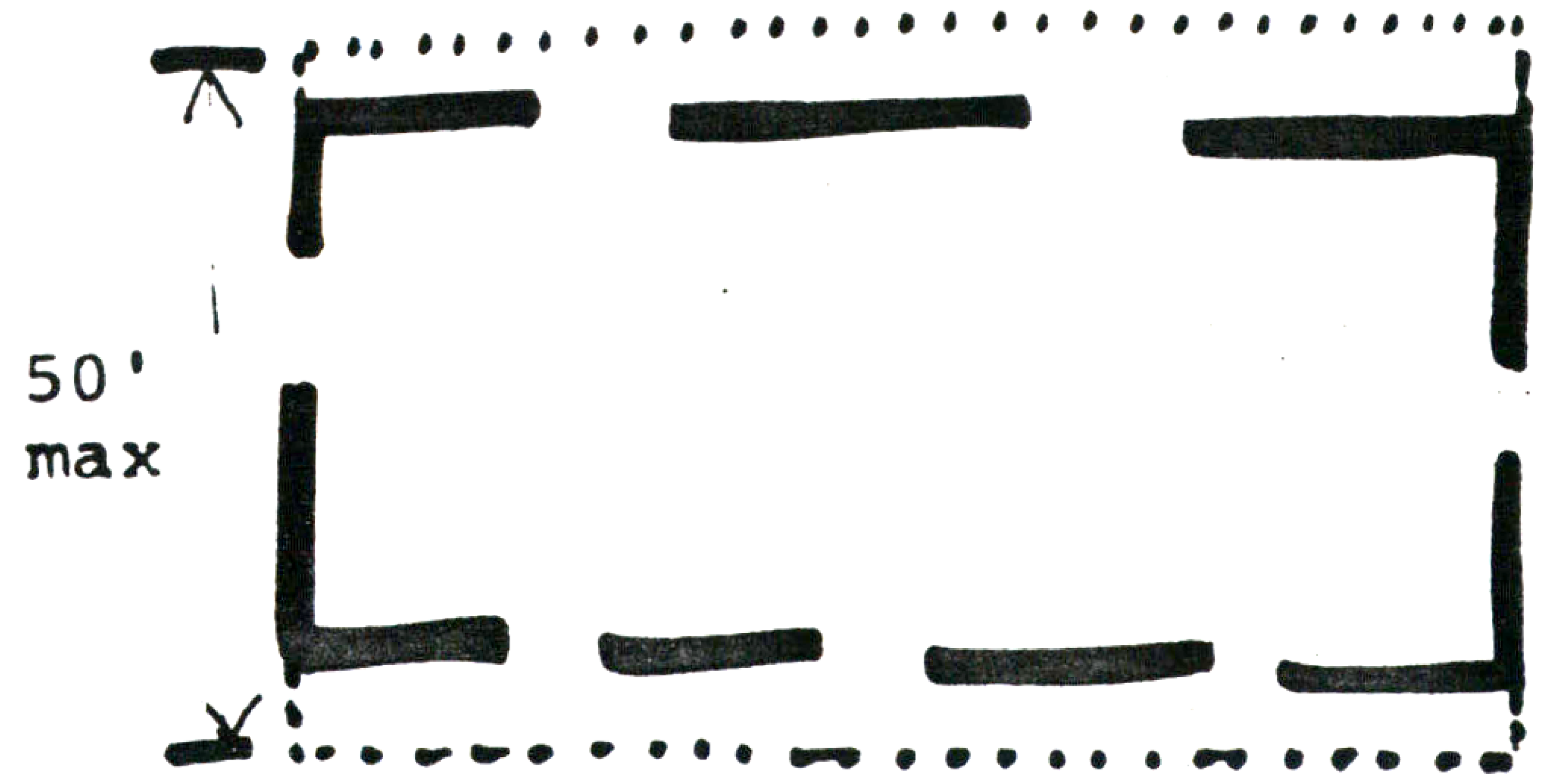
Therefore: Limit the width of buildings. Make buildings whose internal spaces are lit from two sides, up to 50 feet wide – no more. If the building's internal spaces are lit from one side only make it 20 – 25 feet wide. Take the width as a roof-line-to-roof-line measurement.





Problem (continued)

We have discussed the implications of this problem at the scale of individual rooms in the pattern, *Light on Two Sides of Every Room.* Now we ask, what characteristics must buildings have so that all their spaces are naturally lit?

We break this down into two questions:

1. What is the acceptable mix of natural and artificial light, where the natural light dominates throughout the day?

2. At what distance from openings does natural light become so weak that it no longer contributes to the "acceptable mix" defined in question 1?

1. As for the right mix of natural and artificial light, so that natural light will dominate, we propose the following experiment. Turn artificial lights on in rooms with varying amounts of natural light. Invite people into these rooms; after they have spent a moment there, ask them, "Did you notice that the artificial lights were turned on?" At the point where people cease to notice that artificial lights are on, but are aware only that the room is naturally lit—at this point the right mix is achieved. We conjecture that this level can only be achieved if the general illumination provided by the artificial lighting never exceeds the natural light, anywhere in the room. That is, the natural light always contributes at least 50% of the overall light level of the space.

(Note: Any task requiring visual detail may require very high levels of illumination. These tasks will naturally be located near a window, or provided with a spot supplement. The proportion above is intended to apply only to the background light level—the light which gives the room its quality as a room.)

2. To determine the distance from windows where natural light can be effective, we must first determine an acceptable minimum level of general illumination. We take the minimum level of working illumination of 10 lumens/sq.ft. (demanded by the British Statutory Building Regulations) and increase this by ten, giving a minimum illumination level at any point in a room of 20 lumens/sq.ft. This level corresponds to that found in a typical corridor, and is just below the level required for reading.

From the assumption above in 1, we know that 10 lumens of this must be from daylight. If we use the "standard sky" illumination of 500 lumens/sq.ft. (this corresponds to a dull day, introducing a margin of safety), then to achieve an illumination of 10 lumens per sq.ft. requires a daylight factor of 2%.

Experiments have shown that a 2% daylight factor can only be maintained (in a side lit room, with evenly distributed windows, and a ceiling less than 12 feet), if the actual glass area of windows is of the order of 25% of the floor area.

If we consider that the average glass opening is likely to be no greater than 60%, for reasons of reducing glare, providing multiple openings (see *Windows Overlooking Life*), and to accommodate structural components, then the maximum depth of a room which will sustain 10 lumens/sq.ft. at a point furthest from the windows can be determined to be about 25′.

This means that buildings open at one side to daylight, cannot be much deeper than 20-25′. When they are wider than this, the artificial light, of necessity, takes over.

Finally, we discuss the cost increase created by long narrow buildings. A long narrow building has a larger perimeter per unit area than a square building. How big is the difference? The following figures are taken from a cost analysis of standard office buildings, used by Skidmore Owings and Merrill, in the program BOP (Building Optimization). These figures illustrate costs for a typical floor of an office building, and are based on costs of $21/sq.ft. for the structure, floors, finishes, mechanical, etc., not including exterior wall, and a cost of $110/running foot for the perimeter wall.

Area (Sq.Ft.)	Shape	Perimeter Cost ($)	Perimeter Cost Per Sq.Ft. ($)	Total Cost Per Sq.Ft. ($)
15,000	120x125	$54,000	3.6	24.6
15,000	100x150	55,000	3.7	24.7
15,000	75x200	60,500	4.0	25.0
15,000	60x250	68,000	4.5	25.5
15,000	50x300	77,000	5.1	26.1

We see then, that at least in this one case, the cost of the extra perimeter adds very little to the cost of the building. The narrowest building costs only 6% more than the squarest. We believe this case is fairly typical, and that the cost savings to be achieved by square and compact building forms, have been greatly exaggerated.

By: Christopher Alexander, Barbara Schreiner, Murray Silverstein and Ronald Walkey.

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This pattern is tentative. If you have any evidence to support or refute its current formulation, please send it to the Center for Environmental Structure, P.O. Box 5156, Berkeley, California 94705; we will add your comments to the next edition.