Conclusion: Is Full-Spectrum Light the Quality Choice?

Jennifer A. Veitch, Ph.D.
National Research Council of Canada
Institute for Research in Construction
Ottawa, ON K1A 0R6

Fluorescent lighting is most commonly used in commercial, institutional, and industrial applications, where occupational safety and health professionals, facilities managers, and employers all have a stake in ensuring the provision of physical conditions for work that maintain productivity while preserving the health, safety, and satisfaction of the employees and other occupants. We hear more and more often that employees who believe that their working conditions could be improved make their views known, and demand changes. When the request is for full-spectrum fluorescent lighting, the person receiving the request cannot be blamed for not knowing how to respond. The information available until now is complex and conflicting. The impetus to organize a symposium at the American Psychological Association convention, to conduct a thorogh literature review, and to prepare this report came from the persistent inquiries received at the Institute for Research in Construction for clarification about the appropriate uses of full-spectrum fluorescent lighting.

In making a choice about lighting, the decision maker must balance lighting quality concerns -- the likely effects of each alternative on the people who will use the lighting system -- against economic concerns. The lighting quality aspects of full-spectrum fluorescent lighting have been dealt with in considerable detail throughout this volume. Here, the question is, "If faced with a request to install full-spectrum fluorescent lighting, what decision ought one to take?"

Economic Issues

Decisions about buildings are not abstractions. Lighting decision makers do seek to fulfil human needs and to provide a high-quality lighted environment, but they cannot fail to consider the economic consequences of the lighting choice. Three elements determine the economic consequences: first costs, energy consumption, and maintenance.

Where first costs are concerned, full-spectrum lighting is at a distinct disadvantage compared to cool-white lamps. Prices vary by manufacturer, but one major North American lamp manufacturer currently lists its cool-white product at Can$ 1.30 for a 4-foot, 40-watt lamp, while its full-spectrum product is priced at Can$ 8.50 for a 4-foot, 40-watt lamp.

Full-spectrum lamps also produce less light per unit electrical energy. More lamps will be required to maintain the same level of illumination as a cool-white installation. This performance limitation should receive increased emphasis as electricity costs rise. Recommended levels of general illumination have fallen for offices from around 1000 lux to 500-600 lx since the advent of personal computers, but some writers have argued that biological needs for high-intensity light should lead to a dramatic increase in interior illuminance, to around 5000 lx (Wurtman, 1975). Even to maintain the current levels, full-spectrum fluorescent lighting would lead to higher electricity costs than other lamp types. Increasing the number of lamps and their associated ballasts also has implications for heating and cooling costs that could compromise building energy-efficiency overall. Apart from the financial cost to the consumer of this lower efficiency, one might ask whether the environmental cost of a less efficacious lamp is justifiable.

Maintenance costs do not favour full-spectrum fluorescent lamps. Some anecdotal reports (e.g., Piltingsrud et al., 1976) have suggested that the lamp life in some installations may be shorter for full-spectrum lamps than for other lamp types, although the reasons for this rapid drop in visible light are unclear. The lumen depreciation for the ultraviolet phosphors in a full-spectrum lamp is known to be faster than for the phosphors providing visible light (cf. Cameron, 1986). To maintain the intended spectral composition, the user of full-spectrum fluorescent lamps must replace the lamps often enough to maintain the ultraviolet component, or use a special luminaire with separate ultraviolet lamps, which are replaced more often than the white-light lamps.

Lighting Quality Revisited

The scientific evidence reviewed above (Veitch & McColl, this volume) does not support the claims that have been made for full-spectrum fluorescent lamps. For most people, and most tasks, there is no evidence that any particular lamp type is better than any other in its effects on people. Thus, for most commercial, institutional, and light industrial settings, there is no reason to recommend a full-spectrum lamp over any other fluorescent lamp type. Dramatic claims to the contrary, presented in the print and broadcast media in recent years, do not withstand close scrutiny and assessment against the standards of science (cf. Gifford, this volume).

There is one notable exception, in the case of tasks requiring fine discrimination of colour (examples include matching dental ceramics, matching paint samples, and in the textile industries). Fine colour judgements are more accurate under a full-spectrum fluorescent lamp than under a conventional cool-white lamp. Boyce (this volume) has discussed the reasons for this effect. The evidence does not support claims that the enhanced colour rendering has any effect on the appearance of people or rooms in common settings. Furthermore, any white lamp with a high CRI could be expected to facilitate colour matching by definition.

It may be the case that certain sensitive individuals would benefit from closer attention to the spectral characteristics of the lighting in interior spaces. Some people may benefit from a full-spectrum lamp. Others may be adversely harmed by a particular lamp type. No means to reliably identify either group has yet been developed. The specific lighting characteristics to which sensitive people respond may be idiosyncratic, as is already known to be the case in patients having photosensitivity dermatitis.

In special settings, such as for the chronically ill, the elderly, people living at extreme latitudes, in submarines for extended periods, and in space travel, there may also be a role for full-spectrum lighting, or for any light source that provides enough ultraviolet light to provide for adequate vitamin D metabolism. The special needs of people living in these circumstances have not been adequately examined by lighting researchers for any recommendation to be made concerning the appropriateness of any particular light source or system.

For people with access to naturally-occurring ultraviolet light, the exposure provided in the normal way by time spent outdoors should be sufficient for vitamin D production. Excessive exposure to sunlight should be avoided to prevent undesirable effects such as sunburn, wrinkling, and melanoma.

To the extent that good colour rendering and a bright, variable visual environment are desirable, the energy-efficiency of natural daylight is unbeatable. Where possible, this lighting source should be incorporated into the lighting design, not because of any intrinsic benefit of the natural daylight spectrum but because it is "free" light delivered in a form that is preferable to most people (e.g., Heerwagen & Heerwagen, 1986).

Moreover, providing natural daylight with windows also gives a view of outdoors. Having a view outdoors may be important to environmental satisfaction. In one sample, the lack of a view was the most important feature of the office for people who lacked access to windows in their offices; people who occupied windowed offices did not include the view as a determinant of their environmental satisfaction (Boubekri & Haghighat, 1993). People with windows reported relatively high satisfaction with both the lighting and the view; people without offices were dissatisfied with both of these features. It appears from these data that the absence of a view outdoors is salient to people, but when a view exists it may be taken for granted.

The selection of a lighting system is more complex than choosing the type of lamp. Characteristics of the end-users, the setting, and the task all come into the equation. One must weigh these against economic and environmental concerns. Given the diversity of human needs in different settings and for different tasks performed by people of varying ages and abilities, it would be naive to expect any single product to optimize all lighting designs.

Fortunately, the lighting industry has responded to this complexity with a wide array of products with which to tailor the lighting to the needs of its users. The challenge for lighting designers is twofold: to identify the user needs, and then to create a design that meets them. That, by definition, is the provision of lighting quality.

References

Boubekri, M., & Haghighat, F. (1993). Windows and environmental satisfaction: A survey study of an office building. Indoor Environment, 2, 164-172.

Boyce, P. R. (1994). Is full-spectrum lighting special? In J. A. Veitch (Ed.)., Full-spectrum lighting effects on performance, mood, and health (IRC Internal Report No. 659, pp. 30-36). Ottawa, ON: National Research Council of Canada, Institute for Research in Construction.

Cameron, J. T. (1986, January/February). John Ott: The "light" side of health. The Mother Earth News, No. 97, pp. 17-22.

Gifford, R. (1994). Scientific evidence for claims about full-spectrum lamps: Past and future. In J. A. Veitch (Ed.)., Full-spectrum lighting effects on performance, mood, and health (IRC Internal Report No. 659, pp. 37-46). Ottawa, ON: National Research Council of Canada, Institute for Research in Construction.

Heerwagen, J. H., & Heerwagen, D. R. (1986, April). Lighting and psychological comfort. Lighting Design + Application, 16(4), pp. 47-51.

Piltingsrud, H. V., Odland, L. T., & Fong, C. W. (1976). An evaluation of fluorescent light sources for use in phototherapy of neonatal jaundice. American Industrial Hygiene Association Journal, 36, 437-444.

Veitch, J. A., & McColl, S. L. (1994). Full-spectrum fluorescent lighting effects on people: A critical review. In J. A. Veitch (Ed.), Full-spectrum lighting effects on performance, mood, and health (IRC Internal Report No. 659, pp. 53-111). Ottawa, ON: National Research Council of Canada, Institute for Research in Construction.

Wurtman, R. J. (1975b). The effects of light on the human body. Scientific American, 233, 68-77.

Acknowledgements

I would like to acknowledge Peter Boyce, Robert Gifford, Stuart Kaye, Michael Ouellette, and Dale Tiller for their many and varied contributions to this project and this report.