

WHAT ARE THE LIGHTING NEEDS OF THE OCCUPANT (WORKER)?

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Dr. Yonemura: Actually, I am going to reiterate much of what has been talked about before and I think I can serve a function in the sense of emphasizing what we have been talking about. I am a psychophysicist; I am not an architect; I am not a designer; and I think most of us here are in what is called the hard sciences rather than the design sciences. I think we should be made aware of this.

Lighting engineers feel user requirements are fulfilled when physical or physiological needs are satisfied. Furthermore, they assume they know what the user's requirements are; that is, what the user wants the luminance environment to perform, and from this assumption proceed to develop standards. I have seen this, I think, in the last day or two.

When discussing quantitative and qualitative requirements of lighting, user requirements are generally based on task recognition or task performance. We psychophysicists apologize for this. We apologize and say the other side is important and forget about it. Is this acceptable? For example, we ask what must the luminance level be for satisfactory visual task performance? How does the size of the visual stimulus affect task performance? What is the tradeoff between contrast and luminance level for task performance? The emphasis is on the physiological capacity and limitation of the observer or user.

This is not to imply that psychophysicists are not aware of psychological effects. They can and do influence visual task performance. But these psychological effects are treated as undesirable parameters that must be controlled. If we control it, we can ignore it. Even among psychophysicists, disagreement exists as to the kind of visual task and the procedure that are appropriate for evaluating lighting needs. Rather than discuss this problem, I would like

to proceed to the more general problem of physical, emotional and intellectual factors as the basic considerations in user lighting requirements.

Nonvisual scientists, such as architects, interested in the assessment of lighting needs, insist that emotional and intellectual needs are just as important as the physical needs. These psychological requirements are not restricted to aesthetic ones. There is one area involving subjective evaluation of the luminance environment for which quantitative recommended practices are prescribed today. This is discomfort glare which was mentioned yesterday. It is important to remember that we are not talking about disability glare. The experimental procedure followed in obtaining visual comfort probability (VCP) was not task performance but subjective evaluation by observers. The criterion for visual comfort probability is not how the glare source directly affects task performance, although there is an assumption that it indirectly affects task performance as a consequence of psychological effects resulting from dissatisfaction with the visual environment.

It may be that what is today treated as subjective preference may be correlated with physiological response in the future. We had two examples of this yesterday: Dr. Fry's work on discomfort glare and its relation to a cyclic opening and closing of the iris, and Dr. Blackwell brought up the effect of fixation and the probability of fatigue resulting from that. We do not know what the answers are, but he may be right.

What I want to bring out is the necessity to more carefully assess user requirements. Let me take another example from the subject being discussed at this symposium, lighting health and safety. A specific question would

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be: What should the level of illumination be in order that the environment be safe and healthy for the worker? As visual scientists, when we think of safety and lighting for circulation areas—let us restrict ourselves to that—we conclude that the designated areas should have enough illumination that the worker can clearly see any obstruction. This takes care of safety. What is the second half of the equation, health?

For health, I think we should include both physiological and mental health. Is the level of light recommended for safety the same level that will be recommended when psychological consequences are considered? The worker may have enough light to adequately see any obstruction, but he feels insecure in a dimly lit environment, a psychological factor. How much consideration should be given to the psychological need as opposed to the physiological one? This can lead us to another topic, security lighting, which we have looked into a little bit.

What is the function of security lighting? Is it to deter the criminal? Is it to be adequate for observing a criminal act in progress or even require that the illumination level be sufficient so that the felon can be identified? I think that this is Mr. Crouch's criterion. Or should the criterion be that level that makes the occupant feel secure? The obvious solution, which is to take the criterion with the extreme level, has difficulties. The extreme level may prove detrimental to another criterion; and, furthermore, we no longer are living in the age of cheap and plentiful energy.

We can say this is a policy question—this was brought up this morning—and not the responsibility of the engineer or scientist. But, for the lighting researcher, it is a pertinent question that he must answer. He can not say, "I'm only interested in physiological needs." The total user reaction is the problem. Should luminance levels be set according to what the subject feels is the required level, although this may be different from that obtained by task performance techniques? Again, this problem cannot be brushed aside as one of policy. The question of the importance of the emotional and intellectual needs must be answered. This decision can significantly affect lighting design. If there is a discrepancy between luminance levels for visual perform-

ance and preferred levels, what should the criterion be?

Yesterday, Dr. Weale talked about the British standard and he mentioned the fact that it was partly based on performance and partly based on psychological needs, which, in this case was preferred levels. And, if my recollection of the British standard is correct, the preferred levels were much higher than the performance requirements and therefore, they compromised. So they had both needs and they picked an average level. I do not know that I accept a compromise solution in this case. I think it should be one or the other. We should decide what the criterion should be and use that. If the user-preferred level is the most important criteria, then use that. If it is task performance we are interested in, then use that and ignore the more psychological needs.

Now, in summarizing, the purpose of this presentation was to introduce another side of the lighting story, the side that is opposite from mine. I am trying to present the views of the designers and architects. More time and effort should be spent in determining what the user requires of the lighting systems. We think we know what the user wants, but I have my doubts. Should task performance be the basis for recommending light levels, or should equal consideration be given to emotional and intellectual needs, attitudes, impressions, moods, et cetera. A lighting system satisfactory in terms of task performance may not necessarily fulfill emotional and intellectual needs. A visual scientist will unequivocally state that a ratio of peripheral and task luminance of one will be the optimum for task performance. But a designer will insist on modeling considerations, a proportionate amount of light and shadow for a healthy psychological environment.

This is not a new problem. Dr. Cogan has been stating for the last thirty years that psychological fatigue can result from a poor luminance environment with no evidence of organic harm to the eye. Dr. Blackwell has shown that maybe there is some kind of a temporary difficulty; but I do not think that is the problem that we need to attack. How it results is not the question. How important it is to the user is the question that should be answered.

The suggestion is that a real effort be made

to resolve the standing of these psychological criteria rather than give lip service; that is, say they are important but do nothing about them. Let us get the data to better identify the variables and then deal with them in a meaningful way when designing lighting systems. We have half-hearted efforts being undertaken today to investigate these factors.

I hope I have not left the impression that I am fully convinced that emotional and intellectual needs in lighting have just as important a role as physiological needs. I personally feel that many of these psychological factors are highly personal and that, when quantified, the range may be greater than zero to some higher level, but range from negative to positive values. For example, in color harmony, for the same room being used for the same purpose, some will like what we call circus colors—that is, psychedelic colors—combinations of highly saturated and complementary hues. Others will insist on color combinations with little chromatic contrast or what we will call conservative colors, the opposite extreme. The present popularity of multidimensional scaling has increased interest in the investigation of

the more subjective aspects of the environment. But we must be careful, we must quantify the dimensions extracted and identified by the multidimensional scaling techniques. If these variables, upon quantification by experiment, show a highly diverse population—that is, a very large standard deviation, probably indicating the highly personal nature of the dimension—any attempt to utilize them as a criteria for a standardization of lighting design is, I think, hopeless. On the other hand, we may isolate variables that most observers react to in a similar fashion within a reasonable range. A dimension of this type can be used as criterion for standardization purposes.

Well, I have raised many questions and given few answers, but my original purpose was to broaden our outlook when we consider lighting design. These factors have been mentioned and have been used by lighting designers. Now, the question is: Should researchers, building managers, and regulatory boards continue to dismiss these concerns as being unscientific, or should we adopt the opposite viewpoint and consider these issues as a challenge to our experimental ingenuity and try to tackle them?

DISCUSSION

Dr. Weale: I was very interested in Dr. Yonemura's observations; and, whether the U.K. has arrived at a compromise between user and performance, does not, I think, matter very much because it involves an arbitrary decision and any decision which is reached in this field is bound to be arbitrary. Even if this meeting, or any other meeting, does not adopt a particular compromise which has been adopted elsewhere, they have to adopt some other compromise. That is what has transpired from everything that has been said. If you have a ninety percent level of acceptance, this is an arbitrary decision. If you make it a fifty percent level of acceptance, it is still arbitrary. I have very strong reservations about depending on the user exclusively. I pointed out yesterday that the user who drives feels happiest when he has had a little alcohol. By that token, no doubt, this meeting would recommend that you should not be allowed to drive without some alcohol. In addition to light being used for safety, work and pleasure, it also is a commodity to be sold. The user can also be brain-

washed. I need hardly remind you about what can be done in connection with advertising prunes. The same might apply to light. If you are going to tell the user he ought to want more light or less light, it does not matter which way we go. The user can be conditioned into what you want him to do. And it seems to me if any recommendation is going to be based on medical, physiological, and generally scientific considerations, then the user comes into it only on a marginal basis. I quite agree that an environment should be pleasant, but one ought to count the cost. The pleasantness of an environment can be controlled by paint; it does not have to be controlled, necessarily, by luminaires.

Dr. Yonemura: I think that you are saying that what the user wants is immaterial and that it is what we think is good for him that should be the criteria. We have a lot of objections to this. Granted that most preferred levels are based upon experience and learned, but is this immaterial? What the people want, a lot of them, is what we should work for or strive to obtain,

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and, in many cases, it is bad for them; but, still, this is what they want. Should we re-educate them to show them how bad it is, or should we accept their wants and desires as being the real needs?

Dr. Weale: I did not say it was immaterial. I would not like to be reported as saying it was immaterial. My word was "marginal." The use of the word "marginal" was contingent on the assumption that the problem is controlled by economy. It seems to me, if one is in a situation where one has to economize, that one way of bringing this home to people is that they can not have exactly what they want. This is what all this is about.

Dr. Halldane: You would not need standards, effectively, if that was the situation.

Dr. Weale: Quite. If you are going to limit it to arbitration, then you do not have to discuss it. It is like water, you can have what you like. You can have as much water as you like if you can find enough of it. If you go to Israel, I am told, you find that water is metered. It is metering of light we are talking about.

Mr. Caplan: If you are going to bring in the subject of economic benefit or the reduction in energy cost and so on, I think you have to start going into what we do in our planning of cost/benefit ratios where you may increase or decrease the cost of lighting, but your benefit may be reduced by reduction in performance and in worker activity. You have to balance these things out to have those numbers before you can make any intelligent decision as to whether the reduction in cost is worth the reduction in benefit.

Dr. Blackwell: I think that the key thing Dr. Yonemura was saying, I must agree with most strongly, is that we know a lot about performance. The reason is because it is relatively straightforward to measure and we had the basic methodological know-how when this all began. Psychophysics had a history of a hundred years first. So I would justify my life by saying I measured something I knew how to measure, knowing full well it was only part of the story.

I do not say bad things about multidimensional scaling; I look forward to an architectural psychology that will be helpful. I think there are some very bright people who are working on it. It is a very difficult problem and it may be, for the next year, we are not going to have it. But I think we will have in ten years

or twenty years, certainly, a fully developed reaction to the psychology of lighting which may, indeed, modify rather severely the things we concluded before that. The problem, I think, is that we do not have it fully developed today. Now, can we, then, do anything without it?

It seems to me we said that there are fuller bases one could use for deciding about light, preference is one. Oddly enough, as I said yesterday, that leads to the highest levels. You can not justify two hundred footcandles, in my opinion, for many tasks, if any. But that is the level people gave when allowed to set a rheostat in Bodmann's experiment. Performance calls for lower levels. I believe it was said, and was generally agreed this morning with a few minor exceptions, safety probably would call for less yet; and I rather suspect that health will come lower yet. There is a kind of hierarchy, in short, of the light levels, I think, that will come out of different criteria. In a sense, I do not think we can afford user preference; so, in a way I think we can throw it out on the basis of simple economics.

Performance does happen to be the one on which we have the most information. The question is: Are there serious psychological factors that are violated by performance criteria? We have not had time to talk about the fact that raw illumination is meaningless. We hinted at it yesterday. Indeed, in the IES handbook, it says that you do not use illumination units at all; you do not use luminance units; you use effective luminance units in accordance with the CIE report, that is the International Commission of Illumination. My wife and I wrote it so we know a lot about it. This says that you just do not talk about luminance because the eye does not care very much about luminance. The eye cares ten times as much about other things. It cares about the contrast of the task. It cares about luminance ratios in the environment, even from a performance point of view.

The report is so valuable because it puts all these factors together in a straightforward, algebraic way. And, interestingly enough, it throws out as uneconomical most of the environments that people do not like. Now you might say that is a kind of accident, but I think not. People are not attuned to their own performance but they must have some sense of non-wellbeing when informed that their per-

formance is bad. It does seem that an amazing number of the dimensions of preferred environment are handled by performance criteria alone. Later I would like to show you how we could try to use performance criteria to guide decision-making at the Federal level now. I am a reasonable enough man to know that we have to have a highly advanced technology, perhaps, for planning future spaces. It is here; we can do it beginning tomorrow. But we must have a very, very crude technology for evaluating existing spaces. I think we know enough to do both of those and to do it now.

I really believe that, if you are willing to say that, perhaps, if user preference is impossible, you then come to performance and, perhaps, that will take care of health and safety. I think I can make proposals that would not surprise you, perhaps, but might show you that your decision-making today is pretty good and might guide you in decision-making both at the crude level, which is for existing spaces, and at the more refined technology. In short, I would like to talk you into changing your rules only in a small way. Use CIE effective luminance instead of luminance.

Dr. Mead: Are we about to launch into an attempt to demonstrate that a performance measure is, indeed, the kind of measure that ought to be used in making a Federal decision? I wonder whether this is an acceptable measure?

Dr. Blackwell: With respect to considering performance criteria instead of something else, would you not say the sad truth is we do not have highly developed alternatives? And that the statement that has been made, which is, at the moment, if you satisfy performance criteria, you are undoubtedly going to satisfy the other two.

Mr. Crouch: We do not know that.

Dr. Blackwell: I think we do. Remember yesterday, I said—and Hebbard's data show this—that we would get optimum performance and there would be no justification, in God's green earth, for going above VL 8 as far as the ocular motor system is concerned. Hebbard's curve comes out absolutely flat. I think, myself, if you were to use a health basis alone, that it would probably be something of the order of VL 5, somewhere between four and six would be sufficient to avoid symptomatology. We have already established the fact that some people probably will have symptoms at either current light levels or those cut in half;

and, of course, our hosts have given us the solution. Let us emphasize the use of supplementary lighting. It is true that Hebbard's data are, however, limited to a few subjects. We planned to do research on this; but, if you want to know where we stand today, all I can say is that, from everything we know at the present time, I am not surprised with the result that the ocular motor system can be driven rather well with something like two times the ninety-nine percent threshold.

Mr. Caplan: Are you saying that, in general, that if you satisfy a performance criteria, you will, in general, satisfy a safety criteria?

Dr. Blackwell: And a health criteria.

Mr. Caplan: I am just wondering, in the safety field, how often it is that when the performance level illumination necessary is very, very low, it will be below the safety level. I was in the Navy and I remember many times going out on watch at night, tripping over lines and one thing and another, but the actual level that you need for lookout duty and so on was very, very low.

Dr. Blackwell: Your performance included getting to the station without falling over the cables. I think we agree there are certainly cases where serious injury or death can result from an error.

Mr. Caplan: Mining is another example.

Dr. Blackwell: In those cases, one simply has to say performance and safety are one and the same thing. You cannot tolerate an error, it kills a man, or maybe you can. Let that be a political decision. I am saying that, by and large, moving aside special cases like this—which I think are relatively rare—what has been done by ANSI in setting levels of illumination for safety from one-half to five foot-candles as well as OSHA's safety requirements reflects what Professor Grimaldi said, which is that, by and large, if you have enough light to satisfy the performance criteria—even Tinker's value, let us say, of twenty—you have more than enough to keep people from falling down stairwells. I think that is true and that is the point that I am going to make. I am saying that, in terms of a practical outcome of the conference, I think we are in a box, which is, we do not know enough about the other two criteria today to do anything more than to say we need to know more.

I would like to try to give the perspective that I think I see in it, using the only infor-

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mation we have. That is what engineering is all about. It is not ultimate truth; it is all that we know. I believe that this will take a little different shape, perhaps, then some of you realize. The CIE report changes the world as far as vision is concerned. I think it might be helpful to discuss what could be done with the performance criteria and see if you all agree.

Mr. Crouch: In my opinion, the CIE report is only in a draft form and it has not been sufficiently backed by evidence yet.

Dr. Blackwell: Well, Mr. Crouch, let me present the story on that. I am not speaking for the IERI. I am not speaking for the IES. I am speaking only for H. Richard Blackwell and a committee of experts from forty countries who do not care about the IES's opinion one way or the other. This is a scientific document. You may not wish to use it, that is the choice any practical body has. But I am here to give you scientific evidence, speaking as a college professor.

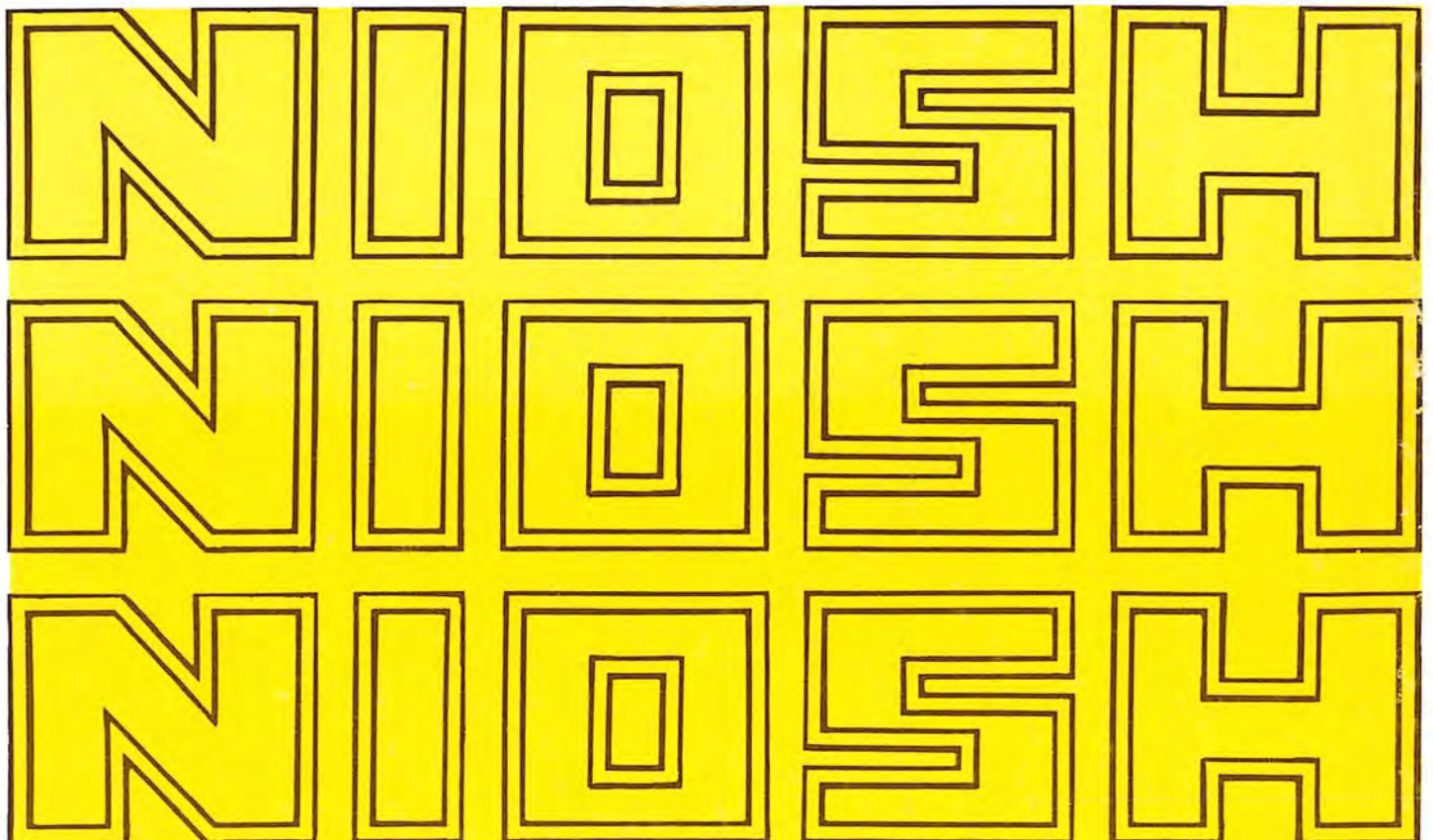
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