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FUNDAMENTAL PROBLEMS WITH VISUAL PERFORMANCE RESEARCH DESCRIBED IN THE CIE 19/2 REPORT

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ABSTRACT

The CIE 19/2 model of performance cannot be used to predict performance or productivity. We present counter-examples to the link assumed in CIE 19/2 between performance and productivity. Statistical arguments show that the fitting parameters are not physically determined as was thought and that the curve fitting in the CIE 19/2 report does not constitute a validation.

Some critics of CIE 19/2 have suggested that RQQ #6 be used in its place for lighting calculations. RQQ #6 is simply a consensus of present practice. The more robust visibility trends presented in CIE 19/2 are inconsistent with the recommendations in RQQ #6. Careful use of the material in CIE 19/2 could lead to better recommendations than are exemplified by RQQ #6.

FUNDAMENTAL PROBLEMS WITH VISUAL PERFORMANCE RESEARCH DESCRIBED IN THE CIE 19/2 REPORT

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General Considerations

Report CIE 19/2[1] summarizes an extensive body of research carried out over several decades. We argue that the report contains very valuable information identifying crucial variables and establishes trends that are consistent with intuition and experience. On the other hand, we argue against the claim made in CIE 19/2 that the model developed can be used to accurately predict performance as a function of visibility.

The robust features of 19/2 which are generously supported by extensive laboratory experimentation can be considered as the following three essential trends:

1. Improvement of visual performance with increases in visibility (VL level).

2. Establishing the relative importance of contrast, size, disability glare and task difficulty when compared to luminance in the calculation of visibility.

3. Saturation of performance at both high and low visibilities.

To be useful for prediction the fixed parameters of a model must either be measureable, or generalizable from one experimental condition to another. The following points outline our argument that the CIE model is not predictive.

1. There are three free parameters, D, W_{123}, and P_{max}, which cannot be measured or estimated in advance.

2. These same three parameters have no intrinsic physical significance so that fitting them to the data from one experiment does not guarantee that they will retain the same values for the same visual task when the experimental conditions are changed.

3. The CIE model assumes a link between visual performance and overall performance that has not been substantiated, and may in fact seriously overestimate the significance of visual performance in most cases.

Over the course of its development the CIE 19/2 model has grown very complex in response to new experimental findings. The added complexity supposedly corrects for physical effects, such as fixation accuracy and so on, that were not considered in the earlier versions of the model. The model has been supposedly validated by its agreement with the twenty sets of data that are presented in the CIE report. These considerations do not constitute a valid defense to our claim that the model is not predictive.

The key point to our rebuttal of these considerations is that visual performance is not rigoursly defined in the CIE 19/2 model. It therefore cannot have strict physical interpretations attached to each parameter. In a statistical analysis of a fit this type of problem may show up as a lack of statistical significance in the fit. The analysis of the twenty data sets in the CIE report fails to follow proper statistical procedures and therefore does not show that the fits are significant. We claim that the complexity of CIE 19/2 model simply gives it a more flexible shape, and does not actually add to understanding, or the predictive ability of the fit.

The practical significance behind visual performance research is the need to provide design guidelines for illumination system designers. We do not feel that the CIE model should be used to set guidelines, but one would certainly hope that guidelines would be consistent with the more robust trends in visual performance shown in CIE 19/2. We argue that this is not the case for the recent IES recommendations.

II. Visual Performance and Productivity

Difficulties arise in interpretation of 19/2 at the outset because the model proposed there assumes that visual performance is linearly related to overall performance[2]. However, the report offers no evidence to show that this is the actual relationship. In fact, a little thought reveals a number of likely ways in which visual performance and productivity can be related.

Consider, for example, situations where performance is measured in terms of speed. If the visual and nonvisual components of a task or job are done in parallel, then the total time for the task is the longer of the times for the visual and nonvisual components. Reading for comprehension may be a pertinent example of this.

We get a similar visual performance/productivity relationship if motivation instead of ability limits overall performance. Workers may only exert themselves to produce a "fair" day's work and no more.[3] In fact, productivity may even be subject to contract bargaining.[4] A more benign reason for limiting output arises from the natural desire to finish the task, or some discrete portion of the task, before taking a break. If the increase in the potential visual performance is not sufficient to allow the worker to get to the next natural ending point on the task, there may be no change in output.[3]

In all of the above cases there is a level of visual performance above which there are no further increases in productivity. This will tend to be the most cost-effective level. In practice this single visual performance level will translate to a range of visibilities due to the differences among individuals.

Now let us assume that the job consists of tasks linked in series. In this case the times for the visual and nonvisual components of the task will add. Let W_t be the fraction of total time it takes to do the visual tasks as visibility approaches infinity, RTP the relative performance on the visual components of the task, and RP the overall relative performance (productivity). Then RP is:

$$RP = (W_t / RTP + (1-W_t))^{-1}$$

The first order Taylor's expansion of this equation around RTP = 1 is equivalent to the linear model proposed in CIE 19/2.[1,5]

The manner in which tasks can combine is more varied when performance is measured in terms of accuracy. For instance, the visual and nonvisual components of a job may be totally separate so that performance on one does not affect performance on the other. If overall performance is just the sum of the performances on the individual tasks, then we get the linear or "dilution" model proposed in CIE 19/2:[6]

$$RP = W_t RTP + (1-W_t)$$

where W_t is now the fraction of time spent on, or value of, the visual tasks.

If instead the nonvisual components of a task contribute directly to final accuracy, then final accuracy will be a product instead of a sum. For instance, the probability of neither the visual nor nonvisual components of a task contributing an error is given by:

$$RP = (P_{nv}^{n_1} RTP^{n_2})$$

where P_{nv} is the accuracy on the nonvisual components of the task and n_1 and n_2 are the number of nonvisual and visual steps, respectively, needed to complete the task.

High values of the n_1 make it very difficult to get high productivity. It therefore seems unlikely that tasks for which this relationship applies are common if the n_1 are high.

A common practice is to introduce redundancy into the task if it is not already naturally present. Redundancy provides multiple chances to correct errors. Some assembly tasks and simple tasks like answering the phone can be performed without any light. For these types of tasks, accuracy is given by the probability that at least one of the (redundant) visual or nonvisual steps is correct:

$$RP = 1 - (1-P_{nv})^{n_1}(1-RTP)^{n_2}$$

where the n_i are now the number of redundant steps involved in the completion of the task. For office tasks which do require vision, redundancy will affect the visual and nonvisual components separately:

$$RP = (1 - (1-P_{nv})^{n_1})\ (1-(1-RTP)^{n_2}).$$

A high value of n_2 will make these types of relationships very insensitive to variations in visual performance.

This discussion barely serves as an introduction to the number of relationships which are possible and even likely. For instance, we have not analyzed situations where the accuracy on one subtask is dependent on the accuracy of another task. We have not analyzed cases where performance is determined by both speed and accuracy. We have not explored many of the possible influences of motivation. Finally, we have not analyzed situations where different relationships apply to different parts of the job. Until studies empirically identify the most common relationships, it is only possible to examine "case" studies.

The easiest case to calculate is a lower limit on visual performance. We expect that acuity limits (free viewing) for the visual tasks are a lower limit on how low visual performance can drop before there is an effect on productivity. In this case we are defining the acuity limit as 100% probability of detection or identification, instead of the 50% criterion that is more common. We feel that the former definition is as low a level of performance as is likely to be acceptable.

The next-easiest model to evaluate is the simple "dilution" model, which, as we have noted before, is the model suggested in CIE 19/2, and is very similar to the series model (Eq. 1). This model probably overestimates the effect of visual performance on productivity. In particular, note that the parallel processing, the redundancy modified (Eqs. 4 and 5), and the motivationally fixed productivity models are all less sensitive to visual performance than the dilution model. Furthermore, the motivationally fixed productivity models are essentially the only models for which there is concrete evidence.[3,4]

The two cases we have listed are useful in that they appear to provide limits to what the real relationships might be. They therefore provide bounds that can be used to evaluate the importance of visual performance.

III. Problems with the detailed mathematical model of CIE 19/2

In the discussion of the visual performance/productivity relationships we found that it was important to specify whether productivity was determined by speed, by accuracy, or by a combination of the two. The CIE visual performance model does not distinguish between these different types of performance. A detailed analysis of the problems that this creates has been presented in an earlier paper by the authors.[6] In this paper we briefly present the results of that analysis.

The CIE 19/2 model uses a weighted sum to describe how the subcomponents of visual performance -- detection, saccadic motion, fixation, and identification -- combine to give visual performance. This is not self-consistent, as different types of performance require different relationships. For example, if performance is measured by speed, then we expect the times for each subcomponent to add to give an overall time, which is the inverse of overall performance (see Eq. 1). If instead we are concerned with accuracy, then the weighted sum implies that each visual subprocess is independently responsible for a fraction of the overall accuracy. This interpretation cannot be reconciled with the physical description of the subprocesses. Finally, if performance depends upon both accuracy and speed, then the criterion the subject uses to allocate time to the task enters the visual performance function either as an independent variable or as a constraint. Neither is consistent with the CIE model. Consider, for example, the case where the subject maximizes his performance. This condition makes the subject's allocation of time dependent upon the form of the performance function.[6] This in turn implies that performance and even relative performance depend upon the form of the performance function. This is not consistent with the CIE visual performance model, which assumes complete independence from the form of the performance function.

The fact that the terms of the CIE model cannot be identified with the physical processes in a self-consistent manner indicates that the functional form provides at best an empirical fit to performance data. This means that the free parameters of the model, D, W_{123}, and P_{max}, have no intrinsic physical significance and therefore in general cannot be estimated in advance. This means that the CIE model is not useful for predicting the results of new experiments under different conditions than the old ones.

A second problem that arises from the failure of the CIE model to distinguish between different types of performance measures is that it can make it difficult or impossible to relate the CIE estimate of visual performance to productivity. Productivity on a job in general will be a fairly specific combination of speed and accuracy. On the other hand the visual performance-data fit by the CIE model can be any combination of speed and accuracy the experimentor chooses to use. If the performance functions in the laboratory and the field are not the same, then the subject's allocation of time may be different in the two situations. This makes it hard to relate the visual performance data to productivity.

The use of arbitrarily chosen performance relationships can distort the visual performance/productivity relationship in other ways, too. For instance, some of the score functions that were used in experiments that were analyzed in CIE 19/2 introduce an arbitrary constant into the fit. The constant is fit by the W_{123} parameter in the CIE model. The introduction of arbitrary change in W_{123} biases the fit, and by extension the estimate of productivity that one would make from the fit.

The only ways to avoid the above problems are to make sure the performance and productivity measures are similar, or to use a model which explicitly fits the variations in both speed and accuracy.

Many of the problems in CIE 19/2 are a result of trying to make the model too general, and too ambitious. In the earliest experiments targets had a well defined size, the viewing angle was well defined, the exposure time was fixed, and performance was simply defined in terms of accuracy. Given this situation the calculation of VL and RVP is unambiguous. In a more general performance experiment there will not be a unique VL, and RVP may not be simply related to accuracy. There is therefore no reason to expect the same simple relationships as were found in the earlier experiments. Adding correction factors without regard to the specific differences between the particular performance experiment and the earlier accuracy experiments results in a loss of physical significance for both old and new parameters.

Consider, for example, the meaning of the eccentricity parameter $\bar{X}$ as measured in an RCS experiment as compared to its meaning in a standard performance experiment. In the RCS experiment the eccentricity is the angular distance of the target from the line of sight. In the RVP experiment the eccentricity correction to the RCS function is calculated from the fitted value of D. The parameter D is adjusted to give the best RVP fit, hence $\bar{X}$ not only corrects RCS for eccentricity, it also gives the correction for differences in speed, motivation and performance measures, and information content and so on. To the extent that RCS is a function of these factors, and CIE 19/2 explicitly notes that it is a function of exposure time (speed), the parameter $\bar{X}$ has lost its physical significance as a parameter that gives the eccentricity of the target from the line of sight. This is but one example of how the parameters in the CIE model started out with explicit physical significance, and then lost it as the model became more complex.

Even the earliest versions of the CIE model suffer from the disease of over ambition. One only has to note that a single RCS function is used for both scotopic and photopic vision. Given the extreme sensitivity of visibility to contrast it would have made more sense to fit these regions with two equations.

As we noted in the introduction problems in the formulation of a fit often show up as a lack of statistical significance of the fit to data. It is therefore useful to examine the claimed agreement between the CIE model and the twenty data sets. One problem in doing any statistical analysis of the visual performance fits is that in half of them no error bars were calculated. Another problem is that most of the fits do not have enough data points to provide very much information on the shape of the visual performance/visibility curve. In one fit there are actually twice as many unknowns as there are data points, giving an underdetermined, not overdetermined, system of equations. In another fit the number of unknowns and data points is equal, and in half of the remaining fits there is only one degree of freedom. Only two of the 20 fits have six or more degrees of freedom.

A related problem with some of the fits is the excessive number of unknowns. The two worst cases have 12 and 13 unknowns respectively. No statistical tests were presented to show that it is signal, not noise, that is being fit while going to such a large number of unknowns.

There is not one visual performance/visibility fit in CIE 19/2 that is completely free of statistical problems. The statistical significance of the fits is therefore unclear and questionable. In the interests of parsimony, a simpler model should be used until it can be verified that more complicated models actually provide more information.

Statistical problems similar to those above appeared when we examined the fits to the data used to determine the relationships between fixed parameters in the CIE model (e.g. the dependance of m on age, of γ and X on task demand D, of α_3 on X, and so forth). Most of this work is in a set of six support documents. In the first of these documents we found what appears to be another serious statistical problem.[7]

The error bars in this first paper appear to be larger than is reasonable. The data points that are plotted are corrected probabilities that range from −.25 to +1. The distribution of points with the largest standard deviation, σ, is the one with half of the points = 1 and half = −.25 so that $\sigma = .625$. The standard deviation of a measurement of the mean of a distribution, σ_m, is $\sigma/\sqrt{N}$ where N is the number of points measured. The data sets consisted of observations on 45-49 subjects so $\sigma_m \leq .09 = (.625/\sqrt{49.})$ The plotted error bars (after correction from probable error to σ) range from ± .05 to ± .1. It seems unlikely that individual scores would cluster closely at both ends of the maximum range with an average exactly in the middle. We therefore suspect that the error bars have been incorrectly calculated, and we feel that the conclusions drawn from the fits are not well supported. This first support paper proposed a weak linear relationship between γ and α. We suggest that this relationship will have to be reevaluated.

IV. Lighting Codes and CIE 19/2

Mark Rea[13] and others have suggested that existing lighting recommendations, i.e. (IESNA RQQ #6)[10] may be better to use than CIE 19/2. We feel that this view is incorrect and provide arguments for our belief below:

The first point is that CIE 19/2 and RQQ #6 are not the same kind of document. CIE 19/2 presents a model for visual performance and could therefore be used in the preparation of a prescriptive recommendation for lighting such as RQQ #6. However, CIE 19/2 was supposedly not used in the preparation of RQQ #6. Instead RQQ #6 ostensibly represents a consensus of experts. Although it does not use CIE 19/2 explicitly, RQQ #6 was developed "....from a consideration of experience and research results from visual performance experiments," and "...is intended for use... where visual performance is an important consideration.."[8]

We have two general objections to RQQ #6. One is that the procedure used in establishing the light levels was unscientific. The determination of light levels which give good visual performance is primarily a technical-scientific problem to be determined on merit, not a social problem that can be resolved by consensus. The RQQ #6 document is a survey (consensus) of what is being done, not a justification of it. The decision process was not open to the general lighting community; there are no clearly stated assumptions or criteria, and there appears to be no supporting documentation for calculations, checks for consistency, approximations, or boundary conditions. In short, while good lighting design is possible at the RQQ #6 levels, it is totally unclear as to whether as good or better designs could not be done at different levels or with a different approach.

Our other general objection is to the content of RQQ #6. For instance, explicit cost criteria are simply not included in RQQ #6. This makes the recommendations inflexible with respect to local conditions and even unresponsive to general changes in the economy. Furthermore, the relative importance of factors that are included in RQQ #6 are so different from their importance in CIE 19/2 that it is hard to believe that CIE 19/2 could be that much in error. Again, as we noted above, there is no explanation for, or documentation of, these differences.

Presumably, the RQQ committee did what it thought best. It is therefore perhaps helpful to go through our argument in more detail.

Lighting level recommendations have important economic implications in terms of performance (productivity) and in terms of capital and operating costs. The problem of determining the "best" light levels or design approaches can therefore be viewed in terms of economic criteria, and be recast as a net-benefit problem. The major technical problem, and the one that will create the most discussion and disagreement is the estimation of benefit.

Except at very low illumination levels the direct estimation of benefit is extremely difficult due to the large number of essentially uncontrollable non-visual factors which affect comfort and performance in the workplace.[3] Lighting levels recommendations have increased above the levels that can be directly shown to be beneficial in response to laboratory studies which show increased visual potential at these higher levels. The 1959 and 1972 American recommendations were, for instance, directly dependent on Blackwell's work on visual performance during the time periods preceeding the recommendations.[8,9]

As might be expected, this approach also has problems. So much so that the RQQ committee decided not to explicitly use the CIE reports on visual performance (CIE 19 and CIE 19/2). Instead, the committee seems to have simply slightly modified the form of the 1972 recommendations and used consensus to set the actual levels. This approach embodies a subtle contradiction. The 1972 levels were originally determined (within limits) by laboratory studies because direct experience was not sensitive enough to demonstrate the need for higher levels. The RQQ committee has turned from direct application of models to expert consensus. The experts, however, have been doing lighting design with the 1972 recommendations. Their consensus, as can be seen from the examples in Figure 1 and Table 1, is, not surprisingly, very close to the 1972 recommendations. Thus the RQQ committee is essentially still using the visual performance models despite their reservations. Result: the original justification for high levels is no longer accepted without reservation, yet essentially the same levels are still being used and no other justification for them has been offered. The use of a consensus simply acts as a smokescreen to hide, as it were, the fact that the emperor is wearing no clothes.

A more professional approach to the committee's problem would have been to encourage open discussion of visual performance studies and models and their application to the setting of light level recommendations. The committee needs to do its homework. It should make assumptions as necessary, do the calculations, publish the results, and finally make the revisions as necessary.

Consider, for instance, the following observations about the CIE models and their application to lighting recommendations. The 1959 and 1972 recommendations were loosely based on a fixed visibility criteria (VL8). When the calculations gave very low light levels an amenity level was, used in place of the calculation. Similarly, very high levels were not recommended because it was assumed that the calculations were not valid (for reasons of cost or glare) at very high illuminance levels. Net benefit is not properly accounted for by this procedure because a number of factors have been left out. Performance depends upon visibility, the task and worker age. Visibility in turn depends upon contrast and luminance, and not just illuminance. Furthermore, the optimal performance level should depend upon the value of work and the cost of obtaining a given level of performance.

The RQQ committee modified the 1972 guide to include factors for reflectance (luminance), worker age, and task importance, but there is no documentaton justifying the magnitude of the factors or the way in which they were applied. This in fact relates to our second complaint in that the relative values assigned to these factors are grossly different from what one would expect from a review of either CIE 19[11] or CIE 19/2.

Consider the following initial conditions: C_{eq} = 0.88, (Illuminance category D), age = 30, speed and/or accuracy is important, and the task background reflectance, ρ, = 0.8. RQQ #6 recommends 20 fc for this situation. Now consider the following 4 changes: 1) C_{eq} = 0.68 (Illuminance category E), 2) C_{eq} 0.56 (Illuminance category F), 3) ρ = 0.2, and 4) Age = 60. The RQQ #6 recommended illuminances for each of the new conditions above are 50, 100, 30, and 30 fc. However, the changes in log VL are (not counting the illuminance changes) 0.1, 0.2, 0.1, and 0.2. Hence, if the reflectance and age factors are to be consistent with C_{eq} in their effects on visibility, their illuminance recommendations should be 50 and 100 fc, respectively. Obviously, this is just one example. RQQ #6 has discrete illuminance recommendation classes (20, 30, 50, 75, 100 and so on), so a range of values of each variable is associated with a single illuminance. A very small change in any of the variables that shifts them from one category to another could result in a moderate change in illuminance with almost no change in visibility. We felt a fairer comparison was to look at changes from the middle of the range, or over several categories at a time. Our example is of this type, and we feel that it accurately portrays the general tendency of RQQ #6 to underweigh the reflectance and age factors. Furthermore, since RQQ #6 breaks the age and reflectance variables into fewer ranges than the C_{eq} variable, their extreme values are even more seriously underweighted than is suggested by the above example. For instance, inserting age = 70 into our example, we find that it is equivalent in visibility to a C_{eq} = 0.3. For age = 70 RQQ #6 recommends 30 fc, but the equally difficult C_{eq} is allowed 500 fc.

Another important point is that the increase in illuminance does not fully compensate for the decrease in visibility from the age, reflectance, or C_{eq} factors. The easiest way to see this is to note that a variation in ρ by a factor of 7/3 or greater yields a recommended change in illuminance of at most 5/3. Thus luminance, and hence visibility, must drop. This makes sense from an economic point of view if one presumes that the RQQ committee is roughly balancing the costs of higher illumination against reduced visual performance. However, this interpretation runs afoul of the fact that there are no correction factors for variations in fixture and electricity costs, and only a minor correction factor (of the same type as the age and reflectance factors) for the importance of speed and/or accuracy. Even on its face this appears grossly inconsistent with either the visibility calculations from CIE 19/2 or the stated purpose of the recommendations as providing a guide for lighting where visual performance is important. A quantative test of this conclusion unfortunately requires a visual performance estimate and a cost-benefit calculation. It cannot be done from the visibility levels alone. We have done a simplified version of this calculation using a modification of CIE 19/2, and have found that the economic benefits and optimal light levels are more sensitive to the importance of speed and/or accuracy and the other economic variables than they are to C_{eq}, age or reflectance.[12] This finding stands in stark contrast to the importance of these factors in RQQ #6.

In general lighting recommendations have included more factors as time has progressed. One can hope that the economic factors will eventually be included in new standards. The RQQ #6 recommendations are generally consistent with the trend towards completeness, but have dropped one factor from consideration. The 1972 procedure gave some recommendations in ESI instead of footcandles. The RQQ committee dropped ESI from the new guide because of problems in measuring, calculating and using it. They recommend that ESI be considered by the designer, but no longer provide guidelines on how to evaluate ESI values. Actually, problems with ESI are obvious from the discussion in CIE 19/2. ESI is extremely sensitive to CRF and luminance when performance is relatively insensitive to them, and vice versa. The presentation of the 1972 guide in terms of ESI represented a failure to properly identify the light level problem as an economic optimization problem with the economic value of performance, and not simply light level or ESI, as the important variable.

The removal of ESI in the guide is thus potentially an improvement over the old guide, however the RQQ committee has failed to replace ESI with a procedure that does properly account for the effect of CRF on performance. Thus this failure to properly identify the problem leads to a fix that is really not much better than what it replaced (although it is simpler).

Most of the problems with the 1972 procedure could have been identified in 1972, and most of the changes the RQQ committee has made could have been done then too. What was needed was a clear statement of the underlying economic problem, lots of work, and an open discussion of the work.

In summary, we claim that not only is RQQ #6 of dubious merit, it is a deadend procedure and document that provides no basis for the type of discussion that might lead to honest improvement. On the other hand an attempt to apply visual performance models such as CIE 19/2, coupled with a clear statement of the economic nature of the recommendations might give as good or better recommendations, and could generate the type of open discussion that can lead to both a better understanding of visual performance and better recommendations.

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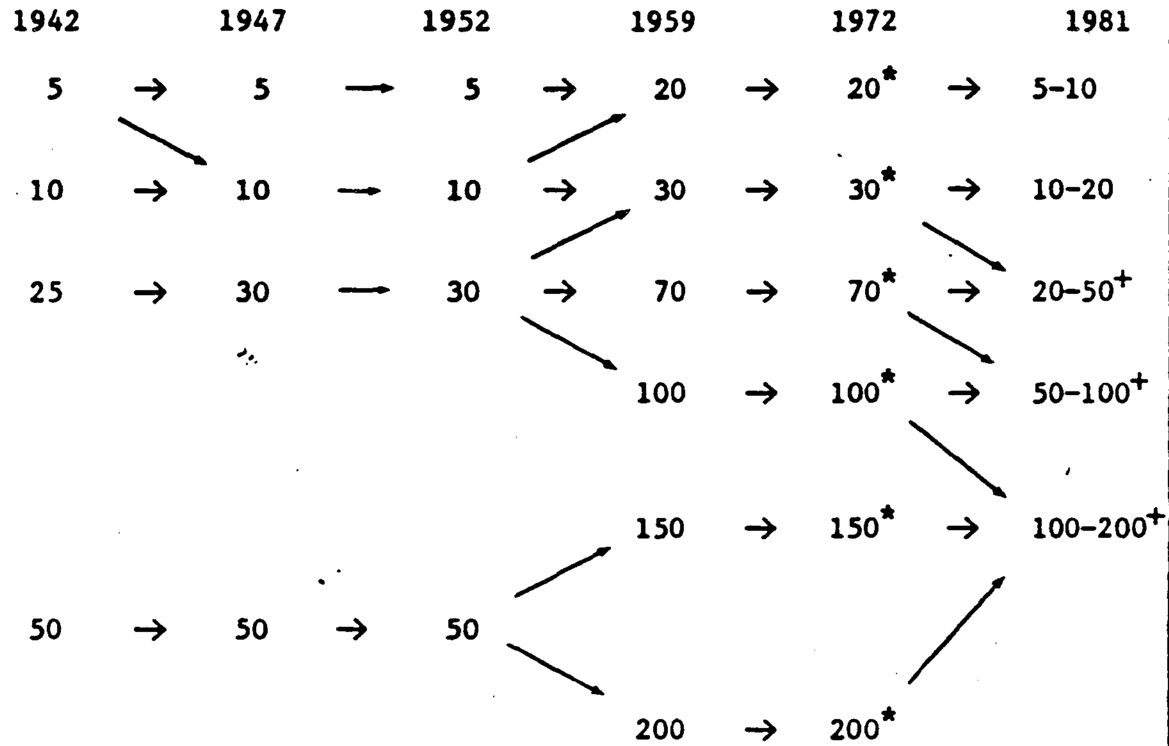
Figure 1.
Office Lighting Level Recommendations
As a Function of Time[1]



[1]The number of entries in a column is the number of separate levels that were listed in that year. Each level has a large number of entries. The arrows show where entries at a particular level in one guide ended up in the next guide. Table 1 gives a list of the more common entries.

* ESI not footcandles

\+ Footcandles, but ESI to be considered.

Table 1 Typical Tasks Listed For Office Lighting Levels[1]

1942	1947 & 1952	1959	1972	1981
1) Simple tasks corridors stairways	1) Simple tasks corridors	1) (Simple) corridors stairways	1) (Simple) corridors	1) Simple corridors CRT's & microfiche
2) Casual Inactive files Reception areas	2) Casual Inactive files stairways Reception areas	2) Casual Inactive files (reception areas) conference rooms	2) Casual Inactive files (reception areas) conference rooms	2) Casual reception areas (inactive files)
		3) (Ordinary) Ink medium pencil intermittent filing	3) (Ordinary) Ink medium pencil intermittent filing	3) (Ordinary) Conference rooms ink good reproductions
3) Ordinary conference rooms file rooms mail rooms General office (ink, pencil etc)	3) Ordinary conference rooms file rooms mail rooms general office (ink, pencil, etc.)	4) (Ordinary) Active filing mail sorting good reproductions hard pencil	4) (Ordinary) Active filing mail sorting fair reproductions hard pencil	4) (Ordinary) Fair reproductions mail sorting file rooms
4) Difficult Accounting etc. Graphics	4) Difficult Accounting etc. Graphics	5) (Difficult) Accounting etc. poor reproductions	5) (Difficult) Accounting etc. poor reproductions	5) (Difficult) hard pencil poor reproductions
			6) (Difficult) Graphics	6) (Difficult) Graphics

[1]Tasks in parenthesis were not directly listed in the guide shown but were inferred from the tasks that were listed and their relationship to the task in parenthesis in the guides from other years.

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