

# **CIE recommendations and standards on colorimetry, what next?**

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## **Introduction**

CIE published its first colorimetric recommendations in 1931. Despite the fact that it was intended only as a preliminary recommendation for signal lights and similar applications, it survived the past 75 years and became used in many other areas of science and technology. As our colour vision knowledge progressed the system became amended and several new parts have been added. From time to time CIE updated its fundamental colorimetric publication (CIE 15: Colorimetry), and published recommendations and state of the art reviews in many colour related subjects. In the present paper we will provide a short overview of the most important developments in colorimetry and will try to offer an outlook on possible further developments.

## **CIE 15: Colorimetry**

The 1931 system of CIE colorimetry and its amendments were originally published only in CIE Session Proceedings, treasure houses of light and lighting knowledge, but having very limited circulation. Due to this fact the spreading of information was via secondary publications: journal articles and books. As colorimetry is used in many areas of science and technology, books, where the authors were experts in a non-colorimetric field wrote the book, and unfortunately in such publications one finds quite often colorimetric misinterpretations. CIE – realizing this situation – published in 1971 its first specialized document on colorimetry.

Colorimetric progress required periodic updating of this document, so in 1986 a second edition was published and in 2004 a third edition became available. This enables authors and teachers to check their knowledge and get up to date information on fundamental CIE colorimetry. The document uses up to date colorimetric terminology, and one can only advise everybody who has to write on colour to consult this publication for the correct use colorimetric terms. CIE 15:2004 summarizes information on the CIE standard and other recommended illuminants and sources, on the CIE standard observers and on the standard reflectance. These chapters are more or less following the previous edition of the publication.

The chapter dealing with geometric conditions for reflection and transmission measurement contains a number of new recommendations. The reader will find new material also in the chapters on calculations, uniform colour spaces and colour difference evaluation and metamerism indices.

A CD-ROM accompanies the publication, where all the important CIE numeric tables are available, together with some important auxiliary programs.

## **Colorimetry: Understanding the CIE system**

To celebrate the 75<sup>th</sup> anniversary of the CIE system of colorimetry CIE experts write a book dealing not only with the questions of fundamental colorimetry, but discussing also issues of advanced colorimetry, i.e. colour appearance, and many aspects of using colorimetry. (A preprint volume of this book, with draft versions of most of the chapters of the book will be available for the participants of the Symposium. Chapters will deal, beside of fundamental colorimetry, with issues of tristimulus and spectral colorimetry, colour management and colour rendering and many hot items of colour science, as e.g. colour appearance models, image colour appearance, temporal and spatial problems.)

### **Possible new work**

CIE technical committees are active in a number of questions that will influence the progress both in fundamental and advanced colorimetry.

Since the middle of the last century colorimetrists were aware of the fact that the CIE 1931 standard observer does not describe the colour vision of the average population well, and in vision science several updates are in use. Two of our TCs are working in this field and we can hope that a supplementary observer will become available soon. But this will probably not solve all the questions, as e.g. it is intended only for field sizes between 1° and 10°. Field sizes are often much larger, and a colorimetry dealing with this question is certainly needed.

New developments of colorimetry are expected not only on the observer side, but also on the source side: Both further illuminants are needed for the proper evaluation of materials containing fluorescent agents (indoor daylight), and the realizations of standard illuminants, i.e. standard daylight sources is still jacking. Such sources, or at least much better simulators are urgently needed. Using LEDs this question seems to be solvable. LEDs pose, however, an other problem: the present colour-rendering index is not a good descriptor of RGB LED sources.

In the field of colour-difference calculation one can hope that the CIEDE2000 formula brought some stability. All the formulae recommended by the CIE up to now were just experimentally optimised equations. The next step has to be a vision mechanism based equation, and with colour difference equations based on colour appearance models the first steps in this direction have been made.

In colour appearance description we are certainly not at the end of development. One very important issue is the description of colour image appearance: how the adjacent coloured patches influence each other, and how a size effect can be described.

### **Summary**

In summary we can state that CIE colorimetry has well served industry and science for the past 75 years. But it has not solved all the questions of colorimetry, there are a number of pressing items to be tackled. In this work CIE colorimetry is relying heavily on colour vision science, and one can hope that as the understanding of the functioning of higher visual cortex levels becomes available, those vision science results will help to build better colorimetric systems.