Video Displays, Work, and Vision

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Panel on Impact of Video Viewing on Vision of Workers

Committee on Vision

Commission on Behavioral and Social Sciences and Education

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Panel on Impact of Video Viewing on Vision of Workers

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Preface

In the spring of 1981 the National Institute for Occupational Safety and Health (NIOSH) requested the National Academy of Sciences to undertake a critical review of existing studies of visual issues encountered in occupational video viewing, analyze methodological problems, and suggest lines of research to resolve remaining questions. In response to this request, the National Research Council's Committee on Vision established the Panel on Impact of Video Viewing on Vision of Workers, which has prepared this report.

The National Research Council appointed panel members with expertise in the diverse scientific and technical areas relevant to occupational video viewing, in particular, ophthalmology, optometry, oculomotor function, physiological optics, epidemiology, occupational health, radiation biophysics, display technology, illuminating engineering, human factors, and industrial and organizational psychology. The areas of expertise of individual panel members are described in Appendix D.

This report focuses on the six issues that NIOSH asked the panel to address:

1. How well are the visual factors and underlying mechanisms that produce discomfort in video viewing understood?
2. What problems are encountered in attempting to define "eyestrain" and "visual fatigue" and to relate physiological, subjective, ergonomic, and performance measures of these concepts?
3. Is existing knowledge sufficient to establish adequate standards for display characteristics (contrast ratios, luminance levels, regeneration rate, etc.)? Is there an adequate basis for standardizing viewing conditions, such as the portion of operators' time spent viewing video display terminals?
4. To what extent are the problems reported with video terminals due to substandard operating conditions (e.g., excessive glare from overhead

illumination), and to what extent would these problems remain even under ideal viewing conditions?

5. What can be said about the relative roles of visual, ergonomic, and psychosocial factors in visual problems encountered? What can be said about the relation of visual symptoms encountered and more general stress responses (e.g., general fatigue) to other aspects of the worker's job?

6. How do visual problems in video viewing compare with those encountered in comparable tasks, such as prolonged editing or typing of print?

Because many workers and labor union representatives have been concerned that radiation hazards may be associated with the use of video display terminals (VDTs), the panel also decided to consider radiation issues in its work.

In the course of its study the panel reviewed diverse literatures, including reports of field surveys of VDT workers and VDT workplaces, laboratory studies of visual functions in VDT work tasks, news articles, and pamphlets prepared by labor unions concerned with VDT issues. The panel also drew upon the substantial technical literatures on visual function, image quality, lighting design, ergonomic design, and industrial and organizational psychology that are highly germane but often neglected in discussions of VDT issues.

To further its discussions of technical issues and to promote the exchange of information among scientists and representatives of labor, industry, and federal agencies, the panel held a public symposium on video display terminals and vision of workers on August 20-21, 1981, in Washington, D.C. (summarized by Brown et al., 1982). Investigators from around the world were invited to present their research on VDTs and to review field surveys of VDT workers. Discussion panels included scientists, who analyzed technical aspects of VDT studies, and labor representatives, who described the concerns of workers. The panel has drawn on the symposium presentations and discussions in analyzing the issues discussed in this report.

The panel recognized early in its deliberations that visual issues in VDT work must be considered within the larger context of the working environment, including the quality of VDT workstation equipment, job design, and workers' concerns and needs for information. This larger context was discussed extensively at the panel's meetings and is considered explicitly in this report.

Early drafts of material were prepared for the panel's review and discussion by panel members, consultants, and staff. The panel's analyses

of survey methodology and of psychosocial issues were prepared by Robert Caplan and Robert Guion. Janet Bertinuson provided guidance on characteristics of various types of working situations in which VDTs are used and on the concerns of the labor community. David Sliney reviewed surveys of radiation emissions, and Alfred Sommer and Hugh R. Taylor analyzed issues involving epidemiology and cataracts. Vincent King, Edward Rinalducci, Stanley Smith, Harry Snyder, and Lee Task prepared material on lighting and reflections and display technology. Panel consultants Martin Helander and K. H. E. Kroemer drafted material on human factors for the panel's discussion. Key Dismukes prepared material on visual tasks and symptoms in VDT work, drawing in part upon ideas and material contributed by NRC fellow Raymond Briggs, Committee on Vision member Julian Hochberg, and consultant John Merritt. Lawrence Stark reviewed the literature on oculomotor factors affecting visual performance. Phyllis Johnston, at the University of California, Berkeley, assisted in reviewing the literature on oculomotor functions. Harry Snyder and Martin Helander provided information on current guidelines and standards for VDT use. Consultant R. Van Harrison provided a review and critique of the NIOSH *Baltimore Sun* study, which appears as Appendix B. Barbara S. Brown and Key Dismukes prepared the summary chapter.

All members of the panel were asked to critically review drafts of the report chapters, all of which were then discussed at panel meetings. The chapters were then revised accordingly, and at its final meeting in February 1982 the panel summarized its conclusions. Thus the study and the report are a collaborative effort of all members of the panel and the staff.

The panel also benefited from thoughtful reviews of early drafts of this report by members of the Committee on Vision and the Commission on Behavioral and Social Sciences and Education and other experts, whose comments the panel drew upon in preparing the final version. Julian Hochberg provided valuable insights on conceptual issues throughout the course of the study and contributed to the development of the entire report; Derek Fender made helpful comments and suggestions on the entire report and contributed to the panel's discussion of several key issues; and several other members of the committee, in particular Anthony Adams, Eliot L. Berson, Dorothea Jameson, and Luis Proenza, provided helpful comments and suggestions. The committee was assisted in its review by comments solicited from David Cogan, at the National Eye Institute; Arthur Jampolsky, at the Smith-Kettlewell Institute of Visual Sciences; and Donald Pitts, at the University of Houston.

Barbara S. Brown played a substantial and invaluable role, collaborat-

ing with us to coordinate and manage the study. In addition, she organized and edited drafts of technical material, wrote supplementary material, and helped integrate the discussion of issues in the report. She also helped organize the panel's symposium and meetings.

Llyn M. Ellison provided expert administrative and secretarial assistance throughout the study. She took care of many administrative details, helped arrange meetings, and was centrally involved in preparing the manuscript for production. In the process of efficiently and expertly producing manuscript drafts on a VDT, she gained firsthand experience in some of the concerns of VDT workers. Gray Jacobik assisted with secretarial tasks and word processing. We are grateful for their skillful assistance. Eugenia Grohman, on the staff of the Commission on Behavioral and Social Sciences and Education, gave helpful advice on organizing the material in the report and expertly edited the final version.

EDWARD J. RINALDUCCI, *Chair*

KEY DISMUKES, *Study Director*
Panel on Video Viewing

Contents

Executive Summary

The issues we were requested to address in this study are presented in the preface. Our findings and conclusions respond both to these issues and to related issues and concerns that we considered in our work.

Although much has been written in the last several years about the problems and concerns of people who work with video display terminals (VDTs), the literature has been based predominantly on a small number of studies, many of which have substantial shortcomings in methodology that severely limit the conclusions that can appropriately be drawn from them. In addition to reviewing that literature, we have drawn upon substantial technical literatures on visual function, image quality, lighting design, ergonomic design, and industrial and organizational psychology. To a large extent our conclusions are based on these more extensive and better validated literatures.

1. Surveys of workers who use VDTs indicate that complaints and symptoms of job-related ocular discomfort, musculoskeletal discomfort, and stress are common. Surveys that have included comparison groups of non-VDT workers suggest that the frequency of such complaints is greater among workers who use VDTs than among those who do not. Most surveys, however, have been poorly designed, and the inferences that may reasonably be drawn from them are suggestive rather than conclusive. Surveys have not established whether complaints and reported symptoms are related to VDT characteristics, other aspects of the workplace and job situation, or some combination of these factors. Most studies have not adequately considered the heterogeneity of VDT job situations. Evidence suggests that job design and task requirements can produce job-related physical symptoms and stress. Thus it is possible that differences in reported symptoms between VDT workers and non-VDT workers might be more directly related to characteristics of the work situation--i.e., the way in which

VDTs are used--than to characteristics inherent in VDTs. Given the lack of adequate controls in survey studies, the relative influence of equipment characteristics and job characteristics remains an open question.

2. The comfort, performance, levels of stress, and job satisfaction of workers who regularly use VDTs have in many cases been adversely affected by failure to apply to jobs and equipment well-established principles of good design and practice. A considerable literature exists on the effects of image display characteristics on legibility and user performance, and well-designed, high-quality VDTs are available commercially. In many instances, however, VDTs have been designed without attention to existing scientific data on image quality, and many VDTs on the market do not provide the legibility of high-quality printed material. In addition, in many instances VDTs have been introduced into workplaces with little attention to principles of human factors, illuminating engineering, and industrial and organizational psychology. We strongly recommend that manufacturers and users of VDT equipment draw upon available scientific data in designing and selecting VDT equipment and in designing VDT-related work.

3. The terms visual fatigue and eyestrain are frequently used in ill-defined and differing ways. These terms do not correspond to known physiological or clinical conditions. We suggest instead that researchers and others use terms that specifically describe the phenomena discussed, such as ocular discomfort, changes in visual performance, and changes in oculomotor functions.

4. The symptoms of ocular discomfort and difficulty with vision reported by some workers who use VDTs appear to be similar to symptoms reported by people performing other near-visual tasks. Temporary changes in measures of visual function reported to occur following VDT work appear to be similar to those observed after performance of near-visual tasks in non-VDT jobs. Most features of VDT work tasks that may contribute to discomfort or visual difficulty are also found in various jobs not involving VDTs; however, poorly designed VDTs, workstations, and work tasks, often produce a particularly problematic concatenation of adverse features.

5. It is not known whether ocular discomfort and reported changes in measures of visual function are related. In general, the physiological and psychological mechanisms underlying ocular discomfort are poorly understood. However, there is no scientifically valid evidence that ocular discomfort or temporary

changes in visual functions are associated with damage to the visual system.

6. A number of competent studies have found that the levels of radiation emitted by VDTs are far below current U.S. occupational radiation exposure standards and are generally much lower than the ambient radiation emitted by natural and human-made sources to which people are continuously exposed. We have not attempted to evaluate the adequacy of existing standards, but our review of the scientific literature on biological effects of radiation indicates that the levels of radiation emitted by VDTs under conditions of normal operation and under conditions of malfunction or aging of the VDT are highly unlikely to be hazardous. These considerations suggest that routine radiation surveys of VDTs in the workplace are not warranted. However, radiation testing of new VDT models should be continued to ensure that product safety standards are met.

7. We find no scientifically valid evidence that occupational use of VDTs is associated with increased risk of ocular diseases or abnormalities, including cataracts. Existing knowledge makes such an association seem quite unlikely. Only if competent pilot studies were to indicate such an association would large-scale epidemiological studies of cataracts among VDT workers be warranted.

8. We find no scientifically valid evidence that the use of VDTs per se causes harm, in the sense of anatomical or physiological damage, to the visual system. There is nothing in the literature on the effects of working with VDTs, or in the broader realm of existing scientific and clinical knowledge, that suggests that such a causal relationship is likely.

9. It is difficult for manufacturers, purchasers, and users to make meaningful comparisons between VDT products because techniques for measuring image characteristics and evaluating quality have not been standardized and applied in commerce. We recommend that efforts be made to standardize measurement techniques. Characteristic measures of products should be made routinely available to purchasers and users.

10. Existing data do not provide a sufficient basis for establishing mandatory standards for display, lighting, and workstation parameters or for task designs and work schedules in VDT-related work. Research is needed to provide adequate data that can be used as a basis for decisions regarding standards. In the meantime, application of well-established principles of good design and