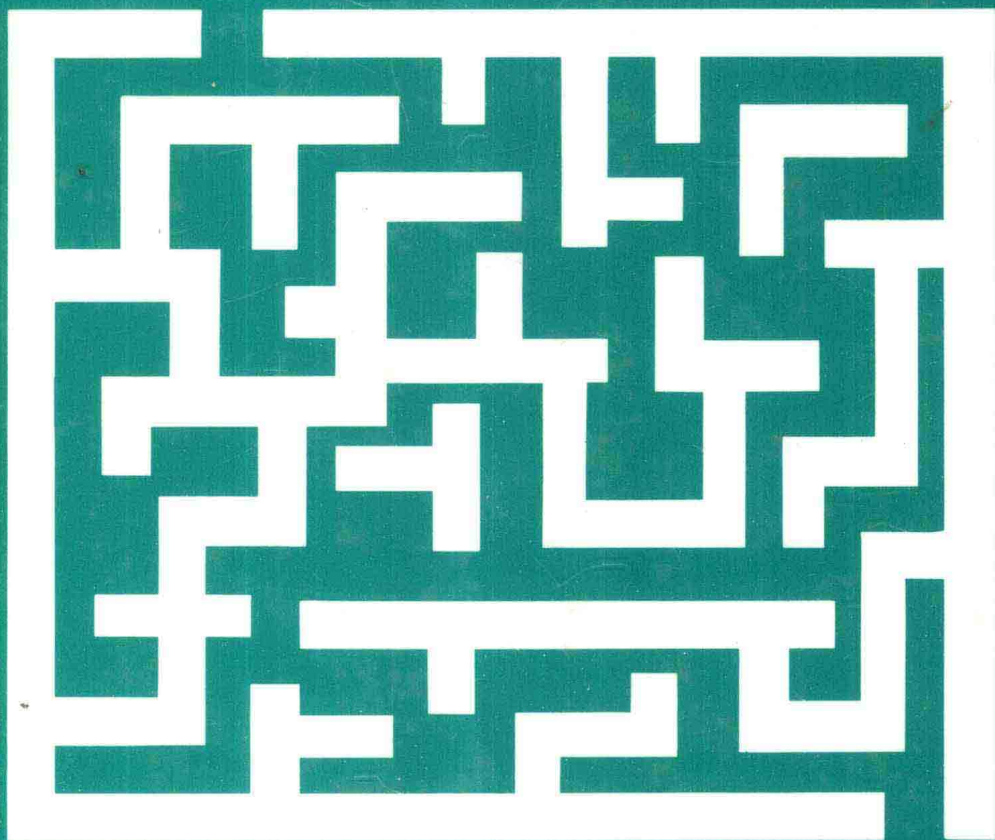


# Performance of Buildings and Serviceability of Facilities



Davis/Ventre, editors



STP 1029

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# Performance of Buildings and Serviceability of Facilities

*Gerald Davis and Francis T. Ventre, editors*



ASTM  
1916 Race Street  
Philadelphia, PA 19103

**Library of Congress Cataloging-in-Publication Data**

Performance of buildings and serviceability of facilities / Gerald Davis and Francis T. Ventre, editors.

(STP ; 1029)

"ASTM publication code number (PCN) 04-010290-10"--T.p. verso.

Papers presented at the Symposium on Overall Facility Performance--Use, Operation, and Cost, held in Toronto, Ontario, Canada, October 13-14, 1988, sponsored by ASTM Committee E06 on Performance of Building Constructions and ASTM Subcommittee E06.25 on Whole Buildings and Facilities.

Includes bibliographical references.

ISBN 0-8031-1292-0

- I. Buildings--Performance--Congresses. I. Davis, Gerald, 1926-.
- II. Ventre, Francis T. III. Symposium on Overall Facility Performance--Use, Operation, and Cost (1988 : Toronto, Ont.)
- IV. ASTM Committee E-6 on Performance of Building Constructions.
- V. ASTM Subcommittee E06.25 on Whole Buildings and Facilities.
- VI. Series: ASTM special technical publication ; 1029.

TH453.P47 1990

690--dc20

90-31703

CIP

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Each paper published in this volume was evaluated by three peer reviewers. The authors addressed all of the reviewers' comments to the satisfaction of both the technical editor(s) and the ASTM Committee on Publications.

The quality of the papers in this publication reflects not only the obvious efforts of the authors and the technical editor(s), but also the work of these peer reviewers. The ASTM Committee on Publications acknowledges with appreciation their dedication and contribution of time and effort on behalf of ASTM.

## FOREWORD

The symposium on Overall Facility Performance -- Use, Operation and Cost was presented at Toronto, Ontario, Canada, October 13-14, 1988. It was sponsored by ASTM Committee E06 on Performance of Building Constructions and ASTM Subcommittee E06.25 on Whole Buildings and Facilities.

Gerald Davis, Chairman, ASTM Subcommittee E06.25, and President, International Centre for Facilities, Ottawa, Canada, and Seattle, USA, served as chairman of the symposium and co-editor. Francis T. Ventre, Professor and Director, Environmental Systems Laboratory, College of Architecture and Urban Studies, Virginia Polytechnic Institute and State University, served as co-editor. Mary-Anne McKiechan, Principal, McKiechan and Associates, and Françoise Szigeti, Executive Director, International Centre for Facilities, served as technical co-editors.

# ACKNOWLEDGEMENTS

Organizing this symposium and assembling this publication have required the combined efforts of many individuals. It is our pleasure to acknowledge here the support we received from ASTM, from its Chairman, DeWayne France, who welcomed our dinner speaker and all present, on to the Executive Committee of Committee E06, who supported our unconventional symposium format, to our Committee Chairman, Fred Pneuman, who welcomed the participants to the symposium. Others at ASTM who should be recognized here include: our former staff manager, Teri McMasters, who got us under way with great enthusiasm and competence, our current staff manager, David R. Bradley, who took over in mid-stream and did a great job in trying circumstances, Dorothy Savini, who also took over the symposium organization in mid-stream and sorted out numerous crises, Kathleen Green and Monica Armata, who supervised the editing process with their usual care, patience and attention to details.

We are grateful to Mr. Dennis P. Caplice, Deputy Minister, Ontario Ministry of Government Services for taking the time to welcome ASTM and the symposium on behalf of the Government of Ontario.

Last but not least, we would like to thank all the speakers and authors without whom there would have been no symposium or publication, and all the reviewers whose thoughtful comments and helpful suggestions ensured the high quality of this publication. Any shortcomings are our responsibility.

*Gerald Davis, President*

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Symposium chairman and co-editor

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## OVERVIEW

### Beyond Aesthetics:

### Can Buildings be Judged on how well they work?

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A group of experts gathered in Toronto to explore ways to measure overall facility performance. For the first time in a public forum, ASTM discussed standardizing "what is an effective building", and how to measure effectiveness.

Buildings have long been judged on aesthetics. That is not enough today. Because the typical Fortune 500 company has a quarter of its assets tied up in buildings and land, there is a need to develop standard ways to measure how serviceable a facility is and how it is performing.

The topic was timely. This special symposium on "Overall Facility Performance -- Use, Operation and Cost, " brought together architects, corporate executives, academics from a variety of disciplines, environmental researchers and planners, as well as representatives of public agencies -- each with different views on facility performance.

The symposium delved into how to measure performance and serviceability, what aspects ought to be quantified, which measurements are important to corporations, institutions and governments, which aspects are important to users of facilities, and which are most important to investors, financial executives, and building economists.

The symposium was organized by ASTM Subcommittee E06.25 to serve several purposes. In particular, the organizing committee the following goals in mind:

#### 1. Standards development

- Add to the knowledge base available for standards development work.
- Provide information and recommendations that would help ASTM Subcommittee E06.25 set directions and priorities for standards development work.
- Bring together individuals from organizations with relevant interests.

#### 2. Research

- Survey the field of facility performance and serviceability.
- Identify gaps in the knowledge base.
- Present and discuss papers on original research and application related to facility performance and serviceability.

#### 3. Practice

- Provide reference information of general application in measuring facility performance and serviceability.
- Contribute to building a network of people who have knowledge and interest in the field, but who are not yet in contact with each other.
- Inform people who are now working in relevant subject areas but have not explicitly considered overall performance or serviceability.

## 2 OVERALL FACILITY PERFORMANCE

ASTM Subcommittee E06.25 on Whole Buildings and Facilities is a relatively new subcommittee. It was formally created in 1983. Its creation was stimulated by questions such as: How well do facilities perform? Do facilities match organizational objectives? How well do facilities meet the needs of the occupants and visitors? What should occupants, visitors and facility managers expect? How can the serviceability of different facilities be measured and compared? How do we know, and show, that we are getting good value from facilities? What are the benchmarks? When is further investment justified? What are others doing with their facilities? What is typical?

Work is currently under way within ASTM Subcommittee E06.25 on several subject areas:

- Methods and techniques, such as how to compare the serviceability of various facilities; rating scales for comparing office facilities; methods for unit area measurement; and behavioural measures of serviceability and of occupant satisfaction.
- Aspects of performance that apply to many functional facility types, such as energy performance of whole buildings.
- Performance of specific functional facility types, such as office facilities with information technology; health care facilities, etc.

As a result of this standardization effort, owners, managers and users will for the first time be able to compare objectively the overall performance of buildings of different ages, construction types or locations for any specific use, such as to house one or another type of office, or for a particular health care service, library, laboratory, etc.

*Gerald Davis*

President/CEO

International Centre for Facilities  
Ottawa, Ontario, Canada K1R 7X6  
Symposium chairman and co-editor

# **PANELS**



## Introduction

### Facility Serviceability Standards: Current Developments

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**REFERENCE:** Davis, Gerald, and Ventre, Francis T., "Facility Serviceability Standards: Current Developments," *ASTM STP 1029, Performance of Buildings and Serviceability of Facilities*, Gerald Davis and Francis T. Ventre, eds., American Society for Testing and Materials, Philadelphia, 1990.

**ABSTRACT:** First, *performance* and *serviceability* are defined and differentiated. Second, the emergence of practices for assessing facility serviceability is reviewed. In the absence of an established, consistent body of data on serviceability, techniques are proposed for rating facilities using standardized rating methods and rating scales. These methods and scales both meet an immediate need of facility managers, and provide a framework for consistent, objective data bases on facility serviceability. Some applications of this work are identified. Standards development and future directions within ASTM Subcommittee E06.25 on Whole Buildings and Facilities are summarized.

**KEY WORDS:** building, building codes, building performance, codes, evaluation, facility, facility serviceability, future, offices, performance, performance concept, rating, rating scales, serviceability, standards.

#### The difference between performance and serviceability

The terms *performance* and *serviceability* cause problems in communication and semantics. In North America in the 1960's and 1970's, the "performance concept in building" addressed the physical subsystems, components and materials in buildings. But problems arose when Europeans attempted to translate the English word *performance* into their own languages. In several languages, the word is spelled similarly but has different meanings. The head of one centre for building research was quoted as saying, "*Performance* is what happens on the stage in a theatre, not in a test laboratory." Tenho Sneek of Finland pointed out the need to find a way of expressing "performance" that could be translated into other European languages. In France, for instance, a phrase of several words is used to express the concept.

North Americans also needed to differentiate between the required *functional performance* of a facility, which focuses on user requirements and should be expressed in the language of the users and the requirements for *technical performance*. The latter requirements are a translation of the user requirements into criteria that can not only be responded to directly by designers and specification writers, but which also facilitate measuring and testing for

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<sup>2</sup> Professor and Director, Center for Building Economics and Industry Studies, College of Architecture and Urban Studies, Virginia Polytechnic Institute and S.U., Blacksburg, VA, USA 24061-0113.

compliance. Although these terms, *functional performance* and *technical performance* were generally understood by building programmers in the United States and Canada, they were unfamiliar to the staff of construction testing laboratories, and were confusing to several European members of the ISO subcommittee on functional requirements and performance in buildings. Consequently, ASTM Subcommittee E06.25 sought other terms in common use that would maintain needed distinctions.

A first step is to distinguish between a building and a facility. A *building* is a physical artifact, "a shelter comprising a partially or totally enclosed space, erected by means of a planned process of forming and combining materials."<sup>3</sup> Whether it is in use or empty, whether it leaks or is weather-tight, it is a physical thing. The concept of *facility* is something else. "A facility may be within a building, or a whole building, or a building with its site and surrounding environment; or it may be a construction that is not a building. The term incorporates both the physical object and its use."

In North America usage, the term *building performance* refers to "the behaviour in service of a construction as a whole or of the building components". *Facility serviceability* is "the capability of a facility to perform the function(s) for which it is designed, used or required to be used". This capability is a quality of the facility as a system, including its subsystems, components and materials, and their interactions, such as acoustical, hydrothermal, air purity and economic. The scope of this capability reflects the relative importance of each performance requirement, considered jointly and severally. The definition of *durability* adds the concept of service life, "the capability of a building, assembly, component, product or construction to maintain serviceability over at least a specified time."

Thus, the terms *facility* and *facility serviceability* address the capability to achieve a specific purpose, while the term *building performance* applies only to the behaviour in service of a building or its component at a specific moment in time under specified conditions, without reference to its intended use, or to its capability to perform for some other use.

### The status of the performance approach today

A glance at any periodical serving the design and construction industry today reveals countless references to requirements, criteria and evaluation methods. Increasingly, technical standards of the type generated by ASTM Committee E06 on Performance of Building Constructions are points of agreement to which all participants can refer and thereby expedite communication and exchange. ASTM, of course, does not work alone.

Building researchers from the world over gathered in Philadelphia in 1972 for a Symposium on the performance approach in building, at which much of this experience was made accessible to the building industry at large.<sup>4</sup> This meeting also signalled both ASTM's furtherance of the performance philosophy and its commitment to sharing this knowledge with

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<sup>3</sup> The definitions quoted in this and the next paragraph are all taken from: American Society for Testing and Materials, Standard Terminology of Building Constructions. ASTM Designation: E631-89a. Philadelphia, 1989.

<sup>4</sup> National Bureau of Standards Special Publication, Joint RILEM-ASTM-CIB Symposium Proceedings, Special Publication 361, Performance Concept in Buildings. 2 Volumes, September 1972.

the rest of the world. The meeting was co-sponsored by two international organizations, Union of Testing and Research Laboratories for Materials and Structures (RILEM) and Council for Building Research Studies and Documentation (CIB).

Since the 1972 RILEM-ASTM-LIB Symposium, CIB has continued its commitment with the establishment of Working Commission W60 on The Performance Concept in Building, whose more recent focus has been the implementation of the concept into the education and training of tomorrow's practitioners and researchers. (This was the subject of W60's international workshop held in Lisbon in February, 1989.)

The International Organization for Standardization (ISO) has prepared draft international standards on, among other things, definitions and means of expression for the performance of a whole building, and has issued ISO 6240 defining the format of a performance standard, ISO 6241 on performance attributes to be addressed, and ISO 6241, defining functional requirements independently of the building, the room or the building subsystem to which they are addressed. Assessment methods for determining compliance with the foregoing are also under development by the cognizant organizations.

The European Community is issuing directives binding on all signatory governments, stipulating the adoption of performance-oriented building standards by 1992. Building product performance is to be documented, and ultimately regulated, using methods that were developed by CIB in the 1970's carrying forward the momentum of the Philadelphia meeting, that were converted into international standards by ISO in the 1980's and will now be mandatory on all nations marketing goods and services to Europe in the 1990's.

Within ASTM, work is advancing on standards to apply the performance approach, by starting with occupant requirements and developing a process and guides for rating the serviceability of a facility. A task group on total building performance was launched in 1981. For a few years, the complexity of whole-building performance confounded efforts to categorize and define the "scope, criteria and evaluation method" for each aspect of serviceability, as understood in the formally defined performance approach. In 1985, following a symposium<sup>5</sup> to explore possible directions for the work, the task group became a subcommittee, now called E06.25 on Whole Buildings and Facilities. Also that year, under the leadership of Gerald Davis and Wayne Meyer, work started on a process for quick rating of facility serviceability, building on the method proposed by Bill Sims and Franklin Becker in the ORBIT-2 study.<sup>6</sup>

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<sup>5</sup> The publication from this symposium is Building performance: function, preservation and rehabilitation, (ASTM special technical publication; 901, issued 1986) Gerald Davis, editor.

<sup>6</sup> ORBIT-2 was a 1984-85 multi-sponsor study of the effects on organizations and the buildings they occupy, when new information technology is introduced. It was led by a 4-person team: Gerald Davis (project director), Franklin Becker, Francis Duffy and Bill Sims. Version 2.1 of the questionnaires and rating method from ORBIT-2 was developed by Becker-Sims Associates and DEGW. Professor Bill Sims, chairman of ASTM Task Group E06.25.41 on Office Facilities with Information Technology has also introduced, as a draft for standardization, the questionnaires from version 2.1.

### Putting the performance approach to work for owners and occupants

Why is rating the serviceability of a facility important? Because owners, users and facility managers need to know whether a facility is performing as intended, and often, whether it could meet a given set of serviceability requirements.

Large building owners, such as Public Works Canada, or General Services Administration's Public Buildings Service in the USA, and large private corporations, each with hundreds of office buildings sited across the country, need a way to compare their properties objectively and consistently even though they differ in location and structure, in mechanical systems, in age, size, in floorplate configuration, and so on.<sup>7</sup> Leasing agents need a quick, economical, consistent way of screening properties offered for rent to identify those few which best fit the renters profile of requirements, and where the budget for relocation is least likely to be exploded by unexpected fitup costs.

The first step is to identify the users' functional requirements, and how they interact. For instance, office workers want enclosure and privacy, but they also want to see the outside. These two requirements interact, and in some facilities they may conflict. Users of video display terminals need protection from the brightness of windows in their field of view. Meeting this need can make it difficult to enable them to glance up from the screen and rest their eyes by looking to the distance.

As well, measures of building performance have typically looked at each aspect separately from the others, and did not take into account the interactions among the parts and systems and among aspects of performance. As an example, acoustic performance is usually measured separately from illumination, using standard tests that give objective, replicable results. Office acoustics are principally important in terms of how what people hear or don't hear affects their work. Yet acoustics and illumination never exist in isolation from each other, or from other aspects of the work environment. If the level and quality of illumination in an office are changed, people using the space may think that the level and quality of sound have changed. People can perceive the acoustic consequences of other changes that "common sense" might not predict: examples include the type of floor covering and wall covering, as well as the quality, size and placement of screens, furniture and equipment. So to meet any one functional requirement, many types of design features must be considered, and the design features must be considered in combination with each other.

In designing a facility, the architects, engineers and space planners typically look for the most cost-effective combination of features that will meet each occupant requirement. For instance, in a moderate-cost office building with a typical plenum air return, a typical combination of features would include exhausting the air through the light fixtures, to remove from the fixtures the heat from the fluorescent tubes and from the ballast. Therefore, when comparing office facilities, or other specific types of facility, it is not only necessary, but also

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<sup>7</sup> The Accommodation Branch of Public Works Canada (PWC) is developing serviceability targets and rating scales for the aspects of serviceability that should be present in the general purpose office facilities for which it has custody on behalf of the Crown. A guide for rating is being prepared for PWC by the International Centre for Facilities, with the collaboration of experienced PWC personnel. On this subject, PWC is taking concepts that have been developed in other contexts, and applying them in a coordinated, comprehensive way to meet its needs as a large property owner.



practicable to rate the combinations of features that have been selected to meet each functional requirement, rather than having to rate all the individual building components. By comparing the combinations of features present in a facility to meet each requirement for serviceability, standard rating scales permit one to score facilities consistently and objectively, independent of the person doing the rating.

This rating approach, while not exact, does allow one to get on with the job and not wait for more precise measures and tests, which do not yet exist. It does allow organizations of national scope to get consistent ratings across the North American continent. When ratings will be done by tens or hundreds of different people, some of whom will never meet each other, we need to be confident they will come up with consistent and comparable results.

This rating method<sup>a</sup> was developed by people working in many fields: large property-owning organizations such as government, manufacturers of building products, trade and professional associations, public interest groups and academic and research institutions, architects, engineers and planners, and professionals from forensic engineering firms.

## Conclusion

The performance approach to specifying what is required in a facility has gained widespread application. During the 1980's, the focus of standards development has moved beyond the performance of building components and subsystems to the creation of standard methods for assessing the serviceability of whole facilities. The symposium whose papers are reported in this ASTM special technical publication suggested directions for the future development of the field, and provided guidance for standards development.

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<sup>a</sup> In the form used by ASTM E06.25, it is a variation on the method used in Version 2.1 of the ORBIT-2 study, referred to in an earlier footnote.