THE IMPACTS OF PRIVATE-SECTOR STANDARDS ON INDUSTRIAL INNOVATION AND GROWTH

Project Plan 80-7

Planning Office
National Bureau of Standards

May 1980

TABLE OF CONTENTS

THE IMPACTS OF PRIVATE-SECTOR STANDARDS ON INDUSTRIAL INNOVATION AND GROWTH

INTRODUCTION

This is the first in a series of studies which will be directed toward the topic of the economic impacts of standards. This first study focuses on the critical relationships between private-sector standards and industrial innovation and growth.

Rationale for Conducting This Study

It is the opinion of the NBS Planning Office that private-sector standards significantly affect industrial innovation. These impacts are thought to be substantial in both positive and negative directions. The direction and magnitude of the effects of industry standards on industrial innovation seem to be determined by a number of quite different and separate factors, including industry structure and behavior, the nature of the generic or underlying technology, the stage in the evolution of the industry and its technology, and so on. In particular, under the conventional economic heading of industry structure and behavior, an important element of the analysis will be the effects of the level and nature of competition, for competition greatly influences not only the demand for a standard per se but also the timing of implementation and the substance of the standard. Moreover, the competitive structure affects the institutional structure and process that sets standards in an industry.

Unfortunately, the economics literature is largely void of any formal and systematic treatment of the role and impacts of standards on industrial growth. The business literature offers a few case studies of specific standards. However, effective policy guidance can only be provided by first developing a conceptual framework which relates different types of standards and different industries to different types and levels of impacts. This framework will then have to be made operational (i.e., useable in a strategic planning situation)

by a comprehensive and detailed empirical analysis with subsequent refinement of the framework. The key point is that policy development at any level requires the legitimacy of a theoretical underpinning, the applicability across industries afforded by a conceptual framework, the accuracy provided by empirical analysis, and the ability to implement the analytical results achieved by involving decisionmakers in all stages of the research.

Thus, research is needed which first provides a framework for analyzing the impacts of standards on economic growth. Second, the framework must be "operationalized" so that it can be used by those with a stake in microeconomic growth policies. Third, for the purposes of NBS and other parties interested in the industrial innovation element of economic growth, extensive empirical analysis is required of the relationships between standards and the incentives to commercialize and adopt new technologies.

Purpose

This study will therefore take the initial steps in developing both the analytical capability and the data base required to assess the impacts of standards on industrial innovation. The focus will be on private-sector standards. That is, those standards adopted voluntarily by the private sector to serve its perceived needs. Two basic categories of private-sector standards will be studied--industry standards developed by industry trade associations and so-called "full-consensus" standards developed by national standards organizations such as ANSI and ASTM. The role of NBS will be analyzed in terms of the types of standards it develops and the contributions of those standards along with other forms of technical inputs to the development and adoption of private-sector standards.[1] This study will not address the regulatory

[1] Note that three phases of the standardization process will be distinguished. The firsh phases is the development phase in which the technical elements of the information needed for the standard are acquired through research either in the industry itself or in some external institution such as NBS. Development also includes the establishment of an institutional mechanism to process this information. This could be a committee set up by an industry trade association (in the case of an industry standard) or an independent committee under the auspices of ANSI or ASTM (in the case of full-concensus standard). The second phase is adoption which is the formal acceptance by individual firms of the standard. The third phase is actual use of the standard for product or process development.

use of standards. This is a complex and comprehensive task by itself and therefore should be analyzed separately. However, the interface between voluntary private-sector standards and regulatory standards may be relevant for the objectives of this study. The term interface refers to the impacts of the regulator and mandatory standards on the incentives of the private sector to set certain types of voluntary standards over others. Conversely, certain types or quality of voluntary standards may affect the decisions of regulators with respect to the imposition of mandatory standards. Thus, the focus of this study is voluntary private-sector standards plus the interface with regulation.

To effectively conduct this study, the latest research will have to be utilized from the areas of technological innovation (or more broadly, technological change), the level and nature of competition in technology-based industries, and case studies of specific standards. Economists, business analysts, and experts on specific industries and technologies will have to be drawn upon. The following sections present some preliminary discussions on the classification of standards and their potential impacts. The specific research tasks to be undertaken are outlined in the statement of work. Because of the pathbreaking nature of this project, intellectually-motivated research will be essential.

THE ROLES OF NBS IN STANDARDS DEVELOPMENT PROCESSES[2]

Since its establishment in 1901, the National Bureau of Standards (NBS) has played an important role in U.S. standardization activities. Standards have long figured prominently in numerous private market transactions and recently have become important components of government regulation. Some recent attention has been given by both academic researchers and policy makers to the economic impact of standards. Pertinent examples from the academic literature include work by Hemenway (1975) on voluntary industrial standards, Caves and Roberts (1975), on regulating product quality and variety, and Settle and Weisbrod (1975) on appropriate strategies for government intervention in private markets. Relevant examples from policymakers include the FTC Staff Report on Standards and Certification (1978) and a series of NBS papers dealing with the economics of standardization. However, researchers are only beginning to investigate the wide range of effects on economic activity induced by the imposition of standards.

---

[2]This section taken from a forthcoming NBS monograph by J. Barth and J. Cordes.

Taxonomy of NBS Standardization Activities

It is useful to begin the analysis by distinguishing between standards and regulations as well as between adopting and participating in the development of a standard. A standard may be defined as:

> "...a prescribed set of conditions and requirements, of general or broad application, established by authority or agreement, to be satisfied by a material, product, process, procedure convention, test method; and/or the physical, functional, performance, or conformance characteristic thereof."

By comparison a regulation may be defined as a set of rules that define legally acceptable performance or behavior by an economic agent. Clearly, since acceptable performance or behavior is often defined with reference to a particular standard, standards can be important components of regulations. However, the terms standard and regulation should not be used interchangeably. Standards may be developed for reasons other than regulation. Conversely, regulations may be imposed without reliance on standards as defined above.

It should be noted that the terms appear to be used interchangeably in the academic literature on the economics of standards. For example, a recent paper by Settle and Weisbrod (1975) defines a standard as a regulation or rule that directly and explicitly restricts the choices of firms and/or consumers. Similarly, a recent survey of the economic literature on regulation by Joskow and Noll (1979) frequently refers to health and safety regulations as health and safety standards. Indeed, it is argued below that most benefit-cost analyses of standards are actually benefit-cost analyses of regulations. Therefore, the results of such studies must be carefully interpreted if used to evaluate the economic impact of standards as defined above.

A standard is adopted when it is promulgated or established by an official entity such as an industry or independent standards committee or government agency. It is also important to distinguish between standards development and adoption. NBS plays important roles in both the development and adoption phases of standardization activities. With respect to the development phase, NBS provides materials standards (Standard Reference Materials) which are

widely used by other researchers in universities and industrial laboratories, by industry in the development of voluntary standards for products, component interfaces, and test methods, and by government agencies in the promulgation of mandatory standards. It also develops interface and test methods standards which are then adopted by a private-sector standards organization. However, much of NBS research activities supports the development phase of the standardization process with major contributions made by private-sector elements. That is, NBS contributes technical information to the standards-setting process where the final product or process standard is set by an industry or independent committee (of which NBS is frequently but not always a member). Thus, the technical information provided to this process can take the form of NBS standards for materials characteristics, test methods developed by NBS which are then adopted by the industry committee, validated scientific and engineering data necessary for developing the desired standard, and test structures which are frequently incorporated by the industry into a product and thus become part of the eventual product standard.

With respect to the adoption of standards, NBS makes an equally important contribution. In addition to its technical expertise, NBS often offers itself as a neutral party in the standards-setting process where the private-sector participants have individual and often conflicting economic objectives. Therefore, because it is regarded by industry as both politically neutral and technically competent, NBS can greatly facilitate the process as well as the substance of standardization.

The NBS role in both public and private standardization activities is defined in both the 1901 legislation establishing NBS and in Departmental Order 90A dated May 12, 1966. The 1901 legistlation authorizes NBS to engage in the following activities:

(1) the development of national standards of measurement and the provisions of means and methods for making measurements consistent with those standards;

(2) the development of methods of testing materials, mechanisms, and structure; and the testing of materials, supplies, and equipment, including items purchased for use by the Government;

(3) cooperation with other Government agencies and with private organizations in the establishment of standard practices, incorporated in codes and specifications.

Departmental Order 90A further "requires NBS to assist industry, business, and consumers in the development and acceptance of commerical standards and simplified trade practice recommendations, and to conduct programs in cooperation with U.S. business groups and standards organizations for the development of international standards."

For our purposes, it is convenient to group these activities into two broad categories: technical input and process participation.

Technical Input

Development of an operational standard requires that: (a) the characteristic(s) of the material, product, process, interface, procedure, or test method to be "standardized" be defined; (b) benchmarks be established for satisfactory or standard levels of the relevant characteristics; and (c) test criteria be determined for evaluating when the particular item complies with the standard. Whether or not NBS employees participate in standards committees, the research, testing, and measurement activities of NBS laboratories undoubtedly contribute to providing the sort of information identified in (a)-(c). Two examples illustrate the point. Efforts are currently underway to develop standards for solar collectors. The technical background work for this activity, funded by the Department of Energy, was performed at NBS. The products of the NBS studies have been furnished to the American National Standards Institute Ad Hoc Committee on Collector Ratings with the intention of assisting the concerned parties in arriving at a consensus for a uniform thermal performance rating method (i.e., a test method) for solar collectors.

A more general example is the development and maintenance of standard reference materials (SRM's) by NBS. Currently NBS sells over 1000 SRM's that are certified for composition or physical properties. NBS also calibrates reference standards in the form of instruments sent by industry to NBS laboratories. These activities clearly facilitate the development of industrial standards by providing benchmarks for comparing performance and/or design characteristics.

Process Participation

Members of the NBS staff also participate in the development of numerous standards. The nature and scope of this participation has been extensively documented by two internal NBS studies, the "Suzuki report" (1970) and a more recent NBS microstudy prepared by Eicher and Koenig (1975). According to the 1975 study, nearly one-third of the NBS professional staff participate in some way in U.S. standardization activities. The Eicher-Koenig report identified 26 separate functions performed by NBS committee participants which the authors of the 1975 report viewed as contributions to standardization work. Descriptions of each category, taken from the 1975 report, are presented below.

> The "Technical" contributions category included such activities as reviewing drafts for technical adequacy; alerting the committee to relevant reports, research, or reference materials; conducting laboratory research and development work; seeing to it that standards are updated as needed to reflect current technology; designing, conducting, or promoting the use of interlaboratory (round-robin) tests; and analyzing the data from interlaboratory tests to provide levels of precision for standards.
>
> The "Editorial" category comprised: reviewing standards for correctness of format, style, and definitions; writing initial drafts or significant portions of standards, and developing guidelines or standards for the writing of standards.
>
> The "Administrative" category contained functions normally performed by committee officers such as coordinating the distribution of committee correspondence, preparing committee reports, running committee meetings, and taking minutes at meetings as well as encouraging the setting and following of priorities and assisting in the organization of new committees or subcommittees.
>
> "Public Interest" functions consisted of acting as an impartial third party to assist opposing parties in reaching agreement, representing government or consumer interests, and encouraging the committee to develop standards in national need areas such as health, safety, and protection of the environment.
>
> The functions in the final category were those which tended to "Improve the Quality of the Standards System." These functions included encouraging the committee to avoid duplicating the work of others, encouraging them to strive for compatibility between national and international standards, urging the development of performance rather than design standards where practical, lending NBS credibility to standards, monitoring committee membership to see that all interested parties are represented, working within the committee to eliminate conflicting national standards, and urging the committee to develop standards only when a real need exists.

Types of Standards

NBS involvement in standardization activities can also be distinguished by the type of standard. In general, individual standards may be distinguished from each other in terms of: (1) the object of the standard, (2) the objective of the standard, (3) the types of behavioral and/or technological constraints imposed by the standard, and (4) the restrictiveness of such constraints. This classification is particularly important for the study to be undertaken.

As indicated by our definition above, the object of a standard may be a material, product, process, procedure convention (such as an interface standard), or test-method. Although precise breakdowns are not available, it is likely that NBS measurement activities contribute to development of standards in each of these categories. However, somewhat more information is available about NBS participation. Using a proposed classification scheme, the Suzuki Report grouped standards into four categories: (1) non-product technological standards; (2) industrial market product standards; (3) retail market product standards; and (4) "obligatory". The first category includes standards, not related to specific products, which apply to procedures, conventions, and general scientific test methods. The second includes standards which apply to products intended mainly for industrial use. The third category includes standards which apply to products sold mainly in retail markets. The final category is a residual group including standards not in the other categories.

NBS staffers who participated in standards committees were asked during the development of the Eicher-Koenig report which category best described the majority of standards developed by their committee. The results of this survey, presented below in Table 1, suggest that NBS participation has primarily been oriented toward nonproduct technological and industrial market product standards, rather than toward retail product standards.

TABLE 1

Type of Standard	Number of Committees
Nonproduct technological	124 (43%)
Industrial market product	96 (33%)
Retail market product	35 (12%)
Other[3]	33 (12%)

Standards may also be distinguished by their intent. For example, Hemenway (1975) finds it useful to distinguish between standards for uniformity and standards of quality. In Hemenway's classification scheme, standards for uniformity include all standards where "better" or "worse" is not the issue, but uniformity or interchangeability is. An example provided by Hemenway is that of standards for screw-threads, which specify "standard" dimensions. Presumably performance or quality attributes of a screw are fairly independent of its dimensions. The value of the standard is to ensure that screws of a certain type have uniform dimensions and are, therefore, interchangeable.

By contrast, quality standards are intended to group products into categories of "better" (meeting the standard), or "worse" (not meeting the standard). There are, of course, many dimensions of quality. For example, standards may be developed for durability, strength, or health and safety. Standards for measurement and testing are also a form of quality standard because such standards are designed to improve the quality attributes of accuracy and precision in testing and measurement, and thereby to improve such important economic factors as yield.

NBS measurement and participation activities contribute to both uniformity and quality standards in a general sense. The data in Table 1, however, suggest that NBS participation in standards committees contributes more to the development of certain types of quality and uniformity standards than to others. The data might therefore indicate the need for a heavier NBS involvement in the development of quality standards for measurement and testing, and of quality and uniformity standards for consumer goods.

[3] Because each type of standard could become "obligatory" as defined by Suzuki, the Eicher-Koenig report substituted an "other" category for the "obligatory" category.

A third dimension that differentiates standard is the type of constraint imposed. The distinction most commonly emphasized in the literature is that between performance and design standards. In a recent paper prepared for NBS, Hemenway (1980) defines performance standards as those written in terms of functional requirements, while design standards are those written in terms of design or construction specifications. There are two distinct ways in which NBS measurement and participation activities may influence the development of design or performance standards. First, such activities provide information to standards developers that may influence the choice between performance and design standards. One aspect of the design/performance choice cited by Hemenway (1980) is that controversy regarding performance regulations often takes the form of disputes over the standards for testing performance. To the extent that NBS measurement activities provide information on the feasibility or accuracy of performance tests, they may (albeit indirectly) either facilitate or impede the adoption of performance standards. In a related vein, NBS staffers surveyed in the 1975 report listed "promoting performance standards" as one of the more significant contributions flowing from participation in standards committees. In addition to influencing the choice of performance vs. design standards, information provided through NBS measurement and participation activities may influence the content and structure of the particular design or performance standard chosen.

Finally, standards will differ in restrictiveness. Specifically, it is useful to distinguish between voluntary, quasi-mandatory, and mandatory standards. Voluntary standards are the least restrictive in that there is no "economic" or legal obligation to comply with the standard. Quasi-mandatory standards entail no legal obligation to comply, but compliance may be required in practice as a condition of doing business in a particular market. Mandatory standards entail a legal obligation to comply which is enforced by a government or by an authority with the necessary legal power. Mandatory standards are also referred to as codes, regulations, or rules. However, a voluntary standard frequently becomes a quasi-mandatory or mandatory standard.

At present, NBS is involved in certain ways in the development of mandatory standards. First, NBS measurement and testing activities provide information that government regulators are likely to find useful in developing mandatory standards. Second, industry voluntary standards developed by committees in which NBS staffers participate may provide a basis for government promulgated mandatory standards. Third, since 1965, Congress has given NBS numerous assignments to help develop mandatory standards. An example is the Federal Fire Prevention and Control Act of 1974 which authorizes NBS to "encourage and assist in the development of uniform codes, test methods, and standards aimed at reducing fire losses and the costs of fire prevention."[4] Fourth, NBS has entered into several interagency agreements under which technical assistance is provided for regulatory programs. Finally, NBS assists state and local governments as well as industry to develop the measurement standards and test methods to determine compliance with Federal regulations.

NBS has long been an important participant in the development of voluntary standards through the involvement of NBS staff in industry standards committees. However, although all standards developed by such committees are ostensibly voluntary in nature, it is the opinion of NBS committee participants that a significant number of such standards are likely to become quasi-mandatory.

POTENTIAL IMPACTS ON INNOVATION

The distinction between voluntary and quasi-mandatory standards is one of several dimensions along which impacts on innovation can be analyzed. Other dimensions include different incentives for standards between users and producers of a particular product; differences resulting from the timing of a standard in terms of stage of the innovation process, particularly the R&D and capital investment stages; and different incentives for specific types of standards as a function of firm size, or, perhaps more accurately, degree of market control.

Whether a standard remains voluntary in practice or becomes quasi-mandatory may depend in part on whether it represents simply the lowest common denominator

---

[4] Such efforts may lead to voluntary standards as well as mandatory ones.

for a particular technology which specifies only a minimum level of quality, thereby allowing a number of proprietary applications; or, whether it specifies a particular design or performance configuration which embodies one proprietary application and thereby effectively eliminates alternatives. In the latter case, potential entrants and even existing firms could be temporarily excluded from the market and face very high R&D and capital investment costs.

The distinction between the motivations of users and producers is important because at a particular point in the evolution of a technology the two groups often have decidedly different views on the need for standards. For example, in the early stages of a technology's development, producers are typically offering alternative versions of the basic technology. Because the user population is not fully established and because the performance characteristics of the competing versions of the basic technology are not fully known or even fully developed, market shares tend to be highly volatile. In this situation, each producer has a significant opportunity to increase its market share. In competitive markets, these producers therefore have an incentive to resist standardization, which would in many cases have the effect of locking-in the technology and thus increasing the stabilization of market shares, or worse, effecting a substantial and largely permanent shift in market shares toward the firm or firms whose version of the technology is represented by the standard. However, at more mature stages in the technology's (industry's) life cycle, producer's may want standards in order to minimize certain costs such as equipment design and to reduce response time to customer requests for bids.

With respect to users and potential users, a standard is typically desired at these early stages in a technology's development because the standard assures the buyer that compatible equipment can be purchased at different points in time. It also allows comparable equipment to be purchased from different producers. Finally, the standard permits users to purchase different classes of equipment (i.e., subsystems) from different producers with the assurance that the subsystems have compatible interfaces. These factors are particularly important for inducing secondary and tertiary groups of users to adopt the technology.

The timing of implementation of a standard is important for a number of reasons. For example, with the exception of a definition standard, a standard should not be set before the technology has sufficiently evolved and enough research has been done to ensure a quality standard. However, the setting of a standard should not be delayed to the point that too much investment has been made in pre-standard equipment. On the other hand, investment could be delayed or could proceed at a low rate without the standard; only with it in place will producers invest at an optimal level. Another aspect of timing is the duration of the standard. Once promulgated, it must remain in place long enough to reward a sizeable investment in the particular version of the technology embodied in the standard. In this sense, a standard is set for the purpose of "stopping" innovation for periods sufficiently long to enable producers to attain an acceptable rate of return on the original innovation. Of course, long-run efficiency in such a market requires that the standardization process be flexible so that innovation does occur, while not preventing an acceptable return on capital.

Market structure is also an extremely important factor in determining patterns of standardization. Established firms with significant market shares may be for or against standards depending on the nature of the underlying technology and its rate of change, the degree of capital intensity, and the prospects of forces external to the industry (such as another industry or a government regulator) creating pressures for standards. For example, large firms in a mature, capital-intensive industry may regard standards as one means for creating high entry barriers. In industries where the technology is changing rapidly and the dominant firm has proven capability to advance and market the technology, that firm may resist standards because the uncertainty for users created by the standard's absence prevents smaller firms from entering the industry and attaining the minimum efficient market share. Finally, in competitive market structures, as indicated by a previous example, volatile market shares create opportunities for producers which can only be seized whithout the equalizing effects of a standard. On the other hand, the market's overall growth will be restrained by user uncertainties with respect to multiple sources and component compatibility.

SUMMARY

Several elements stand out in the above discussion as particularly important for an analysis of the economic impacts of standards in technology-based industries. First, because all markets, especially technology-based ones, are dynamic in nature, the role of standards changes over time and consequently so does its economic impact. Second, and related to the first element, a standard-setting process must be flexible over time so that the right changes can be made with the appropriate timing. Third, an analysis of standards cannot be limited to the actual standards but must also include the events that lead up to a standard. For example, protocols are frequently a preliminary step to a standard and the factors generating them should be extremely important for understanding the impacts of the standard itself.[5] In fact, in some markets almost nothing can be done without protocols.[6]

A socially efficient standard might be characterized as a compromise among firms with competing technologies, which achieves it goal while leaving most firms probably less than happy but still in a viable competitive position within the market. These standards may cover the spectrum from those which are absolutely necessary to the continued vitality of the industry to those which are "nice to have;" from those which set a high technolgical standard and thereby drive the direction of innovation to those which represent the lowest common denominator among competing technologies. Finally, these standards may range from those which are induced, that is, "bubble up" as the technology and industry evolve, to those which are imposed by the industry acting as a single entity.

The rationales for standards might be summarized as mechanisms needed to address market imperfections in information; market imperfections resulting in barriers to entry; and market failures in the use of information. However, there are important distinctions between voluntary private-sector standards--the subject of this research project--and mandatory standards imposed by a regulatory agency. Regulation can further institutionalize a private-sector

---

[5] Protocols are sets of specifications that can be established without hard performance or functional objectives which are necessary for standards.

[6] Telecommunications may be an example of this.

standard and thus might legitimately be included in an analysis of the impact of industry standards on industrial innovation and economic growth. However, regulation typically has different objectives from industry standards, in particular, focusing on objects which have a public good character to them. The object of a regulation frequently is not compatible with the objectives of at least part of an idustry and therefore should be analyzed separately. The most important point in analyzing the rationales for private-sector standards is that they are often proposed for the purpose of removing an existing market imperfection or failure, but in the process of development and implementation, they frequently create market imperfections.

NBS plays an important and diverse role in U.S. standardization activities. That is, NBS does not typically promulgate standards or establish regulations. However, NBS clearly influences the development of standards which are promulgated by private-sector committees or incorporated in government regulations. The major NBS contributions that appear instrumental in the development of standards are material standards, interface definitions, measurement/testing technologies, and participation by the NBS staff in standards committees.

These activities span a wide range of standardization issues. However, several issues have been identified which are relevant to assessing the benefits and costs of NBS standardization activities. The emphasis has been placed on non-product technological and industrial market product standards, as opposed to retail market product standards. This is significant because much of the academic research on the benefits and costs of (mandatory) standards has focused on consumer product quality standards. This suggests that much of the economic "standards" literature applies directly to only a small portion of NBS activities. Another emphasis has been the potential influence of both NBS measurement/testing activities and committee participation on the mix of performance and design standards. A final focal point has been the impact of NBS participation in the development of voluntary vs. quasi-mandatory vs. mandatory standards.

BIBLIOGRAPHY

Bottaro, Drew, The Purpose and Role of Product Standards in the Commercialization of New Energy Technologies: A Preliminary Analysis, MIT Energy Laboratory Report (MIT-GL-78-023WP). Cambridge, MA: Massachusetts Institute of Technology, October 1978.

____, Standards, Warranties and Competition of New Energy Technologies, MIT Energy Laboratory Report (MIT-EL79-043). Cambridge, MA: Massachusetts Institute of Technology, November 1979,

Caves, R. and Roberts, M., eds., Regulating the Product: Quality and Variety. Cambridge, MA: Ballinger, 1975.

Eicher, L. and Koenig, J. A Study of NBS Impact on U.S. Standardization Activities. Washington, D.C.: National Bureau of Standards, June 1975.

Federal Trade Commission, Standards and Certification: Proposed Rule and Staff Report, Washington, D.C.: Government Printing Office, December, 1978.

Harter, P., Regulatory Use of Standards: The Implications for Standards Writers. Washington, D.C.: National Bureau of Standards, November 1979 (NBS GCR 79-171).

Hemenway, D., Industry-Wide Voluntary Product Standards. Cambridge, MA: Ballinger, 1975.

____, "Performance versus Design Standards," Standards Research Issue Paper No. 1. Washington, D.C., National Bureau of Standards, 1980.

Joskow, P. and Noll, R., "Regulation in Theory and Practice: An Overview," MIT Working Paper no. 128. Cambridge, MA: Massachusetts Institute of Technology, April 1978.

Kim, J., Breitenberg, M., and Atkins, R., "Priority Setting in Standards Development," Standards Research Issue Paper No. 2. Washington, D.C.: National Bureau of Standards, October 1979.

Rawie, C., A Guide to Papers Citing Antitrust Cases Involving Standards or Certification. Washington, D.C.: National Bureau of Standards, December 1979 (NBSIR 79-1921).

Suttle, R. and Weisbrod, B. Governmentally-Imposed Standards: Some Normative and Positive Aspects. Washington, D.C.: Department of Labor, 1976 (NTIS PB-256-274).

Suzuki, G. Report of the Voluntary Standardization Policy Study Group, Washington, D.C.: National Bureau of Standards, December 1970.

C. characterize impacts on innovation through

1. firm organization
2. level and type of competition
3. entry and exit from an industry

E. relate degree and type of standardization in an industry to rates and directions of technological innovation.

1. define a measure of standardization
2. relate to different performance measures

F. relate degree and type of standardization in an industry to rates of growth

G. relate the above elements to different motivations for standards

1. strong emphasis will be placed on

   a. demand by industry for voluntary standards
   b. demand by industry for NBS technical inputs (such as Standard Reference Materials, basic data, test methods, etc.)

2. the conceptual framework will include, but will not emphasize, the regulatory use of standards. What attention is given to this element should be focused on situations (if they exist) where industry encourages, or at least does not oppose, the conversion of voluntary standards into mandatory ones. This might be because economic benefits are expected (in contrast to what is probably the case for a majority of regulations where the effect is the internalization of a cost of production without apparent compensating economic gain). However, there are cases where uncertainty as to the interface itself affects the motivation for standards. For example, the current inability to accurately distinguish clearly between telecommunications markets and data processing markets seems to affect the voluntary standardization process.

3. the conceptual framework may include, but will not emphasize, the impacts of international trade on the motivation and need for standards. However, this element should be included where the nature of the international sector of a market, including trade barriers, significantly affects standards in ways that impact innovation.

H. attempt to classify standards in terms of reaction to classic market problems such as

1. market imperfections resulting from uneven availability of information among producers or consumers

2. market imperfections resulting from non-competitive behavior

3. market failure from failure to use available information

I. Prepare a report and submit it to the NBS Planning Office for approval. This report will consist of a description of the conceptual framework, including variable definitions, functional relationships, testable hypotheses, and a plan for how this framework will be evolved into an analytical model.

TASK 2: Conduct an empirical analysis of the impacts of standards on industrial innovation.

A. Using the conceptual framework, develop brief descriptions of a sufficiently large number of standards (say, 25 to 30) so that there are several standards representing each element of the framework. These standards must include a sufficient number where NBS had measurable technical input in order to facilitate effective conduct of Phase II.

B. Using a wide variety of sources, including published materials, NBS staff, industry officials, industry consultants, academics, and government officials, collect the data directed by the conceptual framework.

C. Analyze the data to indicate the various impacts of standards on industrial innovation and growth.

D. Prepare a report and submit it to the NBS planning Office for approval.

TASK 3: Based on the results of Tasks I and II, convert the conceptual framework into an analytical model suitable for indepth analysis of standardization in individual industries

A. Make the model as quantitative as is feasible from theoretical, empirical, and policy planning points of view.

B. Submit a final report, including the earlier interim reports, to the NBS Planning Office for approval.

PHASE II: Applications of the Analytical Model and Development of a Planning Framework.

TASK I: Develop a descriptive model of the ways in which the National Bureau of Standards affects the standardization process and resulting standards with respect to ultimate impacts on industrial innovation and growth in terms of

A. types of standards

B. the nature and magnitude of the technical input by NBS staff

C. nature and magnitude of contributions to standards development processes, including speed and timing of a process, sensitivity of participants to potential innovation impacts, degree of eventual concensus, acceptability of standard to regulatory bodies (where appropriate), and the overall role of NBS as an independent and objective third party.

D. submit an interim report to the NBS Planning Office for approval

TASK 2: Conduct an in-depth analysis of the impacts of standards on industrial innovation and growth

A. Develop selection criteria to identify three standards for case studies which appear to offer the maximum planning-relevant information on the relationships between standards, NBS, and rates of industrial innovation and growth.

B. Using the analytical model and the descriptive model of the NBS role, conduct the three case studies.

C. Develop and submit to the NBS Planning Office for approval a final report which

1. describes the three case studies;

2. provides a clear and useable methodology, including a set of indicators, for projecting the impacts of standards or industrial innovation and growth; these indicators should provide a method for projecting when certain standards have a net positive, neutral, or net negative impact;

3. recommends ways by which NBS can exert a positive influence with respect to desirable technological change on the structure of private sector standards.

Planning Office

Project 80-7

STATEMENT OF WORK

PHASE I: Modeling the Impacts of Voluntary Private-Sector Standards on Industrial Innovation and Growth

TASK 1: Using the available literature, develop a conceptual framework for assessing the impacts of voluntary private-sector standards (hereafter referred to as "standards") on industrial innovation and growth. A conceptual framework is defined as the identification and preliminary structuring of all variables necessary to analyze the designated phenomena (in this case, the impacts of standards on industrial innovation and growth), all relevant relationships among these variables, and hypotheses that have a reasonable expectation of being testable as part of the empirical application of an analytical model. This framework should

A. characterize types of standards by

1. origin of standard, including

a. industry standards (those developed by industry trade associations)

b. "full-consensus" standards (those developed by independent standards organizations such as ANSI and ASTM)

2. product/process focus, including

a. materials
b. test methods
c. measurement methods
d. procedure conventions such as interface standards
e. component/product standards

remembering that these categories are not mutually exclusive

3. functional focus, including

a. uniformity
b. quality

B. characterize types of innovation such as

1. product
2. process
3. major
4. incremental