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FOREWORD

It has been an unusually rewarding experience to coordinate the organization of this technical program. From the time the call for papers went out my telephone has jingled with calls from people offering their papers, their time, and their support. This program is truly the result of the voluntary contributions of its many speakers, moderators, and panelists. Given such a warm start, I am certain that the meeting itself will be an event in which the creative energies of its participants will be renewed, refreshed, and stimulated.

In considering a theme for this technical program we tried to combine the purpose of the Engineering Management Society with what we perceived as the demand faced by engineers and their managers over the decade ahead. *Economic Stimulation via Technological Innovation* was the result.

We then segmented the theme into four sub-themes, and circulated a questionnaire with the call for papers. The papers responded to the five elements of the paper call, made up of the four sub-themes and the main theme, and will be presented in five program tracks corresponding to the five elements, and at luncheons, and in Executive Roundtables.

Over two-thirds of the questionnaires that were returned checked Technology Forecasting as their major interest. In response to this obvious interest, two of our authors will present tutorials on their forecasting technologies, within the context of the Technology Forecasting track.

Several natural clusters of papers have developed within the sub-themes, each cluster providing the integrating theme within its technical session. The needs of managerial generalists have been addressed by the Executive Roundtables. Historical perspectives and futuristic predictions are taken up at lunch.

The Conference will end with a special closing session addressed to the task of reviewing the Conference and its program. All attendees will be asked to contribute evaluatory information in order to help future Engineering Management Society planners in their work of organizing future Conferences, and we ask your cooperation in this effort.

This foreword would not be complete without recognizing the contributions of all the members of the Conference Committee, each of whom has taken a significant part in program development.

Aileen Cavanagh, Chairman

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Keynote Address

Wednesday, November 12, 1980, 9:00 am – 9:30 am

ECONOMIC STIMULATION VIA TECHNOLOGICAL INNOVATION

Robert H. Pry
Executive Vice President, Research & Development
Gould, Inc.

NOTES

Session IN01

INNOVATION 1

Moderator

Aileen Cavanagh

Boston University
Boston, Massachusetts
Chairperson, Boston Chapter EMS
Member, Conference Steering Committee

Wednesday, November 12, 1980, 9:30 am – 12:00 pm

1. *What is Technical Innovation?*

   Roland Mueser, Bell Laboratories

   Explores the meaning of innovation and the place of technical innovation in industrial growth. This paper is based on studies of innovation and its process conducted at Bell Laboratories.

2. *Technological Innovation: Changing Perspectives and Proposed Actions*

   Bruce Rubinger and Linda Noonan, U.S. Department of Transportation

   Reports on a major review of congressional and federal task force activity on innovation, and traces the history of the emergence of industrial revival as a new policy issue in 1979. Causes of past inaction are discussed, and the emerging directions of federal innovation policy in the '80s are identified.

WHAT IS TECHNICAL INNOVATION?

Roland Mueser
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"Technical Innovation" is one of those phrases that everyone uses but no one defines. Even books and magazines with the term technical innovation in their titles often assume the phrase fits the material, and then go ahead and write about anything they please. Why do they use it at all?

WHY TECHNICAL INNOVATION?

ECONOMISTS	To explain a new production function
POLITICIANS	To enhance prosperity
ENGINEERS & SCIENTISTS	To measure output in research and development

At Bell Labs we have a lot of people in the third category. We have found the technical innovation concept useful in explaining ourselves to the outside world of Public Utility Commissions, Federal Regulators, members of congress, and the telephoning public. As a public utility, we need their support and understanding.

EVOLUTION OF THE TERM

The concept of technical innovation owes its birth to economists. They were seeking an explanation of production function not found in the usual considerations of capital and labor. In other words, something was happening in the industrial society that was not covered by classical models. Note how the use of "innovation" has changed over the years:

HISTORY OF THE TERM

1500s	Used to describe revolutionaries
1939	Schumpeter publishes theory on significance of technical innovation
1950s	Term adopted by economists
1970s	Generalized concept

Harvard Economics Professor Joseph Schumpeter first proposed the concept of "technical innovation." Schumpeter recognized the critical significance of coupling technical insight with commercial exploitation. However, neither he nor others who followed him, carefully defined the phrase. Indeed, sometimes it has been defined in one way and then used quite differently by the same writer. Eventually a consensus emerged on the term's use, though definitions are usually sketchy. A review of recent literature indicates that about 85% of the writers employ "technical innovation" in a manner covered by the following definition.

A DEFINITION OF TECHNICAL INNOVATION

When they use the phrase today, most people mean a new technical event like invention, discovery, theory, or an idea that has proved to have practical utility. The assumed criteria for technical innovation require first that the conception be marked by a significant break: in output,

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efficiency, cost, or understanding. It cannot be achieved by a series of incremental improvements. Secondly, the technical innovation must be successful in the practical world being commercially applied or used. The most widely adopted benchmarks for marking the two criteria above are:

BENCHMARKS FOR TECHNICAL INNOVATION

CONCEPTION

- Public announcement
- Patent application
- Publication

APPLICATION

- Commercially available
- Market acceptance
- Wide use

As examples here are two lists of items which might be considered "technical innovations."

INNOVATIONS	NOT INNOVATIONS
• Transistor	• Tail fins
• Airbags	• Striped toothpaste
• Fortran	• Picasso
• Interferon	• PERT diagram
• Cordless telephone	• "You've come a long way baby"
• Spinodal alloy	• Sculptura® telephone
• B-wire connector	• Model changes
• Multidimensional Scaling	

USEFULNESS OF THE CONCEPT

In general, technical innovation has become a popular phrase because it describes something that is important to modern society. To date it has been primarily employed to illustrate points and case histories. However, by developing a consensus definition it may be possible to select innovations which are not just one-of-a-kind examples.

At Bell Laboratories we have tried tracking technical innovations by looking at the historical record back to 1925. We are already finding out interesting facts. For example, this output measure is usually a function of the size of the technical workforce. The exceptions, such as when the number of innovations for a fixed workforce drops sharply, seem to be correlated with stress periods such as depression and war.

Many measures of R&D output such as patents, published papers and scientific awards, favor specific types of technical activity. Patents are seldom granted for computer programs; publishing opportunities are greater for those in research than those doing product development; and awards are more common in science than in engineering. In contrast to these specific measures, technical innovation can be defined to gauge the results of all kinds of scientific and engineering work. Although we are a long ways from certifying that it measures the same degree of accomplishment in all areas, data indicate there is some basis for comparison.

At Bell Labs we have used technical innovations to measure fundamental research and product development. We have counted processes, systems, hardware, and software. In recent years, software innovations have increased sharply, hardware slowly, and fundamental innovations have stayed constant. A count of recent innovations at Bell Labs shows them falling in the following areas:

BELL LABS INNOVATIONS
1970 - 1978

	Number	
Fundamental	31	12%
Processes & Devices	20	8%
Products & Systems	127	47%
Software Applications	87	33%

As we gain experience in working with technical innovation as a kind of measurement, its usefulness increases. We have already applied it in studying the time required for innovations to evolve from concept to application. Care must be taken, however, because of the subjective nature of the measurement tool. Nevertheless, it holds promise of providing a new and quantative way to look at the research and development process.

TECHNOLOGICAL INNOVATION: CHANGING PERSPECTIVES AND PROPOSED ACTIONS

Bruce Rubinger
Linda Noonan
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INTRODUCTION

There is a growing acknowledgement that the Nation has long range economic problems. Productivity growth is stagnant, our comparative technological advantage is eroding, and we are losing market share both at home and abroad. Many key industries have lost ground in world markets, including motor vehicles, aircraft, organic chemicals, telecommunications equipment, and machine tools.[1] A strong opinion is emerging that the federal government must "do something" to stimulate the process of innovation, so that its fruits may be tapped to reduce inflation, create jobs, and enhance the quality of life. One measure of the intense interest in this subject is the recent flood of articles, and papers under such related headings as "industrial policy," "industrial revitalization," "reindustrialization," "innovation climate," and "industrial innovation policy."

In order to engage in a meaningful discussion on industrial innovation policy it is necessary to know and understand the recommendations of the numerous bodies which have examined this problem and the responses those recommendations have elicited. Furthermore, a comprehensive picture of the perceived federal role in stimulating technological innovation from the perspectives of industry, academia, and government is required. To address these questions a retrospective analysis was carried out which focussed on the major task forces and special commissions on technological innovation. Five major studies were identified for the period of interest, 1960 through 1979. These are, with the respective dates of their reports: the National Commission on Technology, Automation, and Economic Progress (1966); the Panel on Invention and Innovation (1967); Commission on International Trade and Investment Policy (1971); the Department of Commerce Technology Policy Review (1977); and the Domestic Policy Review of Industrial Innovation (1979).

The views herein are solely those of the authors and not necessarily those of the U.S. Department of Transportation.

BACKGROUND OF THE MAJOR STUDIES

National Commission on Technology, Automation, and Economic Progress. Accelerating changes in the Nation's technology and the impact of these changes on society led Congress, in 1964 (P.L. 88-444) to create a National Commission on Technology, Automation, and Economic Progress. Chaired by Dr. Howard R. Bowen, President of the University of Iowa, the Commission issued its report in January 1966.[2] The commission's report contained recommendations for improving government's role in supporting technological development and cited its benefits for economic progress.

Panel on Invention and Innovation. One of the most publicized studies was documented in the 1967 Charpie report[3] on technological innovation. Created by the Secretary of Commerce, Luther H. Hodges, in 1964, an ad hoc Panel on Invention and Innovation was asked to explore the opportunities for improving the climate for technological change through antitrust, taxation, and regulatory policies. The Panel was chaired by Robert A. Charpie and had members drawn from industry, government and academia.

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Commission on International Trade and Investment Policy. In 1970, President Nixon established a Commission on International Trade and Investment Policy, chaired by Albert L. Williams of IBM. The Commission was asked to examine the principal problems in the field of U.S. foreign trade and investment, and to produce recommendations designed to meet the challenges of the changing world economy. In its report issued in July, 1971, the Commission emphasized the relationship between industrial innovation and the state of the economy.[4]

Department of Commerce Technology Policy Study. At the direction of Elliot Richardson, then Secretary of Commerce, Dr. Betsy Ancker-Johnson, Assistant Secretary for Science and Technology, headed a study of U.S. technology policy and its relationship to the Nation's economic welfare. Based on this 1977 effort, a report entitled U.S. Technology Policy was issued.[5] It raised concern over the adequacy of existing policy, discussed possible actions for improvement, and recommended steps to achieve a more coherent policy.

Domestic Policy Review of Industrial Innovation. On May 11, 1978, President Carter announced that he had established an interagency committee to conduct a comprehensive review of issues and problems related to industrial innovation.[6]

The interagency committee was chaired by the Secretary of Commerce with members from other agencies. The actual work was coordinated by Dr. Jordan J. Baruch, Assistant Secretary of Commerce for Science and Technology. The goal of the Committee was to present the President with highly focused options, along with data on their impact on targeted sectors, the cost to the government, and windfall gains accruing to others.

RECOMMENDATIONS

Proposals made by the various studies are summarized in Table 1. The recommendations span the entire spectrum of potential policy instruments, and include: federal support for R&D; economic incentives of various types; the use of procurement strategies; support for venture capital formation; changes in the regulatory process; and institutional reform. While generic classes of incentives were recommended, no clear preference was suggested among the policy options available within these general categories.

CONCLUSIONS

A review of major studies on innovation has uncovered a rich data base for policy synthesis. Past recommendations run the entire gamut of policy options, including: R&D; economic incentives; regulatory reform; procurement strategies; and institutional reform.

During the sixties government innovation policy only called for federally funded R&D. Accordingly, the thrust of the study groups was towards improving the effectiveness of federally funded R&D and expanding its scope to include the application of technology to social problems. A critical issue was whether there was a legitimate role for government in facilitating industrial innovation. The Bowen Commission established that such a role did exist, and subsequent study groups focussed on clarifying what that role should be and how it could be performed most effectively. Charpie's Panel examined how the government could improve the environment for technological innovation through its taxation, finance, and anti-trust policies. The Ancker-Johnson report expanded the concept of government involvement by (1) specifying actions which would make the Department of Commerce an advocate within the government for technological innovation, and (2) recommending a series of proposals which would improve the climate for technology-based enterprises. Finally, the Domestic Policy Review went a step further by stressing the need for a comprehensive federal approach to industrial innovation, one which would incorporate a variety of complementary policy mechanisms.

Another important concept established during the sixties and early seventies is that technological innovation and economic development are related. Acceptance of this linkage developed slowly. The Bowen Commission (1966) reported that there is a definite link between technological innovation and economic progress. Subsequent studies accepted this hypothesis and focussed on examining the nature of the relationship. For example, the Williams Commission (1971) concluded that technological innovation