



Small Business

Research Summary

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Technological and Organizational Diversity and Technical Advance in the Early History of the American Semiconductor Industry

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Purpose

The development of the semiconductor industry required technological advances in many areas of science and engineering.

The nature of the technologies in the semiconductor industry is such that there are few, if any, individuals with all of the expertise needed to pursue innovations; teams of individuals must be assembled. Research and development activities must be integrated with manufacturing and marketing activities.

Understanding the role of small firms in the creation of technological change has been a long-standing interest of the Office of Advocacy. This study examines the early years of the semiconductor industry and focuses on the diversity of firms involved in the technological innovations of the developing industry.

Scope and Methodology

Secondary literature sources provided the basic data for industry history. Technical publications and journals, trade magazines, academic monographs, and other analyses of engineering and scientific advances important to the evolution of the semiconductor industry were surveyed. The design for the research and its implementation were carried out by faculty members and a doctoral degree candidate at the Carnegie Mellon University.

Research and development for technological advance in the semiconductor industry was conducted in many areas. Three related technology areas were chosen for in-depth examination: integrated circuits, materials technology and device packaging. Choosing three such closely related technologies helped the research focus on the dynamics of technological advance where firms in an industry are pursuing a broad and diverse array of innovative activities simultaneously. Innovative activities are complementary and reinforce the general process of technological advance.

Highlights

- The backgrounds of firms in the semiconductor and related industries account for the diversity in their research activities. In the earliest years of the industry, firms came from four basic realms of activities: (1) electronics, (2) instrument makers or users, (3) users of electronic equipment (such as aircraft making), and (4) chemicals and other materials.
- The earliest firms entering the field were mainly those from the electronics industry. Large businesses producing

vacuum tubes, such as Raytheon and RCA, were the main early entrants into the industry in the early 1950s. They dominated the production of semiconductor devices in the early years. At this stage there were only a few firms established specifically to enter the semiconductor industry.

- By the mid-1950s, as the market for the new devices grew, new firms were founded and existing firms from other industries, such as aircraft builders and instrument makers, began to pursue semiconductor electronics. Many of the firms that entered the industry during this period were doing work for the military or other government agencies. While many of the new entrants did not last long in the industry, others grew to dominate the industry.
- Small firms also began to cater to the emerging industry by supplying materials and equipment. Many of these firms (chemical firms, optical firms, and specialty metals firms) were established firms entering a new market. These firms contributed to the development of certain aspects of semiconductor technology.
- Small startup firms also entered the manufacturing end of the industry. These firms as a rule were founded by small groups of individuals, mostly men with experience in the then-infant industry or in laboratories doing research in solid state electronics. By the mid-1960s there were well in excess of one thousand firms that were playing some part in the semiconductor industry.
- The semiconductor industry is characterized by great diversity in firm size, and in the scientific and technological foundations. The diversity of firms contributed to the efficiency of its technological development. A large and diverse pool of firms participated in the growth of the industry and each firm built on its previous experience and followed approaches that built on its particular strengths.
- The growing number and variety of applications for semiconductor devices also contributed to the diversity of interests and perceptions of the industry participants.

Ordering Information

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