Licensing and Semiconductor Industry

Competition, not patents, has shaped semiconductor industry; technology is transferred with great care

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My paper will deal with the role of patents in the semiconductor industry, and I will emphasize the nature, function and mechanics of technology transfer.

With this background, we are now almost in a position to discuss the role of patents in the semiconductor industry. There is, however, one other factor that I first must explain and that is the nature of the semiconductor manufacturing processes.

SEMICONDUCTOR PROCESSES

The manufacture of semiconductor devices is not a certain thing. While there are many different processes used to manufacture semiconductor devices, they all have certain things in common.

First, impurities which enter the manufacturing process reduce the number of good devices obtained at the completion of the process.

Second, deviations from the prescribed process or recipe also reduce the number of good devices obtained.

Third, imperfections in materials reduce the yield of good devices.

You will note that I just used the word "yield." *Yield* is the number of good devices obtained at the end of the process compared to the maximum number of good devices obtainable.

If a company has good yields, it usually makes money. If a company has bad yields, it usually does not. There is nothing that strikes terror so rapidly in the heart of a semiconductor manager as to be told that yields have dropped because the process has been "lost" (that is, something has changed in the process and the engineers can't figure it out).

It is not unusual for yields to drop to zero in certain processes. These occurrences are known as "losing the process." Many of the practices in and associated with the semiconductor industry have been developed to minimize the financial impact of yield loss. Certain of these practices will become clear from what follows.

SEMICONDUCTOR PATENTS

Now, let's talk about patents in the semiconductor industry. As you will see, the main factor which has shaped the semiconductor industry is not patents but rather Competition. The semiconductor industry has been characterized by fierce, effective and continuous competition. While patents have been important (and there have been key patents in the semiconductor technology), the importance of a patent is that it covers certain products that are in demand. Competition in the semiconductor industry is such that with a few exceptions, no one patent or combination of patents has enabled a company to achieve a dominant position in the industry.

COMPETITION

Competition in an industry depends on many factors.

1. Ease of entry.
2. Number of competitors.
3. Number of alternate sources for the same type of product.
4. Nature of competition (by that I mean, is the competition on a component level or is it on a functional level?)
5. Rate of technical innovation.
6. Rate of product obsolescence.
7. Pricing policies.
8. Profits (which are important in determining the strength of competition).
9. Mobility of labor (which plays an important role in disseminating technology).

Ease of Entry

Ease of entry is important. For many years it was possible to enter the semiconductor business with a capital expenditure of a few million dollars to obtain some diffusion tubes, furnaces and reactors to carry out the various process steps conducted on the wafers, perhaps a scribe-and-break machine to break up the wafers upon completion of wafer fabrication and then some assembly equipment to put the good dice into packages for sale to the customers. A person might even have had some test equipment to test the product before it was shipped. But if the person didn't, that was no problem. A person could go out and hire someone else to do the testing.

Over the last few years, because of the increased complexity of semiconductor devices, the cost of entering the business has increased. I have been told by a number of people that it now costs from $20 million to $40 million in capital equipment to enter the semiconductor business, should a person desire to do wafer fabrication.

But what if you elect not to fabricate wafers? There are a number of new companies now being formed with a much smaller amount of capital. These companies are

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going to be very effective competitors, because they are taking advantage of a new phenomenon in the industry, the "silicon foundries." These foundries comprise companies which make their excess capacity available to a start-up company or an existing company for a price, so that the start-up or existing company can run selected wafers through a semiconductor process and come up with wafers suitable for assembly into finished product.

The emergence of silicon foundries is important, because if a company buys its wafers from a company which already has a license under the important industry patents, the buyer does not even have to worry about a patent license, because the seller, of course, is operating under its license.

Number of Competitors

The number of competitors is important. With a number of companies offering the same product in the marketplace, there is fierce competition for that product.

Competition, though, isn't just between identical products. Several different semiconductor technologies are in use. Oftentimes an MOS product—that is, a product made using MOS technology—will offer the same function to a system designer as a product made using bipolar technology. If one company has a predominant patent on bipolar technology and another company is unable to obtain a license under that patent, then the other company can often make the same functional product using MOS technology and avoid the patent. Consequently, the value of certain patents is reduced somewhat by the availability of competitive alternative technologies.

But competition also spreads beyond price and technologies into specifications, quality of devices, delivery schedules, and payment schedules. In bad times, competition really becomes heated because each semiconductor manufacturer has a large capacity which it desires to keep busy. Companies reduce prices to take business away from their competitors. Oftentimes, a company will solicit business at prices beneath its cost just to keep its facility busy. So during recessions, such as the one we are in right now, products are available at bargain prices. Unfortunately, during recessions, industries usually do not wish to buy many semiconductor products. Industries have already bought semiconductor products during periods of tight supply and therefore wish to work down their inventories to reduce costs. This compounds the problem in the semiconductor industry. Profits drop drastically reducing the ability of companies to invest in new products at the very time new products are needed to compete more effectively.

Alternate Sources

The problem is compounded by another phenomenon called "alternate sources"—an interesting concept.

Have you ever heard of a company providing its technology to a competitor for no money? This sometimes happens in the semiconductor business. And it happens because customers require it. As I noted earlier, semiconductor manufacturers sometimes lose the process. A manufacturer with a plant idled for lack of one semiconductor component is not happy.

To protect against loss of process, buyers usually insist on an alternate source for any new product before they will design that product into what they make.

Consequently, a semiconductor manufacturer will solicit one or more of its competitors to commit to manufacture a new product and to announce as a second source for that new product. An early enough announcement of a second source will result in more design-ins and perhaps cause the new product to become an industry standard product.

To obtain the second source, the developer will often have to commit to provide the second source with masks, logic and circuit diagrams and testing tapes. Often these are swapped for similar things relating to another circuit developed or to be developed by the second source. The purpose of all this is to enable the developing company to obtain market share by presenting a second source to the marketplace.

The ideal second source originally was a company in trouble. But that practice soon ended, because the manufacturers of the finished goods soon insisted that the second source company be in good health and be able to make the product. Alternate sources were a major reason why technology and patent rights became somewhat disseminated throughout the industry.

Nature of Competition

An alternate source made a component identical, to the extent it could be done, to the component being manufactured by the prime source. Of course, there was also functional competition between functionally equivalent components made using different technologies.

Rate of Technical Innovation and Product Obsolescence

The semiconductor industry was characterized by a rapid development of technology and the rapid introduction of new products.

In any one year, it has been estimated that from 10-30% of the products offered by the industry become obsolete and are replaced by new products—oftentimes more highly dense products.

The result is that a product's lifetime will typically be five years. When it takes 3-4 years to obtain a patent and another 2-3 years to negotiate a license, if ever, patents don't seem to have the importance that they would have if the product was going to have a continuing lifetime substantially beyond the issuance of the patent. A 10-year lifetime for a product in the industry is somewhat unusual.

Infringement

The number of products meant that patent infringement studies were rarely done, merely because there was no manpower to do the studies. The products were changing faster than they could be analyzed. If a company tried to do a patent infringement study, by the time the study was finished, the product would have been sold and sometimes it would have been dropped, and another more advanced product substituted for it.

Oftentimes broad patent licenses were entered into with some study of a few key patents—and there were key patents in the industry—but with no real study of the broad product line in view of all semiconductor patents. In fact, many companies clearly stated that their goal in licensing was solely to remove an impediment to doing business.

Pricing

Another factor that affected competition was pricing. The Boston Consulting Group published the learning curve or "experience curve" which said that cost dropped as a function of cumulative production. Semiconductor products historically have shown approximately 30% per year drop in price which can only be supported by a substantial annual drop in costs.

Some companies used this curve to justify the initial pricing of new products under their actual costs at the time of product introduction. This was done on the theory that even if a little was lost on each unit sold it would be made up in volume.

The theory is that if a price is set beneath cost at product introduction, it will be above cost at a later time. This time can be translated into volume. If time is replaced with an equivalent concept of volume, (volume means total number of units produced) then as the total number of units produced rises, cost per unit goes down. If a large market share is purchased at the start, the volume at which cost is beneath price will be reached earlier in time than if that large initial market share is not purchased. Consequently, costs will go down much faster if prices are set below initial cost at the start, because a large number of design-ins will be obtained that otherwise would not be obtained. The demand for the product, hopefully, will be greater. By this philosophy profits can be reached sooner than if the initial price is set high.

This particular strategy worked and many companies made a great deal of money by using it. However, it again reduced the amount that management was willing to pay in patent royalties for the privilege of making any product, because obviously management could argue initially that it was losing money on a product. Another result of this philosophy was that profits sometimes tended to be somewhat out of proportion to sales—that is, companies sometimes lost money. This particular philosophy assumes that volume is going to go up and a company is going to gain market share. There were companies that tried this philosophy, and unfortunately never quite got to the crossover point.

Mobility of Labor

Labor mobility, of course, strongly influences competition. Semiconductor products are characterized by Jerry Sanders of Advanced Micro Devices as being the crude oil of the technological age. The semiconductor industry basically supplies a raw material, a highly technological raw material, to other manufacturers, who take the product and place it in finished goods or semi-finished goods for sale further into the industry, to consumers, or whatever. Semiconductors are ubiquitous in their uses.

Consequently, a good semiconductor engineer can command a very admirable salary and stock-option package. Engineers have learned that during recessions the employer is going to be quite willing to lay them off.

A company does that once to employees, and the employees soon learn that loyalty is a one-way thing. Companies demand it of employees, but aren't willing to give it to them. When that happens, a company suddenly discovers it has a very mobile labor force. That is free enterprise; that is the capitalist system. Employees will take their general professional skills (and perhaps more) with them to their new employer.

Practices have developed in the semiconductor industry for trying to at least prevent secrets from moving from one employer to another. At the big companies employees are almost always debriefed before they leave. The debriefing essentially comprises an interview with the departing employee, where the employee sits down with a company patent attorney or personnel director to discuss what the employee has done, who the employee worked for and on what project the employee worked, and any inventions, published articles and invention disclosures which the employee might have or should have made.

It turns out that engineers are often very smart. They pave the way so they can leave an employer and use what they developed at their next employer, both through patent disclosures (which will be filed in the patent office) and through papers which are given at technical conferences (which disclose the essence of their work, so it is in the public domain).

Most companies have a procedure by which all publications must be approved by the patent department. That still doesn't prevent employees, though, from disclosing key information at these conferences, which are often oral exchanges as well as written exchanges.

So trade secrets have been protected effectively in many contexts, but trade secrets have not been able to prevent the low-level dissemination of the operating technology throughout the industry.

There have been some very famous trade secret suits in the industry. Judges tend to look upon trade secrets as sacrosanct and upon patents as potentially invalid disclosure documents. It is ironic. I think a company is often much more successful in protecting its trade secrets than its patents, if it can show that it has taken reasonable steps to do so. What are these steps?

Cases seem to say that a company must inform employees of the nature of the trade secrets on a periodic basis, must label areas in which trade secrets are practiced as secure areas, must debrief employees, and should write letters to the new employer of a former employee, informing the new employer of the work which the former employee did in a broad sense and letting the new employer know that the former employer is going to be looking carefully at the products being produced by the new employer over the next year or two to determine whether or not the new employer has used the old employer's proprietary information.

Many companies have been successful in obtaining injunctions against the use of their trade secrets under these circumstances. However, trade secret protection has so many risks that I think most companies have decided that the best protection is patent protection. The classical problem in relying upon trade secret protection is that the company which retains the innovation as a trade secret potentially runs the risk of infringing a patent obtained by another party who, although later to invent, decides to patent the innovation, and successfully obtains the patent. Under 35 U.S.C. 102(g), there is a very express statement that a party who suppresses, conceals, or abandons an invention is not entitled to a patent vis-a-vis another who subsequently applies first for a patent on the same invention. I think the courts would hold in such circumstances that the maintenance of an invention as a trade secret might very well comprise the concealment or suppression of an invention.

TECHNOLOGY TRANSFER

As you can gather from the above, the transfer of technology is an important part of the semiconductor scene. How is this transfer done? Usually very carefully.

First, the parties define what is to be transferred. As you all know, the definition of what is to be transferred is one of the most important parts of the technology transfer agreement.

In the semiconductor industry, the technology to be transferred might be as little as the logic diagrams for a new circuit (leaving to the recipient the problem of laying out the circuit in silicon) to as much as the masks used by the licensor to make the product and sometimes even the process technology used by the licensor.

The ideal second source, from the point of view of the customer for the product, is capable of supplying a product identical to that supplied by the developer of the product in any quantity desired by the customer. The ideal second source from the point of view of the developer of the product is a relatively weak company that gives the appearance of being robust but which does not have the resources to produce the product in large volume.

When the developer is trying to sell a new product to a large company such as a computer company, the ideal second source is the customer with a restriction in the license so that the customer can use the transferred technology only to make product for its internal use and not for sale on the open market. Often the license will also provide that the customer will buy at least a given percentage of its requirements for the product from the developer so long as the developer is competitive in price, quality and delivery schedule. A lot of discussion goes into defining all this.

The developer will usually specify that the alternate source takes the technology as is, without any warranties that the alternate source will be able to use the technology successfully or without infringing the patent or other rights of third parties. This last disclaimer is extremely important because without this disclaimer the developer might be accepting an implied obligation the magnitude of which goes up in proportion to the success of the alternate source in using the technology.

Announcement

One of the benefits of having an alternate source is that the developer gains a selling advantage over competitors with similar products but without alternate sources for their products. Much jockeying centers on the announcement of the second source arrangement. The developer wants the alternate source to be announced as soon as possible to allow the developer to gain a competitive advantage in the market place vis-a-vis third parties. The alternate source wants to delay the announcement until it receives the technology. However it is also in the interest of the alternate source to have the announcement as soon as possible so that it too can gain a competitive advantage. So the alternate source will argue for a prompt transfer of technology. If the alternate source is a formidable competitor, the developer will want to delay the transfer of technology until the developer has established a reasonable presence in the marketplace. Usually the second source will agree to a prompt announcement of the fact that it is planning to become an alternate source.

Timing

The next question is timing. When should the know-how be transferred? Too soon a transfer and the alternate source may get masks with inherent yield problems. Too late a transfer and the alternate source will have difficulty being viable in the marketplace. Many alternate source agreements provide for the transfer of the mask set used to make the first working prototypes submitted to customers which meet the specifications, and all improvements therein used in the manufacture of devices for sale to the general public, for a specified period of time, typically six (6) months to several years.

Implementation

To implement the transfer a liaison person is usually appointed by each party. All documents are transferred with a cover letter identifying the documents to be transferred. All recipients of the documents are instructed to hold the received documents in confidence. Improvements made by either party during a specified time period are made available to the other party to ensure continued compatibility of products in the marketplace.

Termination

Following the lapse of a specified period of time, without breach, typically 5-10 years, each party is usually free to use the technology it has obtained from the other party without restriction although sometimes a patent license from the other party is required to do so.