Efficiency in the Health Care Industries
A View From the Outside

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The health science/health care industry and the microchip industry are similar in some important ways: both are populated by extremely dedicated and well-trained individuals, both are based on science, and both are striving to put to use the result of this science. But there is a major difference between them, with a wide disparity in the efficiency with which results are developed and then turned into widely available products and services.

To be sure, there are additional fundamental differences between the 2 industries. One industry deals with the well-defined world of silicon, the other with living human beings. Humans are incredibly complex biological systems, and working with them has to be subject to safety, legal, and ethical concerns. Nevertheless, it is helpful to mine this comparison for every measure of learning that can be found.

First, there are important differences between health care and microchip industries in terms of research efficiency. This year marks the 40th anniversary of a construct widely known as Moore’s Law, which predicts that the number of transistors that can be practically included on a microchip doubles every year. This law has been a guiding metric of the rate of technology development.

According to this metric, the microchip industry has reached a state in which microchips containing many millions of transistors are shipped to the worldwide electronics industry in quantities that are measured in the billions per month.

By contrast, a Fortune magazine article suggested that the rate of progress in the “war on cancer” during the same 40 years was slow. The dominant cause for this discrepancy appears to lie in the disparate rates of knowledge turns between the 2 industries. Knowledge turns are indicators of the time it takes for an experiment to proceed from hypothesis to results and then lead to a new hypothesis and a new result.

The importance of rapid knowledge turns is widely recognized in the microchip industry. Techniques for early evaluation are designed and implemented throughout the development process. For example, simple electronic structures, called test chips, are incorporated alongside every complex experiment. The test chips are monitored as an experiment progresses. If they show negative results, the experiment is stopped, the information is recorded, and a new experiment is started.

This concept is also well known in the health sciences. It is embodied in the practice of futility studies, which are designed to eliminate drugs without promise. A recent example of the use of futility studies for this purpose is the exercise of narrowing the list of putative neuroprotective agents before launching a major randomized clinical trial.

The difference is this: whereas the surrogate “end point” in the case of microchip development—the test chip failure—is well defined, its equivalent in the health sciences is usually not. Most clinical trials fall back on an end point that compares the extent by which a new drug or therapy extends life as compared with the current standard treatment. Reaching this end point usually takes a long time; thus, knowledge turns are slow. In many instances, a scientist’s career can continue only through 2 or 3 such turns. The result is wide-scale experimentation with animal models of dubious relevance, whose merit principally lies in their short lifespan. If reliable biomarkers existed that track the progression of disease, their impact on knowledge turns and consequently on the speed of development of treatments and drugs could be dramatic.

Even though such biomarkers could have a profound effect on medical research efficiency, biomarker development efforts seem far too low. Although precise numbers are difficult to come by, in my estimation, in the microchip industry, research into development, test, and evaluation methods represents about 10% of total research and development budgets. This 10% is taken off the top, resulting in less actual product development than the engineers, marketers, or business managers would like. But an understanding that this approach will lead to more rapid knowledge turns protects this allocation from the insatiable appetite of the business. The National Institutes of Health (NIH) budget is about $28 billion a year. It seems unlikely that anywhere near 10%—$2.8 billion—is spent on biomarker development.

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A second difference between the microchip and health science industries is the rate at which hard-fought scientific results are “brought to market”—produced in volume in the case of microchips or translated into clinical use in the case of medicine. A key factor in accelerating the movement of discoveries from the research laboratory to marketplace (or from bench to bedside) is the nature of the facilities in which translational work is performed. The world of business has many stories of failures of organizational designs that impede technology transfer. The classical research laboratory, isolated and protected from the chaos and business-driven urgencies of production units, often led to disappointing results. For example, when Intel started, the leadership resolved to operate without the traditional separation of development from production, which worked remarkably well for quite some time. Developers had to compete for resources with the business-driven needs of production, but their efforts were more than compensated by the ease with which new technology, developed on the production line, could be made production worthy.

Today, an evolution of this resource-sharing principle continues in the microchip industry. Dedicated developmental factory units are designed from the ground up with the aim of eventually turning them into production units. They are overbuilt for the needs of development, but once development is complete, the facility is filled with equipment and people and transformed into a production unit in a matter of months. Although overbuilding for the development phase costs more initially, the savings in efficiency of moving products to production more than make up for this initial outlay. Medical facilities are designed for a variety of purposes, ranging from outpatient clinics to surgical centers, from general hospitals to tertiary hospitals. There is room for a translation hospital designed from the ground up with the mission of speeding new developments toward usage in general hospitals. These hospitals would be flexible, equipped for capability of extra monitoring, ready to deal with emergencies—all extra costs but likely to be made up by the resulting increase in translational efficiency. Some examples exist, such as the NIH Clinical Center. Some cancer centers have adopted changes in hospital design that are steps in this direction. However, much more needs to be done before these designs are evaluated and an optimal approach is adopted and proliferated throughout the health care industry.

When it comes to operational efficiency, nothing illustrates the chasm between the 2 industries better than a comparison of the rate of implementation of electronic medical records with the rate of growth of electronic commerce (e-commerce). Common estimates suggest that no more than 15% to 20% of US medical institutions use any form of electronic records systems.5 By contrast, during the last 10 years, more than $20 trillion worth of goods and services have been bought and sold over the Internet (A. Bartels, written communication, June 2005).

e-Commerce started in the era of mainframe computers. It required specialized software, created and owned by the participants (so-called proprietary software). To link buyer with seller, each had to have the same software. The software was expensive and difficult to modify and maintain. Consequently, the use of e-commerce was limited to a few large companies.

The Internet changed all that. Computing became standardized, driven by the volumes of substantially identical personal computers; interconnection standards were defined and implemented everywhere. A virtuous cycle evolved: standards begot large numbers of users, and the increasing numbers of users reinforced the standards. It was easy to become part of an electronic marketplace because it no longer required the installation of proprietary software and equipment.

The early results were pedestrian: orders taken by telephone, manual data entry and reentry, and the use of faxes were reduced. But the benefits were spectacular. Costs and error rates plunged. Small- and medium-sized companies rushed to join the electronic marketplace, necessitating the development of a standardized software code that would translate information from one company’s system to that of another, the computing version of the Rosetta stone.

Although the computer industry is fairly fragmented, the health care industry is even more so. Like the computer industry, health care is a largely horizontally organized industry, with the horizontal layers representing patients, payers, physicians, and hospitals, as well as pharmaceutical and medical device companies. Standard ways of interconnecting all these constituencies are crucial. The good news is that the desire to increase internal productivity has led to at least partial deployment of information technology within the companies of many of the participants. Further good news is that the physical means of interconnecting the many participants already exists in the form of the Internet.

The bad news is that with the exception of a few, large, vertically integrated health care organizations, in which participants from several layers are contained in 1 organization (as is the case with the Veterans Affairs Administration and Kaiser Permanente), the benefits of electronic information exchange are not necessarily realized by the participants in proportion to their own investment.7 The industry faces what is called in game theory the “prisoners’ dilemma” all members have to act for any one member to enjoy the benefit of action.

Such collective action often requires external stimulus. The year 2000 problem (ie, “Y2K”) was an example of such a stimulus, causing the near-simultaneous upgrade of the worldwide computing and communications infrastructure. Although its ostensible benefit was the avoidance of a digital calamity at the turn of the century, its greatest benefit was in readying thousands of commercial organizations for the age of the Internet and e-commerce.
Even though the task facing the health care industry in developing and deploying the crucial “Rosetta code” is much smaller than the task of getting ready for 2000 was, external impetus is still needed to catalyze serious action. The National Health Information Infrastructure Initiative\(^8\) demonstrates some desire to encourage progress along those lines. However, what is needed to cause the industry to act is customer demand. The largest customer—approaching half of total health care spending\(^9\)—is the Medicare system. It seems that the entire health care industry would benefit if Medicare mandated the adoption of a Rosetta code for the health care industry before institutions were granted permission to participate in Medicare business.

There are signs that individual consumers may be taking matters into their own hands. The proliferation of companies providing personal health record services\(^10\) is an indication of such a movement. This phenomenon has all the makings of becoming a disruptive technology.\(^11\) Disruptive technologies, usually initiated by small businesses that are new to the industry in question, can force widespread defensive actions by the much larger industry incumbents. In this case, inadequate response by the incumbents could lead to some of the emerging providers of personal health record services becoming the owners of the customer relationship—a development of considerable strategic significance to all such businesses.

The health care industry in the United States represents 15% of the gross domestic product,\(^12\) and bearing its cost is a heavy burden on corporations and individuals alike. The mandate for increasing its efficiency—in research, translation, and operations—is clear. History shows that whatever technology can do, it will do.

If not here, where? If not now, when?

**Financial Disclosures:** Intel Corporation manufactures microprocessors and other types of microchips that can be used in health care information technology.

**REFERENCES**