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Projections of Future Developments in Health-Care Delivery

A review of the history of medicine reveals that many different figures have played central roles in the practice of medicine, beginning with primitive native healers or “witch doctors” and passing through stages involving clerics, barbers, philosopher-physicians, family doctors, and, most recently, scientific specialists. Healers have held preferential and key positions in most cultures. Many of our current medical traditions can be traced to a mystique which allowed the healer to bring relief and reassurance to patients even when he was incapable of directly affecting the course of illness. The need for a close and understanding doctor-patient relationship may be reduced when powerful and effective treatments can cure or alleviate illness, but it remains very important for the many and varied forms of illness still lacking effective therapy.

The traditional nineteenth-century image of the physician was that of a kindly, sympathetic, unselfish, and dedicated man whose primary goal was to bring comfort and care to his patients. Until the turn of this century the standard treatment for many illnesses was to send the patient to bed and submit him to some unpleasant procedure or prescription. In those days the state of medical knowledge was such that home remedies prepared by a grandmother or maiden aunt were often as effective as the complicated, ineffectual concoctions of the pharmacist. The medicines of the day were derived mainly from natural organic substances such as digitalis, quinine, opium, and cascara. These organic materials and many others were elaborately bottled, elegantly flavored, and carefully prescribed. Oliver Wendell Holmes is reported to have stated that if 80% of these prescriptions had been poured into the sea, only the fishes would have suffered. Therapeutic measures were administered mainly to achieve symptomatic relief.

Increasing Effectiveness—Diminishing Satisfaction

At the turn of the century the country was supplied with a relatively large number of doctors, many of whom had emerged with very limited training from the “diploma mills” and had gained most of their competence

through apprenticeship and on-the-job training. Actually the number of doctors per 1,000 population was greater in 1900 than it is today, and they were at that time more widely distributed in rural areas than in urban America.¹ Hospitals were scarce, but they were not missed because most practice was conducted in the patient's home or the doctor's office. In those days there were always spinster aunts, young cousins, or neighbors to look after the aged, the feeble, the handicapped, the mentally deficient, and the chronically ill. So many people succumbed to acute illness that chronic illnesses were not nearly so prevalent as they are today.

The kindly old family doctor who served as counselor and source of concern and sympathy carved a lasting impression in people's minds. Nowadays the general public still expects the selfless dedication and ready availability of the old family doctor, but they would also like him to be armed with the best that modern medical science and technology can provide.

The accelerated progress in the prevention, cure, and management of many diseases and disabilities during this century, and particularly in the last two decades, is illustrated in Figure 1.1. The health of the nation has greatly benefited from improved nutrition through ready access to essential foods and vitamins. Public-health measures have been effective in eliminating or controlling many frightful epidemic and infectious diseases. The collection of large amounts of quantitative data for a variety of disease states has created a much more objective basis for diagnosis. In turn, the new diagnostic techniques have greatly added to the reliability, objectivity, and specificity of the patient's data base, particularly during the last 25 years.

Surgery has been aided by two major improvements, asepsis and anesthesia, in the last century. The original concentration of surgery on cutting-out or sewing-up has been refined and expanded to include increasingly sophisticated reconstructive surgery, artificial tissue substitutes, and, currently, the development of artificial substitutes for organ function. (An example is the heart-lung machine, which has allowed the meticulous repair of structures inside the heart.) A major contribution to survival following surgery has been made by the enormous improvement in postoperative management afforded by highly sophisticated intensive-care units.

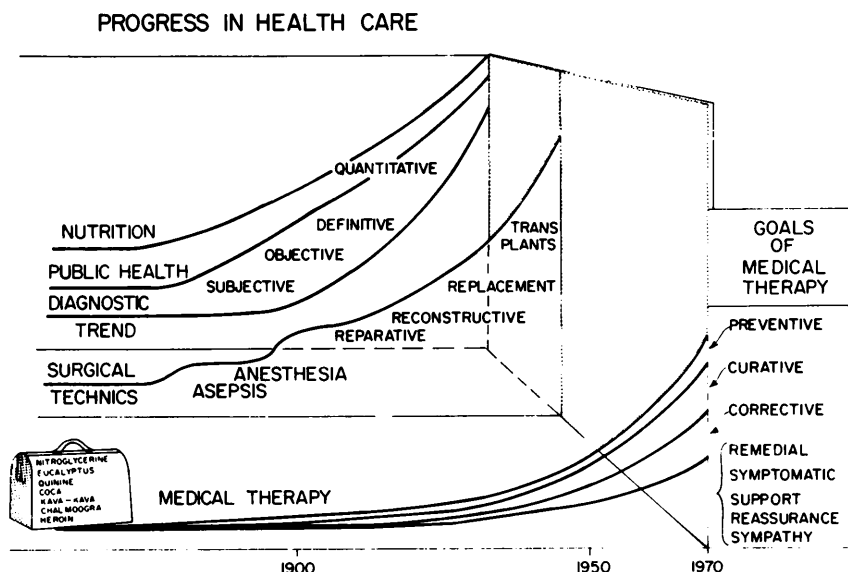


Figure 1.1 During the last century progress in health care has been phenomenal in all its phases, including nutrition, public health, diagnostic capability, and surgical techniques. Medical therapy has extended its goals from support and symptomatic relief to the correction, cure, and prevention of illness.

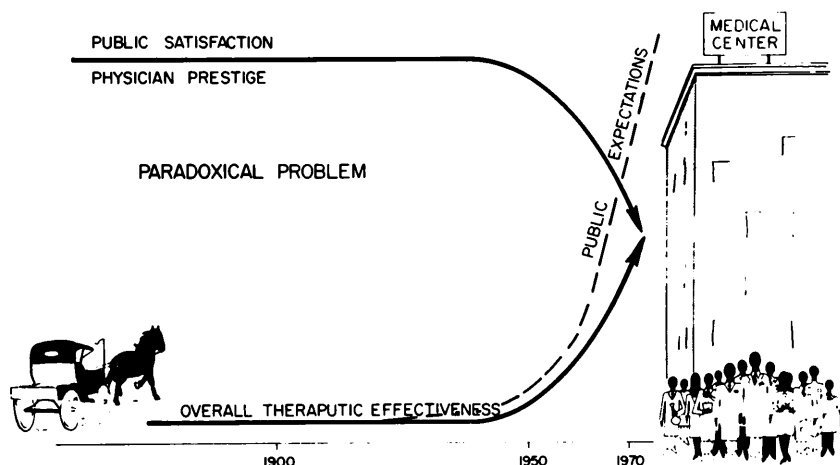


Figure 1.2 Paradoxically, the greatly increased ineffectiveness of medicine achieved by replacing the horse-and-buggy doctor with highly trained teams in medical centers has been accompanied by a precipitous drop in public satisfaction and physician prestige. This is attributable in part to public expectations overshooting the ability of health professionals to deliver.

This improved therapeutic effectiveness of medical care has made it possible to upgrade the goals of medical therapy. Conditions for which only supportive and symptomatic treatment was available in the past can now be remedied, alleviated, corrected, cured, and in some cases even prevented. Continued research and development is designed to expand the number of diseases and disabilities for which definitive care is available. The control of infections and the management of metabolic defects are notable examples.

Strangely enough, major improvements in the medical and surgical management of ailments have not produced corresponding public approval or satisfaction with the health-care delivery system. According to Anne Somers,² paradoxical problems pervade the four essential elements of the health-care delivery system, namely physicians, patients, hospitals, and finances:

Physician paradox. Better trained physicians in larger numbers are seeing more patients, performing more miracles, and earning more money than ever before, *but* an imbalance between supply and demand is producing emotional and financial pressures and a growing resentment and public depreciation of the medical profession.

Patient paradox. Patients are longer-lived, less disease-ridden, better educated, and richer than ever before, *but* rich and poor alike are demanding far more health care and are critical of existing health-care institutions to the point that they seem determined to change them by whatever means are at hand.

Hospital paradox. The hospital—the unique professional and technical center of the health-care world—still enjoys the confidence of most Americans, *but* it suffers partial paralysis in dealing with its essential coordinating role as a community health center because of internal organizational defects coupled with a failure to develop external organizational relationships that might improve its cost-effectiveness and help restrain steeply rising costs.

Financial paradox. Financial barriers to health have been substantially reduced for most Americans through public and private mechanisms (i.e., insurance and governmental subsidies) that benefit both providers and consumers, *but* the influx of money has added further financial pressures to soaring costs and, despite federal subsidies, those segments of the

population that have the greatest need for health care are currently unable to pay for its benefits.







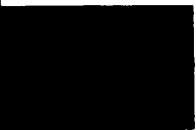

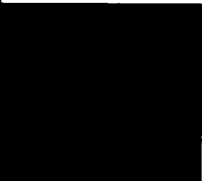
It seems ironic that during the present period, when medical, surgical, public-health, and nutritional aspects of health care have all witnessed their greatest achievements, the public's satisfaction has plummeted to new lows (Figure 1.2). There seems no doubt that the status and prestige of physicians was much higher when horse-and-buggy doctors were available day or night, dedicated public servants willing to make home calls. A doctor was then expected to be knowledgeable regarding the whole patient and his family, and to offer his services willingly and with little apparent regard for his own convenience, income, or well-being. In contrast the medical team functioning in a modern, sophisticated hospital or medical center is far more effective in actively alleviating disease and disability than "old doc" was. The public appreciation and enthusiasm for the enormously enhanced quality and expanded effectiveness of health care has been diluted by disenchantment with the manner in which it is administered. Many patients are convinced that some of their deeply felt needs, formerly satisfied by the country doctor or family physician, could be built into modern medical institutions by some reordering of priorities and restructuring of the system. At the same time exaggerated expectations have been engendered by much that modern patients see and hear through mass media.³

The technical accomplishments of "superspecialists" utilizing sophisticated equipment to prolong lives have been widely publicized but have actually benefited only a relatively small segment of the population. The less dramatic but much more common ailments to which mankind is subject will not likely be alleviated by dramatic innovations of the sort so prominently portrayed in newspapers or on television (Figure 1.3). New techniques have greatly increased our ability to predict the rate at which new technologies will be utilized for health care.

Some Techniques of Futures Research: Technological Forecasting

In the past few years futures research has become a small industry in the United States, involving approximately 3,000 full- and part-time workers. Many different disciplines are represented, including engineering,

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PROBLEM	POPULATION AFFECTED	TECHNICAL RESOURCES APPLIED	PRIMARY RESPONSIBILITY	OBJECT
A. LIFE THREATENING EMERGENCIES			SUPER SPECIALIST	SURVIVAL
B. SERIOUS ORGANIC DISEASES			SPECIALIST	RESTORE FUNCTION
C. MODERATE SYMPTOMATIC ILLNESSES			FAMILY DOCTORS SPECIALISTS	RECOVERY
D. MILD FUNCTIONAL DISTURBANCES			PATIENT FAMILY DRUGGISTS DOCTORS	IMPROVE QUALITY OF LIFE
E. NO DISEASE drugs aging mental illness mental retardation genetic defects			"SOCIETY" government professions people	PROVIDE FUTURE

014 **Figure 1.3** The most sophisticated technical resources, commonly operated by highly
 015 specialized personnel, are generally being utilized to extend the lives of patients with
 016 life-threatening emergencies (A). Technology is utilized to a lesser degree in efforts to restore
 017 function to the numerous patients who suffer serious organic disease (B). Moderate
 018 symptomatic illnesses affect much larger segments of the population, but their treatment
 019 involves very limited technologies (C). Mild functional disturbances (D) and health-related
 020 problems (E) interfere with the quality of life of enormous numbers of people and are
 021 generally managed ineffectually. From R. F. Rushmer, *Medical Engineering: Projections for*
 022 *Health Care Delivery* (New York: Academic Press, 1970), with permission of the publisher.

economics, physics, political science, chemistry, mathematics, and computer science.⁴ A growing number of institutions are designed solely to investigate systematic methods for understanding man's future potentials.⁵ The published literature in the field is now so extensive that it is difficult to encompass it all in a limited space.

Trend Extrapolation

In everyday life we all make decisions based on the assumption that recent trends will continue into the future. Both trivial and important decisions are made on this basis. However, this basic assumption is not as tenable in the present period of rapid change as it might have been two decades ago.

Some deficiencies of trend extrapolation revolve around the fact that the accuracy of a projection becomes progressively less reliable as it extends further and further into the future. In addition certain types of trend are much more subject to change than others. Even more important are unexpected and unpredictable changes in human values and attitudes. It would have required the highest level of genius to have accurately predicted the changes in attitude toward marriage, sex, abortion, and birth control that have occurred among the American people within the last five years. Similarly, recent changes in attitude toward the law, as expressed in violence and criminal activity, would probably not have been predicted fifteen years ago. Despite these deficiencies trend extrapolation will retain an important role. What will be needed is an increasing quantity of objective information coupled with more precisely defined criteria.

Techniques for the extrapolation of trends are becoming more sophisticated. Factor analysis can be used to identify parameters or variables that will correlate with one another to provide a multi-dimensional look at trends. The advent of high-speed computers now makes it possible for a very large number of interacting elements to be taken into account through the use of mathematical models of various social and economic factors.

Simulation and Modeling Methods

The human intellect has only a limited capacity to visualize the interactions of three or more variables. For example, the impact of a single

factor such as population growth on energy requirements can be visualized graphically or in one's imagination, but to get a full view of the need for energy in the future one must simultaneously take into consideration a vast number of other complex, highly interrelated factors. Machine aids are obviously needed.

Simulation modeling or dynamic analysis is a technique that is being widely used today in studies of economics, social behavior, and political activities, and also in models of the economics of health, education, crime, and technological change. One interesting application of dynamic simulation and modeling is set forth in the book *Limits to Growth* by Donnela and Dennis Meadows and their colleagues.⁶ In their study, Jay Forrester's world model was analyzed in terms of predictions regarding population growth, food supplies, the utilization of resources, and the technological advances that might be called upon to accommodate such changes. The results were not optimistic:

Although we have many reservations about the approximations and simplifications in the present world model, it has led us to one conclusion that appears to be justified under all the assumptions we have tested so far. The basic behavior mode of the world system is exponential growth of population and capital, followed by collapse. As we have shown in the model runs presented here, this behavior mode occurs if we assume no change in the present system or if we assume any number of technological changes in the system.

This startling conclusion has been roundly criticized by other "experts," but this has not completely suppressed the sense of insecurity the study has engendered in people in many walks of life, including the highest levels of government.

Mathematical models and computer simulations have been used extensively for the dynamic analysis of many components of the health-care delivery system. The models have varied in scope from individual laboratories to regional health-care systems and have proved quite useful in providing increased insight into their problems. The most notable contribution of this approach so far has been the identification of the *kinds* of data that must be collected if a situation is to be simulated in a meaningful way. In the case of large and complex health-care facilities in particular, the available data are seriously deficient in quantity, specificity, scope, and relevance. Moreover the greatest single deficiency, a

lack of criteria for the *quality* of health care, will be hard to overcome since we have difficulty even defining health, sickness, or health care. Despite these reservations it seems safe to predict that simulation techniques have valuable contributions to make in the study of health-care systems.

Decision Trees

A sequence of key decision points can be converted into a decision tree as a graphic device for displaying the consequences of various alternatives. Such trees point up the necessary conditions required to attain long-range objectives and also indicate the points at which progress might be interrupted. Several alternatives may be available at each of the branch points, and in some cases a decision at one level may feed back to decisions at other levels to produce a more complicated picture of the process. Very large decision trees can be impressed upon computers so that scenarios and future alternatives can be generated from these basic patterns. In addition graphic and computer-generated decision trees may become key elements in initial diagnosis by paramedical personnel or by patients (see Chapter 5).

These brief descriptions do not cover all the techniques currently being employed to project future events. The most commonly used methodologies were included only to illustrate future prospects.

Examples of some of these forecasting methods applied to medicine will help to clarify the distinctions between them. Consider an example based on the following question: "What percentage of U.S. physicians will use computer diagnostic services by 1985?" (See *The Futurist* 6:24.)

1. *Intuition.* In a workshop involving physicians and computer experts and based on subjective judgment, a speaker predicts that by 1985 approximately 65% of U.S. physicians will employ computers based on increasing experimentation in automation.
2. *Trend extrapolation.* The percentage of physicians using diagnostic services increased from 4% to 27% over the past fifteen years. Continuing that trend would suggest that some 65% of physicians will employ computer diagnosis by 1985.
3. *Trend correlation.* A forecast might be based on data showing that the percentage of physicians having access to computer consultation is closely linked to three other factors: increased group practice, coverage by

insurance, and the number of physicians graduating from schools with computer instruction. Projections of these three factors have been made through 1985 and form a basis for predicting computer applications.

4. *Modeling and simulation.* Trend correlation can be extended to include integration of a complex computer model consisting of many equations representing different trends (e.g., physician work loads, specialization, consultative service, cost of computer services, etc.). Using various combinations of variables, one can draw a general picture for the year 1985.

These methods share the common deficiency of being passive and incapable of including unexpected developments, innovations, or changing values.

Group Consensus (Delphi Technique)

Wise leaders have always sought the advice and guidance of "experts." For this purpose an expert is defined as an individual whose judgment has proved better than average in anticipating likely events. The combined opinion of several experts should be more reliable than the views of a single one, but one strong personality in a group may dominate wiser heads. The Delphi Technique is one approach for combining the opinions of many experts without a face-to-face confrontation, thereby eliminating persuasion as an overriding factor. A group of possible or technological accomplishments are first described in questionnaires to a group of selected experts. They are asked to estimate the time at which these developments are most likely to occur in the future. The responses are collated, and the results of the initial inquiry are then mailed back to the same group of experts. This provides an opportunity for them to reconsider their opinion in light of the opinions of others. After a series of iterations of this process the range of dates within which the particular developments are expected to occur are presented by standard diagrams. An application of this technique is illustrated in Figure 1.4, derived from a study of developments in medicine by A. Douglas Bender and his colleagues.⁷ A geometrical figure, shaped roughly like a hip-roofed building with a peak near the center, is constructed to illustrate the range of projected dates for the anticipated accomplishment. The highest point of the figure indicates the most frequent (median) estimate. The highest level of confidence is

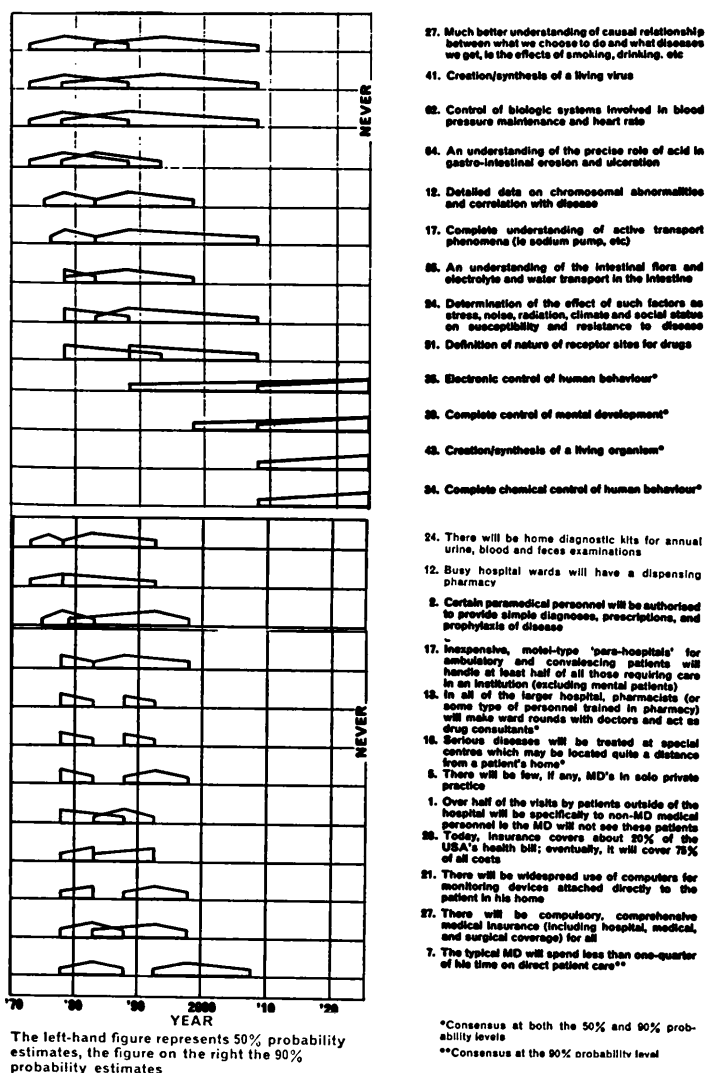


Figure 1.4 A consensus of expert opinion regarding the likelihood of various future developments in medicine as obtained by the Delphi Technique. The times at which the developments listed on the right will reach fruition are indicated at the 50% and 90% probability levels by geometrical figures spanning the next fifty-odd years. The upper and lower 25% of the estimates are eliminated, producing the blunted extremes. The peak of each geometrical figure indicates the median value. These are representative examples from a larger study by A. Douglas Bender and coworkers.⁷

obtained in those predictions of technical and technological advances for which background information is already at hand. This is clearly the case in the examples illustrated in Figure 1.4.

Consensus regarding future developments could be completely upset by new discoveries or innovations that have not yet been even considered. Despite these limitations there is a growing interest in and utilization of consensus techniques of various sorts to strengthen our ability to plan more effectively for the future.

Limits to Forecasting

Peering into the future becomes progressively more important and yet increasingly difficult with the passage of time. Despite notable progress in developing new and improved forecasting techniques the details of the future are still obscured by clouds of uncertainty. Marking out the best path between the many immediate barriers to the future is a task that still defies both the traditional and the newer techniques. Trend extrapolation, modeling, and group consensus (Delphi) have, however, demonstrated reliability and improved consistency in predicting technological developments on the basis of current knowledge.

Hazards of Prophecy

Examining some of the underlying reasons for the failure of past prophets, Arthur C. Clarke⁸ concluded that the inability of competent men to predict what is technologically possible and impossible results from two main factors, which he terms "failure of nerve" and "failure of imagination."

Failure of nerve seems to be the more common problem. Even when all relevant facts are available, forecasters may be so blinded by imagined dangers or so set in their present ways that they deny the conclusion to which the facts seem inevitably to lead. For example, when the first locomotives were being contemplated, dire predictions were often voiced that suffocation would threaten anyone traveling faster than 30 miles an hour, and more recently the possibility of breaking the sound barrier was denied because of the putative ill effects of supersonic flight. Edison opposed the introduction of alternating current, steadfastly insisting that

direct current was the only sensible way to transmit electrical power. And failure of nerve can also be held responsible for the fact that so many of the world's leading authorities disclaimed any suggestion that human flight might be possible, much less the successful transmission of humans to the moon.

Clarke concluded that anything theoretically possible will be achieved in practice *if it is desired enough*. To avoid the failure of nerve that has plagued man's past history it is necessary to retain confidence in the ingenuity of mankind. It is harder to get around failure of imagination, since no one can predict a development that has not yet been conceived. On all sides we see classes of inventions that could easily have been understood or predicted by the great thinkers of the past as intuitive possibilities. Benjamin Franklin, Leonardo da Vinci, and Archimedes would not have been startled by a steam engine or a helicopter. They would have been utterly amazed at the reality of a television set, a computer, or a nuclear reactor.

The contrast between predictable developments and those that cannot be anticipated is suggested by the representative lists in Table 1.1. There are many modern accomplishments that would have been inconceivable in 1900. Looking ahead, it is surprisingly difficult to clearly distinguish possible future developments from the "utterly impossible."

Table 1.1

The Expected	The Unexpected
automobiles	x-rays
flying machines	nuclear energy
steam engines	radio, television
submarines	electronics
spaceships	photography
telephones	sound recording
robots	quantum mechanics
death rays	relativity
transmutation	transistors
artificial life	masers, lasers
levitation	superconductors, superfluids
telepathy	atomic clocks, the Mössbauer effect
	determining the composition of celestial bodies
	dating the past (carbon 14, etc.)
	detecting invisible planets
	the ionosphere, Van Allen belts

After Arthur C. Clarke.⁸

Unpredicted Innovations

The most important obstacle to accurate prediction of the future is, then, the fact that one cannot fully anticipate those revolutionary discoveries that change the course of history in fundamental ways. For example, totally accidental observations have resulted in such fundamental discoveries as x-rays, penicillin, and electricity. To make the assumption that our future is totally dependent upon our current level of knowledge without considering the possibility of totally new and revolutionary discoveries is a serious failure of imagination. A backward look provides ample assurance that new discoveries will be made with even greater frequency in the future.

Even more significant is the prospect that the conversion of new discoveries into useful commercial devices and innovations will continue to occur with shorter and shorter time lags. John McHale⁹ has presented a graphic representation of the progressive shortening of the time elapsing between discoveries and applications in the physical sciences (Figure 1.5). The interval between the discovery of principles and the utilization of photography was 112 years, while the telephone and electric motor required 56 and 65 years respectively. A progressive shortening of the lag times for the conversion of basic discoveries into useful applications has occurred with radio, x-rays, radar, and television. Huge amounts of talent and resources were focused on the development of the atomic bomb only six years after nuclear fission was demonstrated, and, more recently, transistors were commercially produced some three years after their first experimental demonstration and have greatly influenced the entire electronics industry.

The explosive expansion of scientific information is still occurring in myriad basic and applied research-and-development laboratories. The rapid conversion of new knowledge into new technology is as clearly evident in medicine as in other segments of our society. Our long-range plans must not neglect the probability that technological advances, currently beyond our power to foresee, may greatly simplify and improve the various processes involved in data acquisition, information management, and the diagnosis, therapy, monitoring, and management of acute and chronic illnesses. For these reasons the passive projection of coming

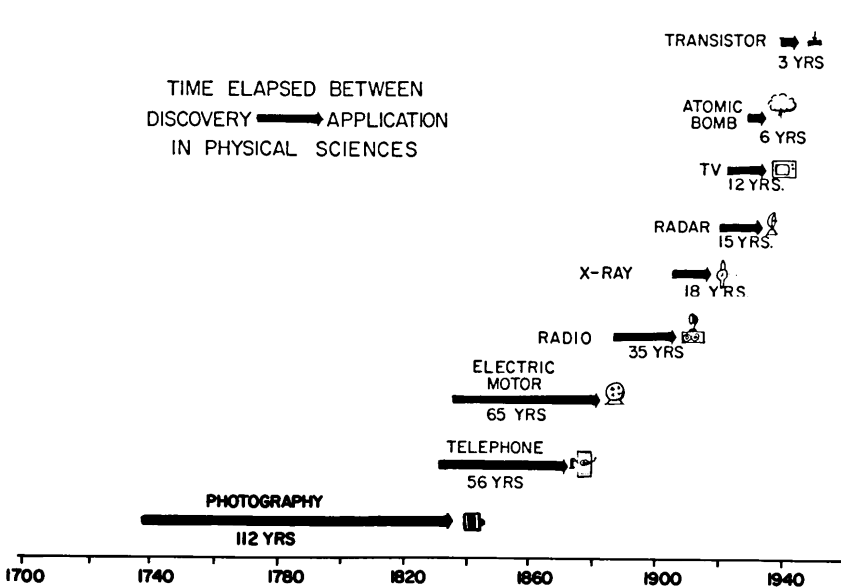


Figure 1.5 Projecting future possibilities is complicated by the accelerating transition of new discoveries into practical applications. The lag time from demonstrated feasibility to commercial production has been reduced from more than one hundred years for photography to less than three years for transistors. Redrawn from John McHale's *World Facts and Trends*.⁹

events from current trends limits the effectiveness of long-range planning.

Summary

During the past few decades amazing progress has been made in the application of scientific medicine and surgery to the diagnosis and effective therapy of an expanding array of diseases and disabilities. During this same period, however, the general public has demonstrated an increasing disenchantment with the present health-care delivery system.

Major causes of public criticism can be traced to exaggerated expectations and to the loss of personal support and individual concern that has accompanied specialization. Indeed the medical triumphs and technical spectaculars of the past few decades have been so impressive and

so widely acclaimed that the general public now seems to believe that any ailment can be alleviated or cured by the ministrations of health professionals. But there is overwhelming evidence that, although many of the most common ailments may be relieved symptomatically, their courses cannot be significantly altered by entering the health-care delivery system. The present priorities for research and development are heavily oriented toward the "leading causes of death" and some other "most-favored diseases," such as cancer, heart disease, stroke, cystic fibrosis, multiple sclerosis, sickle-cell anemia, and a few others. Major technological strides have resulted from this concentration of resources, including such innovations as heart-lung machines, artificial kidneys, and coronary-care units.

Such innovations are to be welcomed, but they have brought in their wake unexpected problems in terms of the overall structure of the health-care system. To avoid unexpected complications of current decisions and future accomplishments, accurate projections of future developments are of great and growing importance. Some newly developed techniques of future forecasting are under intensive study, including trend extrapolation, model simulation, and group-census techniques.

These approaches help to provide perspective, but there are many barriers to accurate prophecy. Failure of nerve can blind us to the drift of facts, and failure of imagination can cause us to miss the unexpected developments that so often prove to be of fundamental importance. In addition, the rate of accumulation of knowledge and of scientific progress always tends to exceed expectations. Finally, present methods of prediction are totally incapable of predicting major shifts in social, economic, and political attitudes. A more effective approach to long-range planning is sorely needed for future health-care delivery. One possibility is the concept of *creating desirable futures*, which will be presented in the next chapter.

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