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INTRODUCTION

This book is a picture of the world in 2025, as shaped by science and technology and based on forecasts and assumptions about that future world.

Four enabling technologies will be central to shaping the world of 2025, each introducing capabilities that will extend far beyond their immediate applications to effect a network of change throughout society, much in the way that the introduction of the electric light and the automobile at the turn of the century powerfully shaped today's world. These four drivers of change are *information technology, materials technology, genetics,* and *energy technology.*

A fifth primary driver of change, *environmentalism,* represents not new capabilities, but a changing worldwide orientation. An emerging pattern of attitudes and beliefs about sustainability and uses of the Earth will direct the shape of the future as powerfully as any of the four enabling technologies.

The world of 2025 can be broken down into three broad population groups: World 1, including the affluent advanced nations of Europe, the United States, and Japan; World 2, the middle, making up the bulk of the world's population, whose immediate needs and resources will be in relative balance; and World 3, the destitute nations, those on the brink of starvation, living with the constant threat of disaster. It is useful to categorize countries within one of these three groups, bearing in mind that by 2025 a worldwide middle class will have emerged, represented to some extent in every society. In many of the middle-income and destitute nations, an affluent few will make up a thin crust living essentially like those of World 1. World 1 countries may have a corresponding but thin bottom layer of abjectly poor.

The following columns show the projected population growth of the three worlds by 2025.

World	1994	2025
Total	5.6 billion	8.4 billion
World 1	1.0 billion	1.3 billion
World 2	3.5 billion	5.1 billion
World 3	1.1 billion	2.0 billion

The chapters that follow emphasize the character and quality of future life in the advanced World 1 nations, particularly in the United States, with some discussion of the midrange, World 2, and poorest nations, World 3. In the text, World 1 is frequently referred to as the *affluent* world, World 2, as the *middle* world and World 3 as the *destitute* world.

About Economics

Any change from old to new or any modification in the way a society behaves must have economic consequences, and also must be limited by economic considerations. Readers may be surprised that we give relatively little attention to the economics of transition from the world of today to that of 2025. Three points are important to consider:

1. The more radical a transition, the more speculative and conjectural are its economics. For instance, it is certain that genome research and its outcomes will stimulate a huge volume of biomedical, biochemical, and physiological research, but it would be difficult to make any plausible estimate of cost and return based on that research. Not all possibilities will be realized, as competition among alternatives gives the edge to some choices over others.

2. Many of the most important factors of change are caught up in intrinsic uncertainty that blunts the significance of any economic discussion and would distract the reader's attention from the powerful forces driving the future. For example, we live in a world that is a network of public and private, market and controlled, independent and subsidized productions and applications of energy. Choices in energy are driven not only by economic considerations, but also by social and political concerns, making it difficult to tease out a plausible *economic* analysis of what might happen to energy in the future.

3. The choices and futures that we describe are more strongly driven by the basic condition of the economy—recession, depression, growth, or boom—than by particular microeconomic choices.

Compound interest is a powerful factor in change. With regard to the macroeconomic state of the United States, we have chosen a midcourse assumption (rejecting both a permanent depression model of Gross Domestic Product (GDP) growth (0% to 1%), and a permanent boom model (3% - 4%

growth)). We assume that economic growth on a *per capita* basis will be about 2 to 2.5%.

That assumed rate suggests that real *per capita* income will double from 1995 to 2025 and, further, that there will be increasing discretionary funds available to individuals, families, public institutions, and government. A substantial portion of this new discretionary income, we believe, will be used to deal with accumulated problems of the past, such as decaying infrastructure and environmental lesions, and to invest in the new alternatives described in *2025.*

The table "Rapid Growth Is Possible" shows the 25-year history of several countries that, in 1996, are clear economic successes. Korea and Portugal, having started from different bases and with strikingly different growth rates, now have roughly the same *per capita* income. Japan—a stellar economic success by any measure, its 1995-1996 performance notwithstanding—has averaged only 4% growth over the past quarter century. Hong Kong, Singapore, and South Korea have run 6.2% to 7.1% annual growth.

Rapid Growth Is Possible: Countries with High GNP/Capita Growth Rates 1965-1990

Country	GNP per capita 1990 U.S. Dollars	Avg. Annual Growth Rate (%) 1965 - 1990
Peoples Republic of China	370	5.8
Indonesia	570	4.5
Thailand	1,420	4.4
South Korea	5,400	7.1
Singapore	11,160	6.5
Hong Kong	11,490	6.2
Japan	25,430	4.1
Portugal	4,900	3.0
World	4,900	1.5

Source: *World Development Report 1992*, World Bank, Oxford Univ. Press, New York, Table 1.

Ultimately, economic choices lie at the core of every discussion about the future. But it is important to realize that the explicit and implicit outcomes described in the chapters that follow do not call for unprecedented, revolutionary patterns of economic development. They are entirely plausible given only the modest 2% to 2.5% growth anticipated for the United States between 1995 and 2025.

Throughout *2025,* costs are given in 1995 U.S. dollars except where otherwise noted.

Where This Book Came From and 107 Assumptions We Make About the Future

2025 emerged from the second phase of a project conducted by Coates and Jarratt, Inc., a Washington, D.C., think tank specializing in the study of the future. The first phase of the project, completed in 1993, organized and analyzed forecasts made from 1970 through 1992 in virtually every subdiscipline of science, technology, and engineering.

> A *forecast* is a simple or complex look at the qualities and probabilities of a future event or trend. Futurists differentiate between the *forecast,* which is generally not point-specific to time or place, and the *prediction,* a specific, usually quantitative statement about some future outcome.

In the second phase of the project we created fresh forecasts, examining how diverse technologies from brain science to information technology might interact to influence every aspect of life in the year 2025. Those forecasts are the topic of this book. They appear in the subsequent chapters as scenarios of 2025. To build these scenarios we assume specific scientific, technological, demographic, social, and other changes will occur. These assumptions are included in this introduction.

Assumptions about the future are not like assumptions in a geometry exercise; they are not abstract statements from which consequences can be drawn with mathematical certitude and precision. They are highly probable statements about the future, forming a framework around which less certain ideas can be tested. We need to make assumptions about the future in order to plan it, prepare for it, and prevent undesired events from happening. Here, we built 15 scenarios of 2025 based on 107 assumptions that we made about the future.

Some of these statements are drawn from the project. Others, such as the estimates of future population, come from public or highly credible private statistical and mathematical analyses of trends. Still others result from integrating a wide range of material; one such assumption is that we will be moving toward a totally managed globe. To present the underlying arguments supporting each of these highly reliable statements (which amount to forecasts) would require a massive introductory section. We have, therefore, presented these statements about the future as simply and in as straightforward a manner as possible.

A few of these assumptions have a normative, or goals-oriented, aspect to them. The assumption, for example, that *per capita* energy consumption in the advanced nations will fall to 66% of the 1990 level is definitely not a trend extrapolation but a judgment about the confluence of social, political, economic, environmental, technological, and other concerns. Readers are urged to formulate and review alternatives that might characterize the next 30 years

and test how those alternatives affect any other thoughts, concepts, beliefs, or conclusions about the future.

What follows is an inventory of high probability statements about the year 2025 in three categories:

A. Scientific discoveries and research, and technological developments and applications.

B. Contextual, that is, those factors forming the social, economic, political, military, environmental, and other factors that will shape or influence scientific and technological developments. These contextual areas form the environment for the introduction and maturation of new products, processes, and services in society.

C. Twenty-four additional high-probability statements that have slightly less probability of occurring.

These high-probability forecasts, especially the first 83, become assumptions in understanding how any particular area may develop under the influence of new scientific, technological, social, political, or economic developments. It would be nice to suggest that these developments are inevitable, but few developments are. Nonetheless, the convergence of evidence indicates that these 107 developments are of such high likelihood that they form an intellectual substructure for thinking about any aspect of the year 2025.

The reader need not accept all these assumptions or high-probability statements in order to find interest and value in the scenarios. The set is rich and robust enough that the reader may reject several or even many of them without undercutting the overall vision of the future in chapters 2-16.

Managing our World

1. Movement toward a *totally managed environment* will be substantially advanced at national and global levels. Oceans, forests, grasslands, and water supplies will make up major areas of the managed environment. Macroengineering—planetary-scale civil works—will make up another element of that managed environment. Finally, the more traditional business and industrial infrastructure—telecommunications, manufacturing facilities, and so on—will be a part of managed systems and subsystems.

Note that total management does not imply full understanding of what is managed. But expanding knowledge will make this management practical. Total management also does not imply total control over these systems.

2. Everything will be smart, that is, responsive to its external or internal environment. This will be achieved either by embedding microprocessors and associated sensors in physical devices and systems or by creating materials that are responsive to physical variables such as light, heat, noise, odors, and electromagnetic fields, or by a combination of these two strategies.

Managing Human Health

3. All human diseases and disorders will have their linkages, if any, to the human genome identified. For many diseases and disorders, the intermediate biochemical processes that lead to the expression of the disease or disorder and its interactions with a person's environment and personal history will also be thoroughly explored.

4. In several parts of the world, the understanding of human genetics will lead to explicit programs to enhance people's overall physical and mental abilities—not just to prevent diseases.

5. The chemical, physiological, and genetic bases of human behavior will be generally understood. Direct, targeted interventions for disease control and individual human enhancement will be commonplace. Brain-mind manipulation technologies to control or influence emotions, learning, sensory acuity, memory, and other psychological states will be in widespread use.

6. In-depth personal medical histories will be on record and under full control of the individual in a medical smart card or disk.

7. More people in advanced countries will be living to their mid-80s while enjoying a healthier, fuller life.

8. Custom-designed drugs such as hormones and neurotransmitters (chemicals that control nerve impulses) will be as safe and effective as those produced naturally within humans or other animals.

9. Prostheses (synthetic body parts or replacements) with more targeted drug treatments will lead to radical improvements for people who are injured, impaired, or have otherwise degraded physical or physiological capabilities.

Managing Environment and Resources

10. Scientists will work out the genome of prototypical plants and animals, including insects and microorganisms. This will lead to more-refined management, control, and manipulation of their health and propagation, or to their elimination.

11. New forms of microorganisms, plants, and animals will be commonplace due to advances in genetic engineering.

12. Foods for human consumption will be more diverse as a result of agricultural genetics. There will be substantially less animal protein in diets in advanced nations, compared with the present. A variety of factors will bring vegetarianism to the fore, including health, environmental, and ethical trends.

13. There will be synthetic and genetically manipulated foods to match each individual consumer's taste, nutritional needs, and medical status. Look for "extra-salty (artificial), low-cholesterol, cancer-busting french fries."

14. Farmers will use synthetic soils, designed to specification, for terrain restoration and to enhance indoor or outdoor agriculture.

15. Genetically engineered microorganisms will do many things. In particular, they will be used in the production of some commodity chemicals as well as highly complex chemicals and medicines, vaccines, and drugs. They will be widely used in agriculture, mining, resource up-grading, waste management, and environmental cleanup.

16. There will be routine genetic programs for enhancing animals used for food production, recreation, and even pets. In less developed countries, work animals will be improved through these techniques.

17. Remote sensing of the earth will lead to monitoring, assessment, and analysis of events and resources at and below the surface of land and sea. In many places, *in situ* sensor networks will assist in monitoring the environment. Worldwide weather reporting will be routine, detailed, and reliable.

18. Many natural disasters, such as floods, earthquakes, and landslides, will be mitigated, controlled, or prevented.

19. *Per capita* energy consumption in the advanced nations will be at 66% of *per capita* consumption in 1990.

20. *Per capita* consumption in the rest of the world will be at 160% of *per capita* consumption in 1990.

21. Resource recovery along the lines of recycling, reclamation, and remanufacturing will be routine in all advanced nations. Extraction of virgin materials through mining, logging, and drilling will be dramatically reduced, saving energy and protecting the environment.

22. Restorative agriculture (i.e., "prescription" farming) will be routine. Farmers will design crops and employ more-sophisticated techniques to optimize climate, soil treatments, and plant types.

Automation and Infotech

23. There will be a worldwide, broadband network of networks based on fiber optics; other techniques, such as communications satellites, cellular, and microwave will be ancillary. Throughout the advanced nations and the middle class and prosperous crust of the developing world, face-to-face, voice-to-voice, person-to-data, and data-to-data communication will be available to any place at any time from anywhere.

24. Robots and other automated machinery will be commonplace inside and outside the factory, in agriculture, building and construction, undersea activities, space, mining, and elsewhere.

25. There will be universal, on-line surveys and voting in all the advanced nations. In some jurisdictions, this will include voting in elections for local and national leaders.

26. Ubiquitous availability of computers will facilitate automated control and make continuous performance monitoring and evaluations of physical systems routine.

27. The ability to manipulate materials at the molecular or atomic level will allow manufacturers to customize materials for highly specific functions such as environmental sensing and information processing.

28. Totally automated factories will be common but not universal for a variety of reasons, including the cost and availability of technology and labor conflicts.

29. Virtual-reality technologies will be commonplace for training and recreation and will be a routine part of simulation for all kinds of physical planning and product design.

30. In text and—to a lesser extent—in voice-to-voice telecommunication, language translation will be effective for many practically-significant vocabularies.

31. Expert systems, a branch of artificial intelligence, will be developed to the point where the learning of machines, systems, and devices will mimic or surpass human learning. Certain low-level learning will evolve out of situations and experiences, as it does for infants. The toaster will "know" that the person who likes white bread likes it toasted darker, and the person who chooses rye likes it light.

32. The fusion of telecommunications and computation will be complete. We will use a new vocabulary of communications as we *televote, teleshop, telework*, and *tele-everything*. We'll *e-mail*, *tube*, or *upload* letters to Mom. We'll go *MUDing* in cyberspace and mind our *netiquette* during virtual encounters.

33. Factory-manufactured housing will be the norm in advanced nations, with prefabricated modular units making housing more flexible and more attractive, as well as more affordable.

34. In the design of many commercial products such as homes, furnishings, vehicles, and other articles of commerce, the customer will participate directly with the specialist in that product's design.

35. New infrastructures throughout the world will be self-monitoring. Already, some bridges and coliseums have "tilt" sensors to gauge structural stress; magnetic-resonance imaging used in medical testing will also be used to noninvasively examine materials for early signs of damage so preventive maintenance can be employed.

36. Interactive vehicle-highway systems will be widespread, with tens of thousands of miles of highway either so equipped or about to be. Rather than reconstruct highways, engineers may retrofit them with the new technologies.

37. Robotic devices will be a routine part of the space program, effectively integrating with people. Besides the familiar robotic arm used on space shuttles, robots will run facilities in space operating autonomously where humans are too clumsy or too vulnerable to work effectively.

38. Applied economics will lead to a greater dependency on mathematical models embodied in computers. These models will have expanded capabilities and will routinely integrate environmental and quality-of-life factors into economic calculations. One major problem will be how to measure

the economic value of information and knowledge. A Nobel Prize will be granted to the economist who develops an effective theory of the economics of information.

Population Trends

39. World population will be about 8.4 billion people.

40. Family size will be below replacement rates in most advanced nations but well above replacement rates in the less-developed world.

41. Birth control technologies will be universally accepted and widely employed, including a market for descendants of RU-486.

42. World population will divide into three tiers: at the top, World 1, made up of advanced nations and the world's middle-classes living in prosperity analogous to Germany, the United States, and Japan; at the bottom, World 3, people living in destitution; and in the middle, World 2, a vast range of people living comfortably but not extravagantly in the context of their culture. We use the terms *World 1*, *World 2*, and *World 3* for the emerging pattern of nations that moves us beyond the post-World War II nomenclature.

43. The population of World 1's advanced nations will be older, with a median age of 42.

44. The less-developed Worlds 2 and 3 will be substantially younger but will have made spotty but significant progress in reducing birth rates. However, the populations of these countries will not stop growing until sometime after 2025.

45. The majority of the world's population will be metropolitan, including people living in satellite cities clustered around metropolitan centers.

46. A worldwide middle class will emerge. Its growth in World 2 and to a lesser extent in World 3 will be a powerful force for political and economic stability and for some forms of democracy.

Worldwide Tensions

47. There will be worldwide unrest reflecting internal strife, border conflicts, and irredentist movements. But the unrest will have declined substantially after peaking between 1995 and 2010.

48. Under international pressures, the United Nations will effectively take on more peace*making* to complement its historic peace*keeping* role.

49. Supranational government will become prominent and effective, though not completely, with regard to environmental issues, war, narcotics, design and location of business facilities, regulation of global business, disease prevention, workers' rights, and business practices.

50. Widespread contamination by a nuclear device will occur either accidentally or as an act of political/military violence. On a scale of 1 to 10 (with Three Mile Island a 0.5 and Chernobyl a 3), this event will be a 5 or higher.

51. Increasing economic and political instabilities will deter business involvement in specific World 3 countries.

52. Despite technological advances, epidemics and mass starvation will be common occurrences in World 3 because of strained resources in some areas and politically motivated disruptions in others.

53. There will be substantial environmental degradation, especially in World 3. Governments will commit money to ease and correct the problem, but many will sacrifice long-term programs that could prevent the problem from happening in the first place.

54. There will be shifts in the pattern of world debtor and creditor countries. Japan's burst economic bubble, the ever-growing U.S. debt, and Germany's chronic unemployment problems are harbingers of things to come.

55. NIMBY ("Not In My Back Yard") will be a global-scale problem for a variety of issues, ranging from hazardous-waste disposal to refugees to prisons to commercial real-estate ventures.

56. Migration and conditions for citizenship throughout the world will be regulated under new international law.

57. Terrorism within and across international borders will continue to be a problem.

The Electronic Global Village

58. Global environmental management issues will be institutionalized in multinational corporations as well as through the United Nations and other supranational entities.

59. A global currency will be in use.

60. English will remain the global common language in business, science, technology, and entertainment.

61. Schooling on a worldwide basis will be at a higher level than it is today. Education may approach universality at the elementary level and will become more accessible at the university level through distance education technologies.

62. In the advanced nations, life-long learning will be effectively institutionalized in schools and businesses.

63. There will be substantial, radical changes in the U.S. government. National decisions will be influenced by electronically assisted referenda.

64. Throughout the advanced nations, people will be computer literate and computer dependent.

65. Worldwide, there will be countless virtual communities based on electronic linkages.

66. There will be a worldwide popular culture. The elements of that culture will flow in all directions from country to country. In spite of the trend toward "demassification" in both information and production, the global links of communications and trade will ensure that ideas and products will be *available* to all whether they like it or not.

67. The multinational corporation will be the world's dominant business form.

68. Economic blocs will be a prominent part of the international economy, with many products and commodities moving between these porous blocs. The principal blocs will be Europe, East Asia and the Americas.

69. Universal monitoring of business transactions on a national and international business basis will prevail.

70. Identification cards will be universal. Smart cards will contain information such as nationality, medical history (perhaps even key data from one's genome), education and employment records, financial accounts, social security, credit status, and even religious and organizational affiliations.

Public Issues and Values

71. Within the United States there will be a national, universal health care system.

72. In the United States, the likely collapse of the Social Security system will lead to a new form of old-age security such as one based on need-only criteria.

73. Genetic screening and counseling will be universally available and its use encouraged by many incentives and wide options for intervention.

74. There will be more recreation and leisure time for the middle class in the advanced nations.

75. The absolute cost of energy will rise, affecting the cost of transportation. Planners will reallocate terrain and physical space to make more-efficient use of resources. In other words, cities will be redesigned and rezoned to improve efficiencies of energy in transportation, manufacturing, housing, etc.

76. There will be a rise in secular substitutes for traditional religious beliefs, practices, institutions, and rituals for a substantial portion of the population of the advanced nations and the global middle class. The New Age movement, secular humanism, and virtual communities built on electronics networking are a few harbingers.

77. Socially-significant crime—i.e., the crimes that have the widest negative effects in the advanced nations—will be increasingly economic and computer-based. Examples include disruption of business, theft, money laundering, introduction of maliciously false information, and tampering with medical records, air traffic control or national-security systems.

78. Tax filing, reporting, and collecting will be computer-managed.

79. Quality, service, and reliability will be routine business criteria around the globe.

80. Customized products will dominate large parts of the manufacturing market. Manufacturers will offer customers unlimited variety in their products.

81. Economic health will be measured in a new way, including considerations of environment, quality of life, employment, and other activity and work. These new measures will become important factors in governmental planning.

82. GDP and other macroeconomic measures and accounts will include new variables such as environmental quality, accidents and disasters, and hours of true labor.

83. Sustainability will be the central concept and organizing principle in environmental management, while ecology will be its central science.

Additional, But Slightly Less Probable, Developments by 2025

These next 24 developments have a somewhat lower probability than the 83 basic assumptions. If they do occur, they could have long-term, extensive, startling, or disruptive effects on people and their societies.

1. Telephone communications within the United States and within Europe will be so cheap as to be effectively free.

2. Telecommunication costs will be integrated into rent or mortgage payments.

3. The greening of North Africa will begin, with megatechnologies to promote rain and build soil along the coast.

4. Antarctic icebergs will be harvested for watering the west coast of South America, Baja California, the Australian outback, Saudi Arabia, and other arid areas.

5. Going to work will be history for a large percentage of people. By 2020 or 2025, 40% of the workforce will be working outside the traditional office.

6. The home work/study center will be the centerpiece of the integrated, fully-information rich house and home. Mom and Dad will work there, the kids will reach out to the resources of the world, and the whole family will seek recreation, entertainment, and social contacts there.

7. Inorganic chemistry will rise to parity with organic chemistry in profit and importance in such areas as ceramics and composites.

8. Biomimetic materials and products that imitate natural biological materials will be common.

9. Micromachines the size of a typed period will be in widespread use. Nanotechnological devices 10,000 times smaller will have been developed and will be in use.

10. Radical cosmetics will leave no component of the body or mind beyond makeover. This will be accompanied by a melding of cosmetics, medicine, and surgery.

11. Ocean ranching and farming for food and energy will be widespread.

12. The asteroid watch will become a recognized institution. Among its most notable achievements will be several trial runs at altering an asteroid's path before it intersects Earth's orbit.

13. Moon mining and asteroid harvesting will be in their early stages.

14. Artificial intelligence devices will flower as aids to professionals, as adjuncts to ordinary workers, as doers of routine tasks, as checks on the functionality of software and complex systems, and as teaching and training tools.

15. Privatization of many highways, particularly beltways and parts of the interstate system will occur. This will be tied to the evolution of an intelligent vehicle-highway system.

16. Restoration of aquifers will be a standard technology.

17. Fuel cells will be a predominant form of electromechanical energy generation.

18. Mastodons will walk the Earth again and at least 20 other extinct species will be revived.

19. Biocomputers will be in the early stage of development and applications.

20. Squaring-off of the death curve will make substantial progress in World 1 and some progress in World 2, leading to most people living to 85 years.

21. Critical experiments in life extension to move the average lifetime of our species from 85 to 105, will begin. One hundred thousand people will be in a lifelong monitoring program. Massive numbers of other people will apply the treatments on a nonexperimental basis.

22. 120 mile-per-gallon cars will be in widespread use.

23. Hypersonic air carriers will be common.

24. Brain protheses will be one of the practical applications of brain technology.

Why the Future is Described in Scenarios

The scenario is an effective tool for presenting complex images in a coherent, integrated picture. These scenarios are presented as business reports of the state of the art in 2025, particularly in relation to developments in science and technology in their social context. Each chapter covers a basic social area, such as genetics, manufacturing, food and agriculture, the house and home, and so on. In each chapter we typically introduce a picture of the situation in the United States first, then go on to take a look at the scene in a World 2 and/or World 3 country. We assume that the United States, as a continental economy, has sufficient variation to illustrate almost all issues likely to be faced by the affluent World 1 nations in the future. We pick countries in Worlds 2 and 3 to discuss because the implications of science and technology for their futures often may be strikingly different.

Each scenario chapter ends with two tables that the reader may find interesting to think about in the context of the scenario he or she has just read. One table lists a series of events and actions that, by their occurrence between now and 2025, drive and support the images of the future described in the scenario. Each action or event is assigned a plausible date.

The other table lists from the perspective of the year 2025 hopes and fears for the future that turned out to be unrealized between now and then. Some of these are hopes and fears that we have now. Others arise between now and 2025. The reader is challenged to think about how different the scenario might be if any or all of them had come to pass.

Because we are discussing events and actions that have not yet happened we have also created some organizations and institutions that do not yet exist and given them names and even acronyms. Some of their names may be familiar and only slightly different from their names today. Others may be new to the reader.

The scenarios can be read in any order. Together they form an integrated whole. Readers should feel comfortable about following their own interests in choosing the order in which they read them. The chapters are organized in a sequence that starts with the familiar, house and home, goes on to the four enabling technologies, information, genetics, energy, and materials, then covers the enabling issue—the environment. The next seven chapters are about large structures and systems, such as global management, transportation, and manufacturing. The last two chapters return the reader to personal experience, with social and cultural experience, and work, leisure, and entertainment.

Chapter 1, Introduction, this chapter, sets out and discusses our basic assumptions about the world in 2025 that underlie the scenarios. Chapter 2, Smart Living, takes the reader inside an American home in 2025, and looks at the state of shelter in countries like Egypt. Chapter 3, Information: The Global Commodity, tells how information technology has remade societies and its institutions and systems, like work and criminal justice. Chapter 4, Harvesting the Fruits of Genetics, examines the U.S. lead in genetics and comments on how, in 2025, we are beginning to integrate genetic approaches and solutions into our worldview. Chapter 5, Powering Three Worlds, shows how U.S. energy use *per capita* is declining and that of the rest of the world is rising as a result of population and economic growth. Chapter 6, The World of Things, highlights the revolutionary impacts of advanced materials on our society and the mixed impacts and availability of such materials in poorer societies. Chapter 7, Working Toward a Sustainable World, shows how concern for the environment is evolving into support for sustainability as a fundamental global value. Chapter 8, Managing the Planet, documents the role of the science and technology in enabling us to better manage the natural, built, and social environments. Chapter 9, Putting Space to Work, illustrates how technology and science in space amplifies our knowledge of, and ability to manage, our planet. Chapter 10, Our Built World, is about the developing global infrastructure and the uneven penetration of the more advanced and intelligent infrastructure and construction methods. Chapter 11, People and Things on the Move, looks at some non-automotive alternatives, as well as describing the gradual integration of all travel systems. Chapter 12, The World of Production, paints

a picture of flexible, customized manufacturing systems that produce universal products for the global market and culture-specific products for local markets. Chapter 13, Food: A Quest for Variety and Sufficiency, points out that some of the world's people have a variety of new foods to eat, others get enough to eat but do not have much choice, and a third group faces periodic famine. Chapter 14, Striving for Good Health, describes affluent societies in which health is more important than medicine, and poor countries in which technology augments centrally-directed public health programs. Chapter 15, Our Days and Lifetimes, shows the reshaping of everyday life and lifecycles by physical and social sciences and technology. Chapter 16, Balancing Work and Leisure, describes less work and more leisure for the affluent sectors of the world's population.

We use the metric system in this book, but believing the reader may be more familiar with American measures, we include a conversion table below.

Metric Conversions

Metric Measure	**Equivalent American Measure**	**American Measure**	**Equivalent Metric Measure**
Linear Measure:			
1 centimeter (cm)	0.394 inch (in)	1 in	2.54 cm
1 meter (m)	3.281 feet (ft) 1.094 yards (yd)	1 ft (12 in) 1 yd (3 ft = 36 in)	30.480 cm 91.440 cm (32 m = 35 yds)
1 kilometer (km) (8km = 5 miles approximate)	0.621 mile (mi)	1 mi ("statute mi") = 1760 Yd. (1 nautical mi, International)	1,609.344 m
Surface Measure:			
1 square meter (m^2)	1.196 square yards (sq yd)	1 sq yd (9sq ft)	0.836 m^2
1 hectare (ha)= 100 Ares (a) = 10,000 m^2	2.471 acres	1 acre (4,840 sq yd)	40.469 a = 0.405 ha
1 square kilometer (km^2)	0.386 square miles (sq mi)	1 sq mi (640 acres)	2.590 km^2 - 259.0 ha
Volume and Liquid Measure:			
1 liter (l) - 1,000 cm^3	1.057 U.S.quarts (U.S. qt) 0.264 U.S. gallon (U.S. gal)	1 U.S. qt 1U.S. gal (231 cu in)	0.946 l 3.785 l
1 cubic meter (m^3)	1.308 cubic yd (cu yd)	1 cu yd (27 cu ft)	0.765 m^3
Weights:			
1 gram (g)	0.035 avdp ounces (oz)	1 avdp. oz. (437.5 gr = 1/16 avdp lb)	28.350 g
1 kilogram (kg) kg = 1000 g	2.205 avdp pounds (lb)	1 avdp lb (16 oz)	453.592 g
1 metric ton (t)	1.102 short tons (sh tn)		
To compute Fahrenheit: multiply Centigrade by 1.8 and add 32.			
To compute Centigrade: subtract 32 from Fahrenheit and divide by 1.8.			

How to Use This Book

We expect the reader will finish this book with a sense of being better acquainted with the future—at least better informed about the potential effects of science and technology on our world in the next 25-30 years. As futurists, however, we are aware that there is no single future, that events, trends, and circumstances may lead to slightly or radically different outcomes. We suggest that the reader view this book as a challenge to his or her own assumptions and powers of futures thinking. All our conclusions and images should be tested against the reader's own knowledge, values, and ideas about the future. The great opportunity here is for the reader to integrate this picture of 2025 into a personal future vision and let that vision inform how he or she may begin to shape organizational, personal, or political decisions and actions.