Thinking in Circles About Obesity

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Applying Systems Thinking to Weight Management

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To Nadia: My wife and best friend.

Preface

Today's children may well become the first generation of Americans whose life expectancy will be shorter than that of their parents. The culprit, public health experts agree, is obesity and its associated health problems.

Heretofore, the strategy to slow obesity's galloping pace has been driven by what the philosopher Karl Popper calls "the bucket theory of the mind." When minds are seen as containers and public understanding is viewed as being a function of how many scientific facts are known, the focus is naturally on how many scientific facts public minds contain. But the strategy has not worked. Despite all the diet books, the wide availability of reduced-calorie and reduced-fat foods, and the broad publicity about the obesity problem, America's waistline continues to expand. It will take more than food pyramid images or a new nutritional guideline to stem obesity's escalation.

Albert Einstein once observed that the significant problems we face cannot be solved at the same level of thinking we were at when we created them, and that we would have to shift to a new level, a deeper level of thinking, to solve them. This book argues for, and presents, a different perspective for thinking about and addressing the obesity problem: a *systems thinking* perspective. While already commonplace in engineering and in business, the use of systems thinking in personal health is less widely adopted. Yet this is precisely the setting where complexities are most problematic and where the stakes are highest. Though the tools and concepts associated with systems thinking are new and advanced, the underlying worldview is extremely intuitive. Even young children can learn systems thinking very quickly.

This book aims to apply systems thinking to personal health in a form that is accessible to the general reader, with the hope that it will have a profound influence on how ordinary people think about and manage their health and well-being. The book is written to help the following readers:

- Individuals seeking to better understand how to control/manage their bodies and their well-being.
- Parents who need to address the systemic, long-term risks of this complex but slowly developing threat before children get trapped in lifestyles that ultimately result in chronic obesity.
- Public policy makers who need to move beyond the *infomercial* model to prevention, that is, aiming to stuff people's "mental buckets" with nutritional guidelines and food pyramid images, to a customized knowledge *restructuring* model—one that challenges people's deeply ingrained assumptions about health risk and well-being.

The Book's Outline

The book has five parts. Part I is an introductory discussion of the problem's scope and its burden (on people and society), and the argument for a *different* way of thinking.

Part II traces the development of the epidemic and delineates its multiple causes. One of the few reasonably reliable facts about the obesity epidemic is that it started in the early 1980s. We need to understand why. The trigger that induced obesity's escalation was not a single factor (e.g., a sudden upsurge in moral failure), but rather the confluence of multiple socioeconomic and technological factors.

Parts III and IV focus on the solution. Reducing the national waistline will require a major shift in thinking about managing our instincts and our environment; motivation alone is not going to be enough. Effective self-regulation of health behavior, as with the regulation of any dynamic system (whether it is the energy regulation of our bodies or the energy regulation of an atomic reactor), requires two essential skills: understanding and prediction. Part III focuses on understanding—helping people think systematically about the inner workings of human weight/energy regulation so that they can better manage their own bodies and health.

Part IV discusses prediction. While understanding helps us look *backward* to make sense of the past (e.g., explaining weight gain), we need prediction to look *forward* (e.g., to devise treatment strategies and assessing treatment outcomes). The ability to infer a system's behavior is essential if we are to know how actions influence the system, and thus is essential in devising appropriate interventions for change. Perfect understanding without a capability to predict the system's behavior is of little practical utility. The two skills—understanding and prediction—are needed together.

Part V discusses prevention. While the attention to the treatment of obesity has heretofore overwhelmed that given to prevention, interest in obesity prevention is attracting increasing attention because of the growing realization that it may be easier, less expensive, and more effective to change behavior, so as to prevent weight gain or to reverse small gains, than to treat obesity after it has fully developed.

The great advances in systems sciences, medicine, and communication technology are converging with another powerful trend: the increase in public initiative, so that people take greater responsibility for their well-being. This is opening enormous possibilities for empowering people with the tools they need for disease prevention and personal health management. Part V discusses the possibilities.

The Story of the Book

The series of events that ultimately led to writing this book are a bit unusual. In the mid-1990s I became extremely interested in the confluence of information and medical technologies, and saw it as one of the most promising new frontiers for system dynamics research and public policy. But I had a lot to learn. So, in 1997, I took an open-ended leave-of-absence and enrolled in the master's program at Stanford University's Engineering Economic Systems and Operations Research Department, where I focused on decision analysis and medical decision making. (Returning to become a master's student while already holding a PhD was certainly a weird experience, for me and for my professors, but it was a lot of fun.) It was during my studies at Stanford that I began to see the natural fit between the obesity problem (as a dynamic system of energy regulation) and system dynamics. (Research was revealing that human bioenergetics belongs to the class of multiloop nonlinear feedback systems, the same class of system that system dynamics aims to study.)

Upon graduation, I spent a year (1999–2000) as an affiliate at Stanford's Medical Informatics Department (part of Stanford's Medical School), where I worked on developing system dynamics models of human physiology and metabolism. In December 2001, I returned to my faculty position at the Naval Postgraduate School where I continued to conduct research on medical decision making and modeling of human metabolism and energy regulation.

I started writing this book in the winter of 2003.

Acknowledgments

Many authors, sitting with keyboard at the ready, must have thought, as I did, of the first few phrases of *Don Quixote*: "Idle reader, you may believe me without any oath that I would want this [work], the child of my brain, to be the most beautiful, the happiest, the most brilliant imaginable. But I could not contravene that law of nature according to which like begets like." If such can be said of Cervantes's brainchild, what can one possibly say about one's own[1]? Only that one has done one's best. And yet, if the truth be told, that "best" may prove to belong as much to certain others as to one's self.

This book is a product of the stimulating environments at three institutions. For twenty years, the Naval Postgraduate School has provided a hospitable environment for my research and writing. I am especially indebted to Dan C. Boger, chairman of the Department of Information Sciences, who fosters camaraderie and an intellectual climate that celebrates bold original thinking that I believe I could not have found elsewhere. My students are not only the country's "fittest" but also our finest. They make going to work every day a lot of fun and have been a source of pride and inspiration. (My only complaint: they are all so "Navy fit" that they proved to be very poor research subjects.)

I have been blessed to have attended two great learning institutions: MIT and Stanford. Among the many people who have contributed to my work and thinking at MIT, I am particularly indebted to Professors Stuart E. Madnick, John Sterman, and John Morecroft.

I have also been fortunate to have had the opportunity to learn from Professor Elizabeth Paté-Cornell at Stanford. She taught me everything I know about risk management, and she is the one who sparked my interest in health prevention.

[1] Konner, M. J. (1982). *The Tangled Wing: Biological Constraints on the Human Spirit.* New York: Holt, Rinehart and Winston.

At Springer I am grateful for the excellent support, genuine enthusiasm, and good cheer of my editor Janice Stern and her tireless assistant Ian Marvinney.

Special thanks to Rena Henderson and David Kaplan, whose editorial suggestions have been invaluable and for teaching me a thing or two about style and clarity.

But there is only one person who has made every single aspect of this book possible—my wife, Nadia. Others have contributed greatly, but nobody could possibly match her encouragement, guidance, commitment, and sacrifices.

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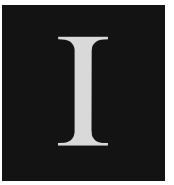

1 Like Boiled Frogs

Today's children may well be the first generation of Americans whose life expectancy will be shorter than that of their parents.[1,2] The culprit, public health experts agree, is obesity and its associated health problems.

For more than a century now, people's weights in the United States have been steadily rising. But the recent rise in obesity that started around 1980 is fundamentally different from past changes. In the early decades of the twentieth century, weights were below levels recommended for maximum longevity, and an increase in weight represented an increase in health, not a decrease.[3] The problem we now face arose because we did not know when to stop. Rather than leveling off, weight gain in the population has continued its rise unabated, leaping beyond healthy levels and leaving them in the dust. Today, Americans are much fatter than medical science recommends, and weights continue to increase. The worry is that if this trend is not reversed, it could start wiping out much of the progress that has been made in preventing some of the other major chronic health problems, such as heart disease, diabetes, and certain cancers.[4]

How the Problem Sneaked Up on Us

As the upward and outward trend in the population's weight and waistline was gradually accelerating in the late 1980s and early 1990s, most public health experts, as well as the public at large, failed to perceive the escalating threat. It is not difficult to see why: unlike old-fashioned communicable diseases such as AIDS, malaria, or tuberculosis, obesity exhibits no immediate symptoms. Initially, obesity affected a few people, and the numbers of the overweight and obese grew slowly enough that we have had time to get used to them.[5] Furthermore, in the 1980s and 1990s the science establishing links among diet, weight, and health was just developing.[6]

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On a personal level, weight gain also seems insidious to most people. And that too is understandable. Unlike the polar bear, people do not get fat by voracious fat eating in a short period.[7] Instead, weight gain typically occurs slowly, over decades. For example, the age-related upward drift in weight for adult men is, on average, only about half a pound per year.[8] Because of a lack of immediate adverse consequences, the early stages of weight gain often go unnoticed or may be viewed as innocuous and inevitable, or even as a sign of maturity.[9] And so a gradual increase in body weight might not be recognized until people are trapped in an unhealthy lifestyle, which can ultimately result in chronic obesity.[10]

It would take years for the nation to take notice. Not until the tail end of the 1990s did we begin to pay much attention to obesity and the effects of a poor diet and a sedentary lifestyle on health and well-being.[11]

Maladaptation to slowly building threats is by no means limited to obesity, and neither is it uncommon. Human beings are exquisitely adapted to recognize and respond to threats to survival that come in the form of sudden, salient events. "We are here today, as a species, because when something went bump in the night in the primeval forest, we noticed and reacted."[12] Our fixation on jolting events, it has been argued, is part of our evolutionary programming.[13] Change that is slow and gradual, however, is less perceptible to our cognitive apparatus. It is why, for example, we are much less likely to notice signs of aging in someone we live with (e.g., spouse or child) than we are in people we see intermittently (e.g., distant relatives). It is not that we are incapable of sensing continuous, gradual change; indeed, we often do. (For example, as a sailor I know I have no problem tracking every change in cloud formation of an approaching storm front while at sea.) But because our attention span is not unlimited, while the number of life's events competing for our attention is quite large, we tune in only to the changes we perceive as particularly important or threatening.[14] In the case of obesity, a lack of immediate adverse consequences often means that it is off our radar screen.

Societal maladaptation to creeping threats has been so pervasive and enduring in human affairs that it has been enshrined in social and public policy circles as the parable of the boiled frog:

> If you place a frog in a pot of boiling water, it will immediately try to scramble out. But if you place the frog in room-temperature water, and don't scare him, he'll stay put. Now, if the pot sits on a heat source, and if you gradually turn up the temperature, something very interesting happens. As the temperature rises from 70 to 80 degrees Fahrenheit, the frog will do nothing. In fact, he will show every sign of enjoying himself. As the temperature gradually increases, the frog will become groggier and groggier, until he is unable to climb out of the pot. Though there is nothing restraining him, the frog will sit there and boil. Why? Because the frog's internal apparatus for sensing threats to survival is geared to sudden changes in his environment, not to slow, gradual changes.[15]

The parable aims to highlight how subtle and insidious gradual change can be, and even if unhealthy and contrary to survival, it nevertheless can be tolerated over time and ultimately take life from the unsuspecting or complacent.

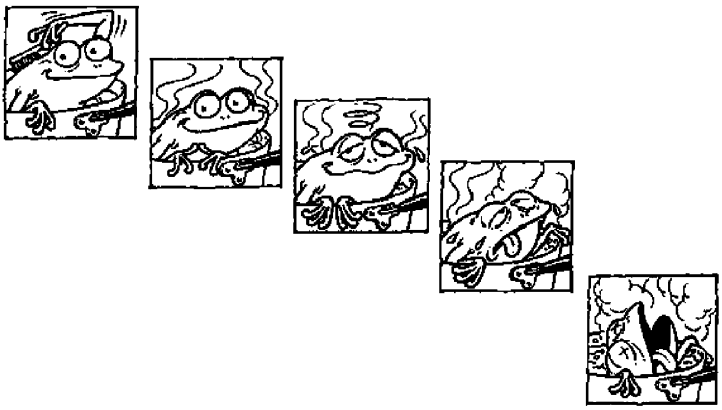

Figure 1.1 The boiled frog. (*Source:* www.crownresearch.com/RIJ.htm)

Early in our evolution as a species, our alertness to jolting threats had some powerful payoffs. The irony today is that the primary threats to our collective survival come not from sudden events but from slow, gradual processes.[16] The rise of religious militancy, environmental decay, global warming, and the depletion of the ozone layer are all slow, gradual threats, as is the growing obesity epidemic.

The Temperature Is Rising

Since 1960, five National Health and Nutrition Examination Surveys have been conducted to track health status and behavior in the United States.[17] Collectively, these surveys are considered the most definitive assessments of Americans' weight because of the duration and size of the studies and because they actually measure people's height and weight. The results of the latest survey (in 2004) reveal that two of every three American adults older than 20 (or 65 percent) are overweight, with a body mass index (BMI) of more than 25. The BMI is calculated as weight in kilograms divided by the square of the height in meters. This compares to fewer than one in four in the early 1960s.[18–19] This means that, currently, there are more than 130 million Americans who are overweight enough to begin experiencing health problems as a direct result of that weight. Even more

concerning, close to half of them (approximately 60 million Americans) are heavy enough to count as clinically obese (with a BMI greater than 30); that is, they are so overweight that their lives will likely be cut seriously shorter by excess fat. A BMI of 30 (the threshold to obesity) roughly means being 30 pounds overweight for an average-height woman and 35 to 40 pounds overweight for an average-weight man.[20]

Not only has the speed at which obesity escalated in the population been alarmingly impressive, but so has its breadth. A recent study by researchers at the Centers for Disease Control and Prevention (CDC) found that "the rate of American obesity was increasing in every state and among both sexes, regardless of age, race, or educational level."[21] It seems hard to believe that a chronic condition like obesity could spread with the speed and breadth of a communicable disease epidemic, but it has.[22]

What is perhaps most ominous of all is that obesity is increasing even more rapidly among children and adolescents than it is among the adult population. Most of today's obese adults were not obese children, accumulating their extra pounds only after they were 25 or 30 years old. "But now we have more and more [young] people who are already obese at the age of 10, 15, or 20."[23] Today there are nearly twice as many overweight children and almost three times as many overweight adolescents as there were in the 1980s. The latest government data show that 30 percent of children and adolescents—about 25 million—are overweight or are at risk of becoming so.[24] That is the highest number ever recorded. All these overweight children and adolescents are on a course to fuel an even bigger national health problem as they mature into obese adults.

Even our pets are not immune. Almost 25 percent of America's dogs and cats are now obese. And the experts are saying our pets are gaining weight for many of the same reasons people do. "They're living longer . . . are often fed too much . . . and are increasingly confined to fenced-in suburbs with shrinking yards. Guilty owners, meanwhile, are showing their love not with walks, but [with] snacks."[25],[26]

If the rate of obesity in the general population continues to increase at the same pace it has for the past two decades, the *entire* U.S. adult population (and its pets) could be overweight within a few generations.[27] This is more than a red flag; this is fireworks going off.[28],[29]

Yet, despite all the grim statistics, obesity has not yet entered America's social consciousness. Rather than seeing a red flag (or fireworks), the general public continues to view obesity as a cosmetic rather than a health problem.[30] A recent study by Harvard University researchers found that most Americans are still not seriously concerned with obesity and do not view it as a major health concern either for the country as a whole or particularly for themselves. The general public's perceptions about health risks were instead found

to be skewed by highly visible and more emotionally charged health issues, such as heart attacks and AIDS, which were ranked far ahead of obesity as the most serious health concerns. Interestingly, more than half the respondents in the Harvard study were overweight, yet few saw their own weight as a serious heath issue.[31]

The Heavy Burden of Obesity

All this would matter less if being overweight were beneficial or, at very least, safe. But in most cases it is neither. While the complications of obesity may not be as dramatic as those of HIV, for example, its burden can affect more people and is a source of far more deaths. According to the CDC, obesity now kills five times as many Americans as microbial agents—that is, infectious diseases.[32] In 2000, the most recent year for which CDC figures are available, obesity accounted for more than 112,000 deaths in the United States.[33] Experts predict that if current trends continue, with Americans smoking less but continuing to get fatter, obesity will soon overtake smoking as the primary preventable cause of death among Americans.[34]

In a new study, a group of Dutch researchers sought to quantify the mortality risk people face from being overweight. Specifically, they sought to assess the years of life lost (YLL) due to obesity, that is, the difference between the number of years one would be expected to live if obese versus not obese. The study was one of a few that actually tracked a group of individuals over an extended period and that helped identify the deleterious effects of obesity on health and longevity in ways that cannot be revealed by "snapshot"-type studies that look at a cross-section of the population at one point in time. Their findings, based on a study of the health history of more than three thousand people over four decades (between 1948 and 1990), were portentously straightforward: getting fat, indeed, kills. And as the degree of overweight increases, the life spans contract. Somewhat of a surprise was the finding by the Dutch researchers that even moderate amounts of excess weight "conferred a noticeable diminution in life expectancy."[35]

Here are some sobering findings from this important study:[36]

- Nonsmokers who were overweight but not obese (which roughly means being 10 to 30 pounds above a healthy weight) lost an average of three years off their lives.
- Obese people (with BMI greater than 30) died even sooner:
  - Obese female nonsmokers lost an average of 7.1 years.
  - Obese male nonsmokers lost 5.8 years.

- For those who were obese *and* smokers, the double burden caused the loss to be significantly higher:
  - Obese female smokers died 7.2 years sooner than normal-weight smokers and 13.3 years sooner than normal-weight nonsmoking women.
  - Obese male smokers lived 6.7 years less than normal-weight smokers, and 13.7 years less than normal-weight nonsmokers.

To put these figures into perspective, just consider that completely eliminating all kinds of cancer in America would add only about 3½ years to life expectancy.[37]

Obesity, it is becoming increasingly clear, exacts such a heavy toll on longevity because it increases the risk of developing many chronic diseases at surprisingly low levels of excess fat—as little as 5 to 10 pounds above desirable body weight.[38] That's because surplus body fat, which was once thought of as little more than an inert storage depot, is, metabolically, a highly active organ, producing hormones and chemical substances that can flood the body, damaging blood vessels, causing insulin resistance, and promoting cancer-cell growth.[39]

A growing number of studies are now allowing us to quantify the links between obesity and coronary heart disease, diabetes, hypertension, and selected cancers, which are the major ailments most frequently associated with obesity.[40] In one recent study, for example, obese individuals were 1.7 times more likely to have heart disease, twice as likely to have hypertension, and three times as likely to have diabetes compared to normal-weight people.[41] Another study that investigated cancer risk found that excessively heavy men and women were three times as likely to develop kidney cancer compared with those of healthy weight, while obese postmenopausal women faced up to a 50 percent higher chance of developing breast cancer than nonobese women.[42]

These obesity-associated health risks increase in direct proportion to increases in a person's weight and the duration of a person's obesity. Research is also revealing that the *distribution* of the body's excess fat—the so-called body fat topology—has a bearing on health risks as well.[43] For example, people who carry excess weight in the abdomen (the so-called apple shape) are more likely to have diabetes and heart disease than are those built like pears, who deposit fat in their hips, thighs, and backsides.[44,45]

As science marches ahead and the methods for studying disease become more sophisticated, we can expect the news about weight and health to grow even worse.[46] New research, for example, already points to a link between excess body weight and the risk of death from most cancers. A recently published study by the American Cancer Society found that the higher a patient's BMI, the greater the risk of cancer death. The researchers attributed

the higher death rates in obese cancer patients to several possible causes. For some patients, the cause was delay in diagnosis. That's because the cancers of obese patients may be under layers of the body fat and, thus, can be harder to detect (a person's fat can literally be too dense for x-rays or sound waves to penetrate). It was also recently found that in men, excessive body fat can suppress the prostate-specific antigen (PSA), the blood protein used to diagnose prostate cancer in its early stages. The resulting delay in diagnosis explains why in obese men, prostate cancer tends to be diagnosed in more advanced stages.[47] For others, the culprit can be biological mechanisms associated with obesity, such as increased levels of certain hormones (sex steroids, insulin, and growth factor I) that are believed to stimulate the growth of nascent cancer cells in various organs.[48]

For Older Americans, The Future Is Now

For obese people in their fifties and sixties, the physical burden of carrying excess weight can interfere with even the most routine activities. Physical tasks, such as climbing stairs, maneuvering into an automobile, sitting comfortably in a chair, and walking any distance, can become difficult and sources of pain and embarrassment.[49] A recent study to assess disability among older Americans (aged 50 to 69) found that difficulties in performing tasks such as bathing, eating, dressing, and getting in or out of bed rise by 50 percent in men who are moderately obese and threefold in those who are severely obese (BMI greater than 35). In women, the likelihood of such problems doubles with moderate obesity and quadruples with severe obesity.[50]

As baby boomers get older and fatter, they are also more likely to develop one of the double burdens of age and weight: arthritis. Survey data from the CDC suggest that the likelihood of experiencing arthritic pain increases fivefold in very obese people aged 60 and older, compared to those who are underweight.[51]

Putting on extra weight may also be far riskier for cognitive dysfunction than most people have imagined. Recent scientific studies have determined that weight gain may lead to degenerative changes in the aging brain and, quite possibly, Alzheimer's disease—a disease that many elderly and their families fear more than death itself.[52]

Such findings fly in the face of widely held assumptions that older Americans are getting healthier and that their disability rates are dropping. Instead, obesity-related ailments may very well be wiping out the recent health gains that the elderly have heretofore enjoyed from reduced exposure to infectious diseases and advances in medical care.

The Sociocultural Burden

Obesity not only affects long-term health and longevity, it is unique among chronic disease risk factors in that it also carries a sociocultural burden.[53] Indeed, to most of its victims it is through psychological pain that obesity has its most noxious effects.[54] The full public health burden of the obesity epidemic must thus be measured not only by the traditional measures of morbidity and mortality, but also by the psychological and social consequences experienced by those who suffer and by those around them.[55]

Using an imaginative new method they called "owning one's disability," two University of Florida (Gainesville) researchers, Rand and MacGregor,[56] sought to quantify the heavy psychological toll that obesity exerts on the psyche. They had patients answer a series of forced-choice questions as to whether they would prefer their current disability to a number of other handicaps.[57] In a sample of formerly severely obese patients who had undergone gastric surgery, Rand and MacGregor found that every single one of the patients they interviewed would prefer to be deaf, dyslexic, diabetic, or to suffer from very bad heart disease than to return to their morbidly overweight status. Ninety percent of the patients also preferred blindness to obesity, and 92 percent preferred having a leg amputated than to return to their overweight state. All patients preferred to be of normal weight than to have "a couple of million dollars" when given a hypothetical choice.

The extensive research done on obese people's quality of life suggests that the obese live in a world that often treats them with notable antipathy.[58] Some observers have gone so far as to characterize the disparagement of overweight and obese individuals as the last socially acceptable form of prejudice[59]—the last, perhaps, but certainly not the latest. "History shows that prejudice against obese individuals is not simply a product of society's current worship of a thin ideal. As early as the 12th century, Buddhists stigmatized obesity as the karmic consequence of moral failing."[60]

The frightening thing is that even small children are not immune from prejudice against the obese. Researchers have found that children "learn" at a very early age to associate obesity with undesirable personal characteristics. In one study, when children as young as 6 to 9 years of age were shown a fat person's silhouette and asked to describe the person's characteristics, they said: "lazy, lying, cheating."[61,62] And when shown black-and-white line drawings of an obese child and children with various handicaps, including missing hands and facial disfigurement, the participants singled out the obese child as the one with whom they least wished to play.[63] It is no wonder that "among the most prevalent consequences of obesity in children is the discrimination that overweight children suffer at the hands of their peers."[64]

Such discrimination is effectively robbing those overweight kids of their childhood, preventing them from doing the same kinds of activities that their leaner peers do.[65]

As children grow older, discrimination against the obese becomes more institutionalized.[66] Society's negative attitudes toward the obese take the form of discrimination in areas such as employment opportunities, college acceptance, and even marriage. In a study of college students, as an example, the eligible bachelors and bachelorettes rated embezzlers, cocaine users, and shoplifters as more suitable marriage partners than obese individuals.[67] Other studies found that obese young women were far less likely to marry than nonobese women, and those who did marry were more likely to marry "down"—that is, to marry someone of a lower social status—than were nonobese women.[68]

Feeling obesity's economic pinch can be even more direct, however. Insurance premiums, for example, rise in proportion to one's girth and could easily be double, triple, or up to five times the normal premium, even if one is otherwise in perfect health. And some severely overweight people may be declined insurance coverage altogether. To add insult to injury, this "fat tax" often falls on a slender wallet.[69] Studies consistently show that overweight job candidates are less likely to be hired than nonoverweight candidates (even when perceived to be equally competent on job-related tests).[70] And when hired, they often earn less.[71]

The physical and psychological consequences of obesity have profound economic ramifications for the nation as a whole. These economic ramifications take the form of direct costs, which include the costs incurred on preventive, diagnostic, and treatment services related to overweight and obesity, such as on physician visits, hospital care, and medications, as well as indirect costs that accrue to the wider economy because of time and productivity lost to sickness and premature mortality.[72] In 2000, the U.S. Surgeon General estimated these costs at $117 billion annually—an amount that's comparable to the entire gross national product of countries such as Portugal, Ireland, or Argentina.[73,74]

"Globesity"

The obesity problem is no longer just an American problem. The situation is nearly as dismal around the globe, with people in country after country following the American lead and growing heavier.[75] According to Dr. Stephan Roessner, a past president of the International Association for the Study of Obesity, "There is no country in the world where obesity is not increasing.

Even in developing countries we thought were immune . . . the epidemic is coming on very fast. . . . In some areas of Africa, overweight children outnumber malnourished children three to one."[76] Not even "paradise" has been spared. On some South Pacific islands, as many as three-quarters of adults are dangerously obese. These are levels so high that the magnitude of the disorder is changing and molding the very culture of these islands.[77]

"It has often been said that one of the great tragedies of human social evolution is that half the world's population worries about the consequences of overeating while the other half starves."[78] This is now literally true. Today, for the first time, the number of overweight people in the world has risen to match the number of undernourished: 1.2 billion.[79]

In her 2003 annual message, Dr. Gro Harlem Brundtland, the Director-General of the World Health Organization, was clearly alarmed:

> These are dangerous times for the well-being of the world . . . . Too many of us are living dangerously—whether we are aware of that or not . . . either because we have little choice, which is often the case among the poor, or because we are making the wrong choices in terms of our consumption and our activities.[80]

A Bucket Half-Empty?

The "temperature is rising," and like the frog, we are showing every sign of enjoying ourselves. "Our lives are characterized by too much of a good thing—too much to eat, to buy, to watch and to do, excess at every turn."[81] The risk we face, if we do not address the obesifying forces in our environment and patterns of behavior, is that these forces will get woven so tightly into our social fabric—our economic system, leisure and entertainment, health care, even education—that it will be difficult to reverse the damage,[82] not unlike the frog whose capacity to respond to the threat of boiling slowly atrophies with the slow rise in temperature, getting groggier and groggier until ultimately it becomes unable to climb out of the pot. We have got to be smarter than that boiled frog if we want to avoid that amphibian's fate.[83]

Reducing the national waistline will require a major shift in the way we think about managing our instincts and our environment. "Gone are the days when weight control was instinctual, when food was scarce and humans had to be active just to survive," says James Hill, director of the Center for Human Nutrition at the University of Colorado, and a leading researcher in the obesity field. As a result, says Hill, "we have to use our brains to restrict those instincts. . . . We have to teach people to override their biological instincts with their cognitive abilities."[84]

But how can this be done?

Scientists and health officials have long believed that the key to reversing obesity is information, offering the public more and better information about healthy food choices, for example. Most government programs aimed at weight control are based on this principle. This viewpoint relates to what the philosopher Karl Popper used to call "the bucket theory of the mind." When minds are seen as containers, and public understanding is viewed as a function of how much scientific facts are known, the focus naturally is on how many scientific facts public minds contain.[85]

An irony of America's obesity epidemic is that, at a time when Americans arguably know more about food and nutrition than at any time in their history, they are gaining more weight.[86] Despite all the diet books, the wide availability of reduced-calorie and reduced-fat foods, advice from weight-loss specialists, and the broad publicity about the obesity problem, the number of obese is not declining.[87] Something other than ignorance must be driving the trend.

What people need to realize is that effective self-regulation of health behavior, as in any other endeavor, requires certain cognitive skills. Knowledge (in the bucket) without the requisite decision-making skills will produce little change. Paradoxically, the recent advances in medicine have made these skills more critical, not less. Improved medical care and the elimination of infectious diseases have increased life expectancy, so that minor dysfunctions due to personal mismanagement have more time to develop into chronic diseases later in life. Gaining 30 or 40 pounds at the age of 20 or 30 may not have been too much of a concern a century ago, when the life expectancy was only 40. Today, the life expectancy of the U.S. population has nearly doubled, from 40 to almost 80 years (although the trend may be reversing), which means that there is ample time for those 30 or 40 pounds to translate into serious ailments.[88]

An old comedian once remarked: "Had I known I would live this long, I would have taken better care of myself." This is no longer a joke.

The Leverage (or the Impediment) Is with the People

In the United States today, most obese individuals attempting to lose weight do so themselves, without seeking professional help.[89,90] For example, dieting, the mainstay of obesity treatment, is most often undertaken as a self-directed process with instruction from a book or slimming club within the community, or often just by self-induced restraint. Experts expect this trend to continue, for several reasons. Given the sheer number of obese individuals

who need help, it is clear that there are not enough health professionals available to provide intensive, long-term treatment.[91] A second important driver is the cost of weight-loss programs. At the moment, most insurance companies and health maintenance organizations do not consider obesity per se—that is, obesity uncomplicated by other conditions—a reimbursable expense. As a result, if dieters seek professional treatment, they usually must pay out of pocket for all or most of the cost of treatment (which can be as steep as $65 an hour for an average nutritionist).[92,93]

Third, weight has always been seen as a very individual, very personal thing. The wellness movement, which has taken hold of the health mentality of the U.S. population, is rooted in the concept of personal control over health. This focus on individual responsibility reaches extremes in the search for the perfect body. Because eating is under one's conscious control, most people consider weight "to be a matter of an individual's decisions, or perhaps of a failure to make decisions."[94] One (unfortunate) consequence is that individuals, like the culture in general, assume more control than actually exists. This perhaps explains why most people believe that every overweight person can and should achieve slenderness, and why obese people are stereotyped as lacking in self-control.[95]

Control over our bodies, however, must be considered within the context of biological realities, and the reality is that obesity is not simply a problem of willful misconduct—eating too much and exercising too little—as it continues to be (mis)viewed not only by the lay public but by health care providers and insurance companies as well. Obesity is a complex multifactorial disease involving genetics, physiology, and biochemistry, as well as environmental, psychosocial, and cultural factors.[96]

People must come to realize that in managing our health—and our bodies—we are decision makers who are managing a truly complex and dynamic system: the human body.

It Is Not Easy Becoming a *Top Gun*

To underscore the often hidden complexities of human weight regulation, I have often asked my students (many of them navy pilots) to think about the similarities and the differences between the task of managing their bodies (which they must do to stay "navy trim") and flying their state-of-the-art aircraft. There are several interesting parallels between the two tasks. Both our bodies and the navy's latest flying machines are marvelously complex systems. Yet, both are quite vulnerable in turbulent environments, and in both cases the "piloting" task is not a simple matter of making a single

one-time decision. Rather, it is a dynamic decision-making process involving a series of decisions made over time. Furthermore, the decisions are not independent of one another since what we can or cannot do *now* is often constrained by decisions we have already made.

The analogy, while useful, is not perfect, however. Managing our bodies poses two subtle (and tricky) complications. For one, in managing our health we are not merely "flying" our bodies, we are also *redesigning* them in "flight." Our bodies are continuously changing over time, both autonomously (e.g., because of aging) and in reaction to our lifestyle choices. Managing our bodies is, therefore, akin to pursuing a target that not only moves but also reacts to the actions of the pursuer, which may explain why it can be an extremely challenging, and often frustrating, endeavor.

A second complication is time delay. Unlike with the controls on a supersonic aircraft, the time delay between taking an action (eating a piece of chocolate cream pie or smoking a cigarette) and its effect(s) on the state of our health can be quite long. Time delay complicates things because it means we can no longer rely on receiving timely feedback on the outcomes of our decisions and actions. And that makes it so much harder to learn and to adjust. (We shall see later that because many of obesity's health consequences are the result of the cumulative stress of excess weight over a long period of time, this issue has proven particularly troublesome for obesity prevention efforts.)

What would it take to become a "top gun" on this lifelong "flight"? Research in control theory and behavioral decision making suggests that effective control of a dynamic system, whether it is the energy regulation of our bodies, the energy regulation of an atomic reactor, or the flight attitude of a supersonic jet, requires two essential cognitive skills: the operator's ability to develop an adequate model of the system and the ability to "run" that model, that is, to infer how the system changes over time.[97–98] By the operator's model of the system is meant *structural knowledge*—knowledge of how the system's variables (such as the energy consumed and expended in the case of weight regulation) are related and how they influence one another and are influenced by the system's external environment. A perfect operator model without a capability to "run" it is of little practical utility however.[99] The ability to infer system behavior is essential if the decision maker (or pilot) is to know how actions taken will influence the situation or system and, thus, is essential in devising appropriate interventions for change. The two skills are needed *together*.

Unfortunately, living systems—the human body included—do not come with an operator's manual, nor are their structures always readily apparent, and so grasping a system's structure and its dynamic tendencies is never automatic. It requires skills to see *through* complexity to the underlying structures generating a complex situation or problematic behavior.

The good news, though, is that, while the skills are not necessarily innate, they can be successfully acquired.[100] It just may require reading an entire book to acquire them!

Let's see why.

States *In* Mind

People analyze many situations and make hundreds of decisions every day while at home, at school, at work, or on the road. Rarely, however, do we stop to think about *how* we think. No one's head contains a family, city, school, hospital, or business. All human decisions are based on models, usually mental models (of family roles and relationships, a city's layout of streets and neighborhoods, the power hierarchy in a business organization, etc.) created out of each person's prior experience, training, and instruction.[101] They are the deeply ingrained assumptions, generalizations, or even pictures or images we form of ourselves, others, the environment, and the things with which we interact. These cognitive constructs are not simply repositories for past learning; they also provide a basis for interpreting what is currently happening, and they strongly influence how we act in response.[102]

Figure 1.2 Mental models (*Source:* Courtesy of Peter Arkle.)