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Tobacco Control at a Crossroads

This chapter outlines key issues defining the state of tobacco control at the beginning of the twenty-first century and introduces the systems approaches under study in the Initiative on the Study and Implementation of Systems (ISIS) to improve public health outcomes related to tobacco use. The problem of tobacco use is discussed within a framework of the interaction of product, person, the tobacco industry, and the environment in which all exist. The chapter also discusses population-level efforts as early systems models for tobacco control, as well as some of the issues that frame the use of systems methods. The chapter concludes that the interaction of complex factors points to the need for a strategic systems approach to support future reductions in the prevalence of tobacco use.

For thy sake, tobacco, I would do anything but die.

—Charles Lamb (1775–1834)

Introduction

The need for systems approaches in tobacco control is largely framed by trends in the evolution of tobacco control and public health over the last few decades. These trends, and their role as a backdrop to the systems approaches addressed by ISIS, are examined here. Subsequent chapters present the argument for these systems approaches and explore them in more detail in a public health context. This chapter discusses (1) how the scientific view of tobacco use evolved from a model focused on individual behavior to a broader model that considers the full complexity of the problem and (2) how that evolution leads to a global systems orientation toward eradication of tobacco use.

Tobacco use is the most important preventable cause of disability and death in the United States¹ and is a risk factor for four of the five leading causes of death (heart disease, cancer, chronic obstructive lung disease, and stroke).² Analysis of the number of tobacco-related deaths from all causes during the 1997–2001 period shows that cigarette smoking was responsible for approximately 438,000 deaths each year in the United States.³ Cigarettes and other tobacco products are highly engineered to create and maintain dependence. Many of the compounds in cigarette smoke are toxic, mutagenic, or carcinogenic.² Use of these products has long-term public health and economic consequences. Successful prevention of tobacco use and its associated morbidity and mortality is a national priority; it can also illustrate best practices and approaches to addressing other major public health problems.

Tobacco control research and practice have led to significant public health accomplishments in the past half-century. The prevalence of smoking among U.S. men decreased from nearly 60% in the 1950s to 24% in 2005.⁴ During the same period, smoking prevalence among U.S. women

decreased from approximately 30% to 18%.⁴ Because tobacco use is the most important modifiable risk factor for chronic disease and early mortality, this represents a major victory for public health.

However, tobacco control is now at a critical juncture. Previous successes may be in jeopardy because of systematic barriers to tobacco control efforts. An ever-vigilant and highly profitable tobacco industry has become more sophisticated in its approach to marketing tobacco products and developing new marketing schemes and products that outstrip the responsiveness of tobacco control research and practice. Moreover, in some cases, research funds are being shifted to other health priorities, such as obesity.⁵

Healthy People 2010 provides the United States with a comprehensive, nationwide health promotion and disease prevention agenda. Among the many objectives to be achieved by 2010 are to reduce the adult smoking prevalence to 12% and to reduce high school student smoking prevalence to 16%.⁶ However, it does not appear that the nation will meet these goals. More than 45 million U.S. adults are current cigarette smokers,⁴ and each day, approximately 4,000 young people between the ages of 12 and 17 years initiate cigarette smoking.⁷ Worldwide prevalence of smoking is increasing and, if current trends continue, tobacco use will become the leading global cause of death within 30 years.⁸

Tobacco manufacturers spent more than \$15 billion in 2003 to advertise and promote tobacco products.⁹ However, combined public and private resources for tobacco control amount to only a small fraction of this figure, and tobacco control initiatives are often fragmented. Additionally, because funds from tobacco taxes and other related sources often help sustain vital governmental infrastructure, the incentives to reduce or eliminate tobacco use and tobacco-related harm may not be as

strong as they should be, despite tobacco's enormous negative impact on society.¹⁰ The slow progress in tobacco control is likely due to many complex and overlapping factors that must be better understood if more effective action is to be taken.

Societal and environmental factors have continuously changed both tobacco use and the tobacco control environment. The resource-rich tobacco industry has paid close attention to the myriad intersecting threats to its business, with the aim of maintaining or increasing sales and undermining industry critics. The continued existence of the industry depends heavily on its ability to counter antitobacco efforts. The companies continue to invest billions of dollars in advertising and promotion, including payments to retailers.¹¹ They have advocated for state laws that preempt the ability of local communities to enact evidence-based tobacco control measures.^{12,13} Tobacco use permeates the popular media, competing with the growing efforts of antitobacco advocates to decrease the acceptability of tobacco use.¹⁴⁻¹⁶

The battle against tobacco use has resulted in substantial victories. Today, more than one-half of all adults who have ever smoked have quit.¹⁷ However, to increase the proportion of former smokers, more efficacious behavioral and pharmacological therapies must be developed and community and policy interventions need to be improved. In both clinical and community environments, translating research efficacy into real-world effectiveness is essential. For example, the efficacy of nicotine replacement therapy has been shown in numerous studies; however, these medications are often not used in the real world as they were in clinical trials.¹⁸⁻²⁰ As a result, changing nicotine replacement therapies from prescription to over-the-counter status does not seem to have had the predicted population effect.²¹ Research is needed to better understand and address this issue.

To more effectively counter the tobacco industry's efforts, the tobacco control community must become better organized. Tobacco control resources must be used more judiciously and include approaches that have the greatest strategic effect in a system that optimizes the outcomes of all efforts. This goal of being more effective in practice is inexorably linked to construction of a more integrated system of scientific discovery, development, and delivery.

Need for a New Approach

Most twentieth century research has been driven by reductionism, the process of attempting to understand a problem by first deciphering its components.²² The result has been an attempt to grasp the whole of tobacco use and tobacco control by understanding the parts, including the biological basis of nicotine addiction, the structure and function of cigarettes, the advertising and marketing of tobacco products, the economics of tobacco use, and the effectiveness of different tobacco control programs. Much has been learned about these dissociated aspects of tobacco use and tobacco control. However, few strides have been made in understanding the whole or in reducing tobacco use through systemwide change. Barabási puts it well: "Riding reductionism, we run into the hard wall of complexity."^{22(p6)} A new paradigm must be adopted to address the complexities and ultimately improve the health of the public. Because of the complex problems involved, systems thinking is needed in tobacco control efforts.

Tobacco Use as a Complex System

To illustrate that population-level tobacco use and control involve a complex system, it is helpful to think in terms of the

Key Terms and Definitions

System: A set of elements interrelated among themselves and within the environment

Systems approaches: Theories that use systems methods in an organized framework to address systems (e.g., chaos theory or complexity theory)

Systems methods: Specialized techniques or procedures for researching and understanding systems (e.g., system dynamics modeling, structured conceptualization, or network analysis)

Systems thinking: Use of systems approaches to view the world

system of tobacco products: the industry that produces, distributes, and promotes the use of its products, and the people or populations who start, maintain, and stop using tobacco, or are harmed by exposure to secondhand smoke. In addition, the system includes the environment that helps to promote or prevent tobacco use and forces related to public policy, family and community norms, culture, and history.

Product

Tobacco products are diverse and include conventional cigarettes, pipes, cigars, smokeless tobacco, bidis, kreteks, and others.

Some of the complexity of the product is illustrated by conventional cigarettes. A commercial cigarette is not simply a column of tobacco wrapped in paper to which a filter is attached. The modern commercial cigarette is a highly engineered nicotine-delivery device. It is specifically designed for the rapid delivery of nicotine to the brain, allowing nicotine to enter a smoker's bloodstream via gas or particle deposition in the respiratory tract and mucous membranes. This rapidity of nicotine delivery results in immediate reinforcement

of smoking behavior and enables the smoker to exert exquisite control over his or her nicotine intake, from one puff to the next.²³ Smokers may self-dose with nicotine several hundred times a day. For example, a one-pack-per-day smoker likely inhales smoke 70,000–100,000 times per year.²³ Experienced smokers are expert at dose titration, with much of the process occurring with little conscious control.

Commercial cigarettes are engineered to allow significant flexibility in the delivery of nicotine and other components of smoke that reinforce smoking behavior. As smokers became more aware of the health consequences of smoking, tobacco manufacturers responded with changes to the cigarette's design that purported to reduce the delivery of toxins to the user. With the advent of filters, including ventilated filters, and porous cigarette papers, the average machine-measured, sales-adjusted yields of tar fell from 21.6 mg in 1968 to 12.0 mg in 1998,²⁴ while those for nicotine fell from 1.35 mg to 0.88 mg per cigarette.

These dramatic reductions might have been expected to yield significant public health benefits, but there is no convincing evidence that they have resulted in important health benefits to either smokers or the whole population.²⁵ The high degree of elasticity of delivery afforded by modern cigarettes has allowed smokers to compensate for the decreased machine-smoked yields of nicotine. Smokers use multiple compensatory mechanisms for increasing nicotine delivery, including increasing the number and volume of puffs and blocking filter ventilation holes.^{26–31} Data indicate that cigarettes with low or medium quantities of nicotine are smoked much more intensely than is indicated by the test data from machine smoking analyses.

Moreover, use of the Federal Trade Commission method of measuring yields from machine-generated smoke

leads to overestimations of the degree of exposure reduction afforded by low-yield cigarettes.^{27,32} Most studies that compare smoking behavior in people who smoke cigarettes with different yields of nicotine reveal at least partial compensation for lower levels of nicotine by smoking behavior. This finding suggests that cigarettes with lower yields are smoked more intensely than are those with higher yields.²³

Additionally, cigarettes may be manufactured to increase the potential for addiction by making more of the nicotine in smoke available for rapid transfer to the brain. The “free-base” (unprotonated) form of nicotine is volatile and is more rapidly and efficiently absorbed through the lungs and mucous membranes than is the “non-free-base” (monoprotonated) form of nicotine.^{33–35} It has been postulated that rapid absorption increases the speed of nicotine delivery to the brain, increasing the potential for addiction.^{36,37} The free-base form of nicotine has been likened to the free-base form of cocaine (“crack” cocaine)—both are rapidly absorbed, resulting in an explosive effect on the nervous system.³⁸

The sensory and hedonistic qualities of cigarettes, including immediate perceptions of impact and satisfaction,^{39,40} contribute to their high liability for abuse. The addictive consequences of swift delivery of nicotine to the brain became apparent when the subjective responses of smokers were examined. For example, a 1974 Liggett report demonstrates that a cigarette with a high proportion of free-base nicotine has “...more free nicotine in its smoke, and consequently, a higher nicotine impact.”³⁹(Bates no. 2073832754) Similarly, a 1976 R.J. Reynolds document describes free-base nicotine as “more rapidly absorbed by the body and more quickly gives a ‘kick’ to the smoker.”⁴¹(Bates no. 502420399) Another document notes that nicotine in its free-base form is more readily absorbed through the body tissue.⁴² Hence it is the free nicotine that is associated with impact; that

is, the higher the level of free nicotine, the higher the impact.⁴³

It is apparent that the reinforcing and rewarding effects of cigarettes are such that the smoker is likely to become addicted and have great difficulty in stopping smoking. Personal characteristics also can make a person particularly susceptible to starting to smoke and having difficulty in stopping smoking.

Person

Nearly all people in the United States are exposed to advertising and promotion of tobacco products and to others smoking around them. However, not everyone initiates cigarette smoking or uses other tobacco products. Some people can stop smoking easily, while others may experience great difficulty.

Early research focused on the biobehavioral aspects of smoking initiation and cessation. For example, a person’s level of educational attainment is an important predictor of smoking status. In 2004, smoking levels were higher among adults with a general equivalency diploma (43.2%) or 9–11 years of education (32.6%) than among adults with an undergraduate degree (women: 9.6%; men: 11.9%) or a graduate degree (women: 7.4%; men: 6.9%).⁴ Additionally, cigarette smoking is more common among adults with incomes below the poverty level (29.9%) than among those with incomes at or above the poverty level (20.6%).⁴

The prevalence of smoking among adults has declined considerably in recent decades. However, cigarette smoking among adolescents rose in the late 1980s through the mid-1990s, before decreasing.⁴⁴ Among children and adolescents, associations have been reported between starting to smoke and factors related to the spheres of family, peers, personality, and environment. For example, higher smoking prevalence has

been reported among adolescents who show symptoms of depression, have poor academic performance, or are prone to rebelliousness.⁴⁵ Smoking among family members and friends, and exposure to tobacco advertising and promotion, are associated with higher levels of childhood cigarette smoking.^{45–49} Parental support and negative parental attitudes toward youth smoking are protective factors.^{50–52} Traits such as impulsivity are associated with both starting to smoke and relapsing after attempting to stop smoking, suggesting that nicotine may be disproportionately rewarding for some people.⁵³

The proportion of young adults (18–24 years old) who started to smoke cigarettes and who transitioned to regular smoking increased during the late 1990s.^{54–57} In 2005, the prevalence of smoking among young adults was 24.4%, statistically equal to the rate of adults aged 25–44 years (24.1%),⁴ the age group that traditionally had the highest prevalence. It is unlikely that the increase in smoking among college-age young adults is solely the result of adolescents aging into the group. Rather, specific targeting by advertising and promotion of tobacco companies has probably contributed to the increase.⁵⁵

Emerging evidence suggests a genetic basis for some aspects of smoking behaviors in some individuals, which may explain part of the variation in smoking patterns among individuals. Behaviors in which genetics have been implicated include initiation of cigarette smoking, onset of addiction, and success in stopping smoking. Heritability has been implicated in starting to smoke, for men more than women, and for persistence in smoking.⁵⁸ Monozygotic twins have been shown to have a greater concordance for failure to stop smoking than have dizygotic twins.⁵⁹ One study of twins reported that genetic factors may account for 50% of the variance in risk for starting to smoke and 70% of the variance for continuing to smoke.⁶⁰ A review⁶¹ of published studies

relates *DRD2 Taq1A*, *CYP2A6*, *DAT VNTR*, and *5HTTLPR* genetic polymorphisms (different forms of genes) to smoking patterns. The data were insufficient for performance of a meta-analysis. However, the authors conclude that the contribution of specific known genes to smoking behavior is probably modest.

Cigarette manufacturers place their product in the person's environment and promote its use. Particular activities of the tobacco industry are especially potent in countering public health efforts to eradicate tobacco use. These counterefforts underscore the need for a systems approach to tobacco control.

Tobacco Industry

Prior to the invention and patenting of the cigarette rolling machine in 1880, cigarettes were not the most popular tobacco product. The “cigarette market was small.... Cigarettes were expensive and hand rolled by the cigarette girls. Most manufacturers didn't see a use for that many cigarettes.”⁶² The advent of the cigarette rolling machine, which could produce 120,000 cigarettes in 10 hours, “led not only to the widespread use of cigarettes as America's favored form of tobacco, but to the modern era of mass-market advertising and promotion.”⁶² The success of mass marketing was also enhanced by the availability of bright (Virginia or flue-cured) tobacco, which produced smoke that was more easily inhaled than that of other tobaccos in previous use. In 2003, despite a ban on advertising on radio, television, and billboards,⁶³ the U.S. cigarette manufacturers together spent more than \$15 billion—more than \$41 million each day—to advertise and promote cigarettes.⁹

Tobacco companies maintain a sophisticated distribution system that results in the widespread availability of cigarettes. It is virtually impossible for consumers to avoid protobacco messages while going about their day-to-day activities. While

communities often limit the number of outlets for the sale of alcohol by restricting the number of retail licenses or the density of stores, tobacco outlets are not similarly restricted. Most retail stores that sell necessities such as milk and bread also sell cigarettes. More than 80% of all cigarette advertising and promotional dollars are spent in ways that affect the retail environment. Ninety-seven percent of retail tobacco outlets contain at least one advertisement or promotional item, aside from the tobacco product itself. The average number of such items per store rose from 13 in 2001 to 17 in 2002 (P. I. Clark, pers. comm., October 21, 2005). No other consumer product is as heavily promoted in retail stores,^{11,64} and the Master Settlement Agreement did not include provisions for restricting retail advertising.

In the earliest years of cigarette manufacturing, the tobacco companies had only to manufacture and distribute their products and convince people to buy and use them. However, by the early 1950s, reports about the association between smoking and adverse health outcomes began to appear in the scientific literature.^{65,66} On January 11, 1964, Surgeon General of the Public Health Service Luther Terry released the report of the Surgeon General's Advisory Committee on Smoking and Health. The first Surgeon General's report, based on more than 7,000 articles from the biomedical literature, concluded that cigarette smoking causes lung cancer and stated that "cigarette smoking is a health hazard of sufficient importance in the U.S. to warrant appropriate remedial action."^{67(p33)} The report was released to the public on a Saturday to avoid a strong reaction from Wall Street.⁶⁸

Within weeks of the public release of the first Surgeon General's report, the tobacco companies fought back. George Weissman, then president of Philip Morris, reacted to the report by sending a confidential memorandum to Joseph Cullman III, then

Philip Morris's chair and chief executive officer, which referred to the report as a "propaganda blast" and provided ideas about how the tobacco industry could counteract it. In this memorandum, Mr. Weissman noted that he had originally supported a mild federal labeling act to thwart the efforts of the individual states, saying, "If possible, the state legislatures could be held off on the basis that this is a federal matter and the federal can be the subject of many hearings." He suggested working clandestinely to ridicule the findings of the Surgeon General's report, saying, "While it should not be done in the industry's name, someone ought to be contacting all the cartoonists, television gag writers, satirical reviews, etc...." He continued, "...However, at some point, reflecting the same seriousness with which we met the report, we must in the near future provide some answers which will give smokers a psychological crutch and a self-rationale to continue smoking...."^{69(Bates no. 1005038559-8561)}

Since that time, the tobacco companies have countered every major public health initiative with varying degrees of success. An extensive body of peer-reviewed literature describes the diverse strategies and tactics the tobacco industry has used to undermine public health.⁷⁰⁻⁷⁸ The industry has long been concerned that large-scale, comprehensive tobacco control programs would reduce smoking and thus reduce profits.⁷⁹ An important example of a program that the industry perceived as a threat was the American Stop Smoking Intervention Study for Cancer Prevention (ASSIST), a 17-state initiative that sought to reduce tobacco use by changing the sociopolitical environment through policy and media advocacy and through the development of state infrastructures to deliver tobacco control.⁸⁰⁻⁸² Given the scope of ASSIST, it is not surprising that the program caught the attention of the tobacco industry.^{73,79} While local, state, and federal governments expended resources to reduce smoking rates

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and promote tobacco control, the tobacco industry expended significant resources to promote sales of their products, influence governmental bodies, and undermine programs such as ASSIST.^{73,79}

The tobacco industry has relied heavily on lobbying and campaign contributions to oppose antitobacco legislative initiatives.^{83–86} Some tobacco company efforts have made use of front groups or third-party allies to advance their goals.⁸⁷ For example, tobacco companies have used financial analysts from the investment banking industry, as though from an independent source, to promote the tobacco industry's public policy agenda.⁷⁴

Early on, the tobacco industry realized that policies to reduce exposure to secondhand smoke were a serious threat to profits. For example, Philip Morris estimated that smoke-free workplaces would increase smoking cessation rates and reduce cigarette consumption by 11%–15% and that widespread restrictions on smoking in the workplace would severely affect the industry.⁷² In response to the threat, the industry paid scientists and academicians to present research countering the evidence against the health hazards of exposure to secondhand smoke.^{88–91} The tobacco

industry developed a network of experts on ventilation who represented themselves as independent consultants. However, these consultants promoted strategies of the tobacco industry under close, but generally undisclosed, industry supervision.⁷² The ventilation consultants were used to steer public concerns about indoor air quality away from secondhand smoke, arguing that it was an insignificant component of a much larger problem of poor indoor air quality and inadequate ventilation. The consultants carried this message to businesses, particularly the hospitality business, and to regulatory and legislative groups.⁷²

Over time, the tobacco companies developed strategies to counter or co-opt public health initiatives and maintain company profits. For many years, the major U.S. cigarette companies were able to coordinate their efforts through the Tobacco Institute, a trade association formed in 1958 to promote the tobacco industry's positions, primarily through public relations and lobbying activities. For many decades, the Tobacco Institute was a major force in the effort to counter antitobacco initiatives.⁹² The Tobacco Institute was required to dissolve in 1998, pursuant to litigation brought by the state Attorneys General.

Tobacco and Public Officials: A Complex Relationship

While the tobacco industry is seen by tobacco control professionals as a “vector” for disease, its relationship with the public sector can be considerably more complex. The financial aftermath of the 1998 Master Settlement Agreement (MSA) is a case in point. As a result of a class action lawsuit in Illinois, Philip Morris was required to place billions of dollars in escrow while the case was appealed.^a The company argued that such a bond could result in bankruptcy, jeopardizing funds the states were to receive under the MSA. In response, 37 state and territorial Attorneys General submitted a friend-of-the-court (*amicus curiae*) brief, requesting that Philip Morris be allowed to decrease the amount of bond required by the court. The court granted this request. It appears that, on occasion, dependence on MSA funds has provided an incentive for states to take positions that support the continued financial health of the tobacco industry.

^aAltria Group. 2003. Illinois court reduces \$12 billion bond: Philip Morris USA set to begin appeal; To make MSA payment to states. Press release. New York: Altria Group. http://www.altria.com/media/03_06_04_12_04_pricerpr.asp.

Image and the Tobacco Industry: A Systems Response

Market leader Philip Morris has demonstrated the tobacco industry's ability to change in response to pressure. In the early 1990s, Philip Morris faced pressure from the public health community and groups promoting the rights of nonsmokers. The company's own polling data showed that Philip Morris was viewed far less favorably by the public than other companies, including Exxon following the Exxon Valdez oil spill. In response, Philip Morris decided to revamp its corporate image by developing an image-enhancement campaign, "Philip Morris in the 21st Century," which included changing the company name to Altria, to distance itself from the negative image of a tobacco company.

Philip Morris and the other major U.S. tobacco companies have continued to use image-enhancement programs, including those focused on youth smoking prevention, and Web-based quit smoking assistance. Research to date demonstrates that these programs are either ineffective or actually harmful.^a However, they may serve to help relieve some of the public pressure on the tobacco industry.^b

The early years of the twenty-first century have been marked by decreased funding for tobacco control programs, including the near eradication of highly successful programs in Massachusetts and Florida. The transformation made by the tobacco companies provides evidence that tobacco control initiatives have been successful and that tobacco control strategies need to be sufficiently nimble to continue to apply pressure on the industry, especially in light of its recent efforts to reposition itself in the public eye. An integrated system of tobacco control will provide the needed agility.

^aHenriksen, L., A. L. Dauphinee, Y. Wang, and S. P. Fortmann. 2006. Industry sponsored anti-smoking ads and adolescent reactance: Test of a boomerang effect. *Tobacco Control* 15 (1): 13–18.

^bHirschhorn, N. 2005. Corporate social responsibility and the tobacco industry: Hope or hype? *Tobacco Control* 13 (4): 447–53.

Sources. Smith, E. A., and R. E. Malone. 2003. Altria means tobacco: Philip Morris's identity crisis. *American Journal of Public Health* 93 (4): 553–56. Warner, K. E., and D. M. Burns. 2003. Hardening and the hard-core smoker: Concepts, evidence, and implications. *Nicotine & Tobacco Research* 5 (1): 37–48.

The tobacco industry continues to influence attitudes and behaviors toward smoking, particularly in areas in which it retains an economic influence. This influence occurs both at the micro level, through retailers, restaurant owners, and others, and at the macro level, where tobacco interests form a significant part of regional economies. At the micro level, tobacco interests often form coalitions with economic partners. For example, the industry may partner with hospitality industry allies to challenge a comprehensive clean indoor air law.^{93,94} At the macro level, studies have shown that tobacco-producing states have substantially lower tobacco taxes,⁹⁵ fewer laws restricting smoking,⁹⁶ and less overall control of tobacco use⁹⁷ than do other states.

Economic factors such as these remain a challenge to address.

The product, the person, and the tobacco producer operate in an environment of national-, state-, and community-level factors. The significant influence of the environment on tobacco use is evident from the wide variation in smoking prevalence across the states. In 2005, the median prevalence of cigarette smoking among U.S. adults was 20.9%; however, the prevalence ranged from 11.5% in Utah to 28.7% in Kentucky.⁹⁸ Outside the 50 states and the District of Columbia, the median prevalence of cigarette smoking among adults was 13.6%, ranging from 10% in the U.S. Virgin Islands to 34% in Guam.⁹⁹

Environmental factors such as clean indoor air laws and regulations, economic dependence on tobacco (e.g., tobacco-growing regions), and levels of taxation on tobacco products may contribute to this variation.

The interrelationship of environmental factors, combined with the broader relationship of product, person, and producer of tobacco products, provides a focus on understanding and managing behaviors associated with tobacco use as an integrated system. This approach is not entirely new, as is illustrated by the history of the evolution of systems thinking in tobacco control.

Population-Level Tobacco Control Efforts: Beginnings of an Integrated System

Tobacco use was once seen primarily as a problem of individual behavior, to be addressed at the individual level through interventions such as health education and assistance for smoking cessation. Today, experts recognize that population-level factors related to tobacco use function as a system. Moreover, population- and policy-level changes have a measurable influence on health outcomes. Indeed, this premise was reflected in the very first National Cancer Institute (NCI) Smoking and Tobacco Control Monograph, *Strategies to Control Tobacco Use in the United States: A Blueprint for Public Health Action in the 1990's*.⁸¹ That seminal monograph delineated the framework for a “systems approach” by characterizing tobacco control as a complex interplay of priority populations, channels for reaching priority populations, and individual and community interventions.

Beyond the direct impact of these types of population-level interventions, the resulting

changes in social attitudes toward smoking also affect overall tobacco use. For example, although clean indoor air laws are primarily aimed at protecting nonsmokers, they also help decrease smoking prevalence and consumption, which in turn, changes the social environment toward smoking.^{1–8,100–102} Clean indoor air laws may also have helped to change attitudes toward secondhand smoke, including helping to decrease the social acceptability of smoking in homes and cars. Voluntary bans on smoking in the home are associated with longer and more frequent attempts by adults to stop smoking, lower rates of relapse to smoking in adults,^{103,104} and lower rates of smoking among youth and young adults.¹⁰⁵

Some tobacco control efforts focus on the biopsychosocial determinants of tobacco use. Interventions are targeted to the individual, such as use of medications to quit smoking. At the same time, some tobacco control interventions, such as banning smoking in bars and restaurants or increasing tobacco taxes, target policy and environmental influences on tobacco use. In the complex tobacco control environment, individual and policy approaches interact and influence each other in ways that need to be better understood. At the same time, tobacco companies continue to attempt to undermine individual and policy interventions. For example, major media campaigns encourage smokers who want information on quitting to visit the Philip Morris Web site.¹⁰⁶ Such campaigns may permit Philip Morris, a leading promoter of cigarette smoking, to gain credibility with the public. Philip Morris has also recently expressed support for legislation that would give the U.S. Food and Drug Administration authority to regulate tobacco products, despite having opposed this in the past. These and other efforts by the tobacco industry result in perturbations in the complex tobacco control system and will require new thinking, analysis, and action.

The growing realization that tobacco use is a systems problem has led to an increasing number of population-level tobacco control efforts, which serve as a precursor to the kinds of systems methods under study in ISIS. Three earlier efforts in Europe and the United States illustrate the evolution of thinking in tobacco control: the North Karelia Project, the Community Intervention Trial for Smoking Cessation (COMMIT), and ASSIST.

North Karelia Project

Tobacco use is mediated by social forces. Therefore, concerted efforts to change tobacco-related social and environmental influences may reduce tobacco use. An early intervention program attempted to approach tobacco use as a problem amenable to social change rather than individual change. The North Karelia (Finland) Project began in 1972 in response to unusually high rates of cardiovascular disease in Finland.¹⁰⁰ Three risk factors were identified for targeted community interventions: hypertension, hypercholesterolemia, and cigarette smoking. Health care personnel were trained to give advice on quitting smoking, to give dietary advice, and to conduct blood pressure and cholesterol measurements. A variety of activities were implemented to increase public awareness and to reduce risk factors of cardiovascular disease. These included, for example:

- Organization of cholesterol-lowering competitions between villages
- Working with food manufacturers and supermarkets to facilitate dietary changes, including development of low-fat dairy and meat products and the reduction of salt in a number of food items
- Workplace weight loss and smoking cessation programs, and the introduction of more vegetables in workplace cafeterias

- Broadcasts of nationwide television series in which people would volunteer to make healthy changes in their lifestyles with expert help
- A project that encouraged people to grow berries

Many factors contributed to the observed drop in smoking prevalence among men, including “buy in” from the media that resulted in extensive media coverage, educating health care providers to give advice on smoking cessation, group sessions for help with smoking cessation, using lay leaders to educate the public, prohibiting smoking in most indoor public places, eliminating tobacco advertising, and dedicating a portion of tobacco taxes for tobacco control programs. As a result of the program, smoking among men dropped by one-third. Although smoking increased among women, the prevalence was low. Fewer than one in six women smoked cigarettes.¹⁰¹ The success of the project may be attributed to several factors, including

- Institution of a massive knowledge management process that integrated systems ranging from health care records to researchers
- Comprehensive efforts aimed at schools, workplaces, homes, and communities using a variety of channels and interventions
- Use of network-centric approaches to link networks within the province

The project was extremely influential and paved the way for several other community-based systems efforts. In the 1980s, three studies of community health education were conducted in the United States: the Stanford Five-City Project, the Minnesota Heart Health Program, and the Pawtucket Heart Health Program.^{102,107} The effects of these interventions were modest and failed to reach statistical significance in

many cases, perhaps because of positive changes in the environments of the control communities.^{102,107}

COMMIT

In 1982, NCI's Division of Cancer Prevention and Control launched the Smoking, Tobacco, and Cancer Program. Recognizing that the link between tobacco use and cancer death had been persuasively demonstrated, this research effort was aimed at identifying, developing, and evaluating effective means of reducing tobacco use. Intervention trials were conducted to examine school-based prevention programs, self-help and minimal intervention strategies, advice delivered by physicians and dentists, mass-media approaches, and community-based programs. Interventions focused on youth, racial and ethnic minorities, women, users of smokeless tobacco, and heavy smokers. These interventions were later delivered through NCI's COMMIT, a randomized community trial to determine whether a community-level, multichannel effort could increase rates of smoking cessation.^{108,109}

The intervention phase of COMMIT was conducted from 1988 to 1992. Trial activities were implemented through five major channels: community mobilization—an overarching effort to organize the community around tobacco control; health care providers; worksites and organizations; program services; and public education.¹¹⁰ One community in each of 11 matched community pairs was randomly assigned to the intervention, and the other community in the pair served as a comparison community. Following the intervention, 10,019 heavy smokers and 10,328 light-to-moderate smokers were surveyed by telephone. There were no differences found between intervention and comparison communities among heavy smokers (more than 25 cigarettes per day). However, at the project's end, 30.6% of light-to-moderate smokers (less than 25 cigarettes

per day) in the intervention communities quit smoking, as compared with only 27.5% in the comparison communities.¹¹⁰ COMMIT's impact on light-to-moderate smokers, although modest, had a significant public health impact. Additionally, the trial provided valuable lessons about how to mobilize communities to support environmental change. As in previous community trials, COMMIT's limited effectiveness was thought to result, at least in part, from secular trends in comparison communities.¹⁰⁹

ASSIST

In 1991, NCI launched ASSIST to prevent or reduce cigarette prevalence and consumption, primarily through state policy-based approaches to alter the social environment.⁸¹ The principal focus of ASSIST was to alter the environmental and social influences affecting cigarette smoking through development of skills in media advocacy; promotion of local and state clean indoor air laws; reduction of youth access to tobacco products; limitation of tobacco advertising, especially that targeting children, women, and members of minority groups; increases in tobacco taxes; and increases in demand for smoking cessation services.¹¹¹

The COMMIT strategy, which ASSIST extended across entire states, recognized that powerful social forces affect tobacco use, and that the community must be mobilized to make smoking socially unacceptable. In community mobilization, networks of public and private organizations and special interest groups pool and coordinate resources—personnel, time, money, goods, and services—to support a broad range of tobacco control activities. Through ASSIST, state- and community-based coalitions for tobacco control were formed. These coalitions comprised community organizations capable of coordinating and delivering effective interventions.

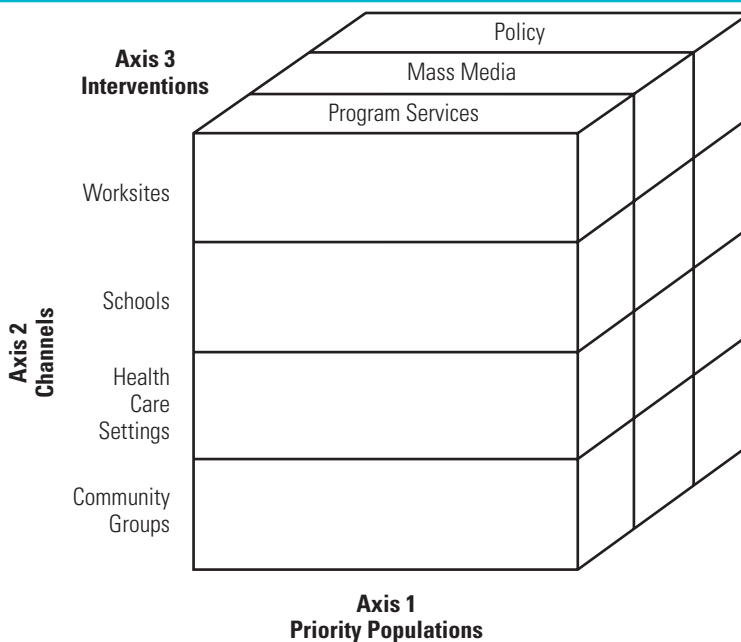
NCI joined the American Cancer Society (ACS) and 17 state health departments in planning and managing ASSIST. ACS had long been involved in local smoking prevention and control activities and had a strong network of volunteers to mobilize communities and expand the delivery of tobacco use prevention and control interventions. Health departments—with their commitment to public health, experience in working in a culture of institutional partnerships, access to priority populations of smokers, and guaranteed continuing presence—competed to receive ASSIST contracts.

ASSIST was oriented toward developing, implementing, and evaluating multiple interventions, using a variety of channels to reach multiple populations. ASSIST used a three-dimensional cube (figure 2.1) as a model to define its scope.¹¹¹ This cube

represents the domains of focus for states participating in ASSIST and provides a graphic reminder that the components (interventions, channels, and priority populations) are interrelated and represent critical constituents in a comprehensive approach to tobacco control.

By developing a matrix approach to the complex tobacco control enterprise, it was possible to create and improve on a framework for state tobacco control efforts. The ASSIST evaluation and modeling led to development of a revised model (figure 2.2) that retains the perspective that multiple variables interplay in a complex way, but includes factors not considered in the ASSIST cube (e.g., tobacco industry efforts to impede tobacco control). The evaluation effort was developed to enable both (1) a comparison of tobacco control in ASSIST and non-ASSIST states and (2) a modeling

Figure 2.1 ASSIST Interventions and Delivery Channels



Source. Adapted from National Cancer Institute. 1991. *Strategies to control tobacco use in the United States: A blueprint for public health action in the 1990's* (Smoking and tobacco control monograph no. 1, NIH publication no. 92-3316), xii. Bethesda, MD: National Cancer Institute.

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of the complex relationships among tobacco control program components to begin exploring their relative impacts.

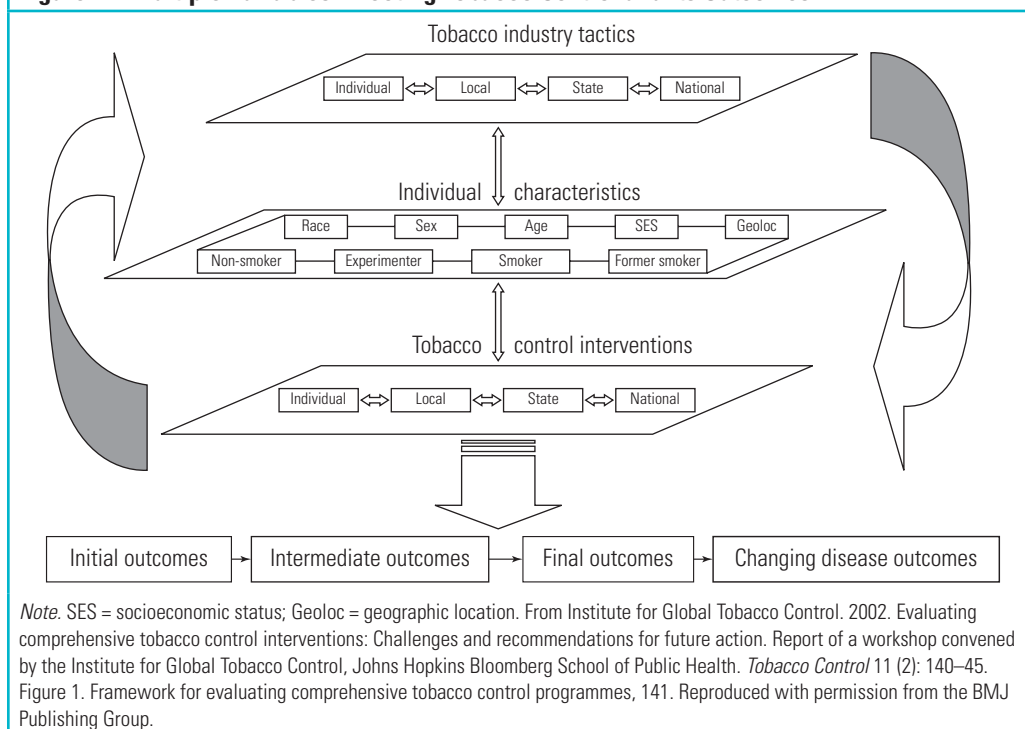
ASSIST and similar intervention programs have been important to tobacco control efforts for several reasons. States that participated in ASSIST experienced a greater decrease in smoking prevalence than states that did not.¹¹² At a time of devolution from federal to state funding of tobacco control efforts, participating states demonstrated the ability to mobilize tobacco control resources. They also showed that investment in building state tobacco control capacity and in promoting tobacco control policy change was an effective strategy for reducing tobacco use.¹¹²

Before NCI and ACS instituted ASSIST, few state health departments had tobacco control programs of significance. In 1994, the Centers for Disease Control and

Prevention (CDC) funded the remaining non-ASSIST states (excepting California, which had Proposition 99 funding) and the District of Columbia to implement tobacco control programs through a program titled Initiatives to Mobilize for the Prevention and Control of Tobacco Use. The emphasis of these initiatives was to develop comprehensive state tobacco prevention and control programs involving participation of diverse community groups, coalitions, and community leaders. In 1999, CDC created the National Tobacco Control Program to provide funding to the state and territorial tobacco control programs.

In 1993, the Robert Wood Johnson Foundation founded the SmokeLess States Program, designating the American Medical Association to serve as the National Program Office. The goals of the program were to concentrate efforts in three general areas: (1) increased public awareness of the

Figure 2.2 Multiple Variables Affecting Tobacco Control and Its Outcomes



dangers of tobacco use, (2) public education on effective tobacco control policies (e.g., increasing excise taxes, promoting clean indoor air), and (3) enhancement of local smoking prevention and treatment programs. The program initially funded statewide coalitions in 19 states; two years later, additional funding raised the number of coalitions to 30.¹¹³

Programs such as those described here highlight a growing focus on population-level tobacco control interventions that seek to create environmental change. They provide evidence that systems approaches make a difference in tobacco control efforts and tobacco use. These approaches represent an important evolutionary step, but alone they are not sufficient. There is a growing realization that relationships evolve among the individual and his or her environment, the tobacco product, and the industry that produces and promotes that product. It is increasingly important to approach tobacco control research and practice from a systems perspective, understanding the complex interactions among these components.

Current Tobacco Control Research and Practice: Systems Problems

The tobacco control problems that remain are systems problems—complex, interdependent issues that lie within the fundamental nature of today’s tobacco control environment. Applying what is known about tobacco use as a system and what has been learned from earlier tobacco control efforts helped the ISIS team identify the following problems:

- Numerous disparate communities of interest and duplication of effort
- Ineffective integration of research and practice
- Competition from a well-financed and organized tobacco industry that has well-integrated dissemination and networking efforts
- In some cases, lack of evidence for effectiveness of specific tobacco control efforts on key outcomes such as smoking cessation, morbidity, and mortality
- Diffuse tobacco control efforts reflecting a lack of strategic, multipartner planning and execution

The ISIS team concluded that these substantial and often overlapping challenges must be overcome to bring tobacco control resources and efforts into an integrated system. Identifying problems provides direction for tobacco control efforts.

Moving tobacco control forward will require the recognition that the landscape today is different from that of 10 years ago. The tobacco industry has responded to tobacco control efforts with a new level of sophistication. As in many fields, good science frequently sits in scientific journals and reports, unused by many who could benefit from it. The tobacco control community is likely responsible for “tipping” the national consciousness in favor of reduced acceptance of tobacco use. However, the community has not adequately addressed long-term strategies and is, on occasion, at odds with itself over issues such as harm reduction.

To proceed to the next level and to more effectively translate scientific discoveries into practice, the ISIS team concluded that it is necessary to move beyond familiar approaches and toward systems methods that address fundamental issues of complexity, interdependency, knowledge management, and engagement of organizations as a system. Because the

current challenges in tobacco control are related to the complexities and dynamics of the systems in which tobacco control is embedded, the solutions must lie in addressing those systems.

Lessons from ISIS

Unlocking the promise of systems approaches requires a participatory, collaborative environment among the stakeholders. In turn, this requires a fresh approach to management, leadership, and interactions within and among organizations. ISIS explored how organizations can function as systems through facilitation, empowerment, self-organization, participation, and continuous evaluation. The aim of ISIS was to apply methods of systems thinking to practices in tobacco control. Chapters 4 and 7 discuss systems thinking in the framework of a systems approach to organization and management and creation of a “combined toolbox” for the development of outcome-oriented implementation strategies for tobacco control.

ISIS is based on the idea that the growth of systems methods in areas such as epidemiology,¹¹⁴ organizational behavior,¹¹⁵ and national defense¹¹⁶ are applicable to tobacco control. Here, the argument is made for applying integrated methods for strategic systems thinking in response to critical needs in tobacco control and as a proof of concept for applying these approaches to similar challenges in other key areas of public health. Six key facets of the ISIS perspective also are discussed here: (1) using a transdisciplinary approach; (2) transcending or integrating diverse cultures and missions; (3) accelerating transfer from discovery, to development, to delivery; (4) setting evidence-based priorities; (5) creating a federation of systems, also called “networks of stakeholders” in this monograph; and (6) setting long-term goals.

Using a Transdisciplinary Approach

Researchers, practitioners, policy makers, and other stakeholders approach tobacco control from the perspective of their own disciplines, which include law, economics, epidemiology, the behavioral sciences, neurobiology, toxicology, chemistry, addiction medicine, and public health. Members of these disciplines speak different languages, use different research and intervention tools and models, and read and contribute to different literature bases. To most researchers and practitioners, the composite whole of tobacco control and related literature is inaccessible and use of the full scientific basis for practice is unlikely.

Understanding the complex problems of tobacco use and tobacco control requires true transdisciplinary collaboration in both research and practice and between research and practice. However, creating the mindset and functionality of a transdisciplinary approach is difficult, because it represents a worldview requiring increased teamwork across a wide array of fields and disciplines. This approach may also be more time consuming, at least initially, because it depends on the development and maintenance of relationships and infrastructures among diverse partners.

Disciplines serve a critical function by ensuring depth of knowledge in a particular field, partly through the exchange of information within discipline-specific social networks. They have also allowed relatively rapid gains in knowledge. However, disciplines may also become “stovepiped,” in that the knowledge from one discipline gives rise to unique terminology that tends to isolate it from others. The lack of linkage among disciplines has created the effect of “silos dotting the landscape.” These silos are effective in holding their contents but inefficient at allowing carryover from one silo to another.

Tobacco Control: A Multitude of Stakeholder Organizations

Organizations that focus on tobacco control vary greatly. For tobacco control efforts to succeed, it may be necessary to develop a strategic and collaborative vision and action. Major government research agencies such as the National Cancer Institute and the National Institute on Drug Abuse have different but overlapping areas of focus. The same holds true for more public health and practice-oriented government agencies, such as the Centers for Disease Control and Prevention and the Substance Abuse and Mental Health Services Administration. Furthermore, within the agencies that address public health research and practice, still more areas of focus overlap. When organizations such as the Robert Wood Johnson Foundation, the American Legacy Foundation, the Campaign for Tobacco-Free Kids, state health departments, and corporate leaders such as the Chief Executive Officer Roundtable on Cancer are also considered, the challenge of and opportunity for optimizing the missions of these many potential partners into a functional network oriented to achieving the greatest public good in the most efficient way are expanded. Fortunately, in diversity there is strength. Diversity allows for breadth of thinking and action. One key challenge is to harness and focus within that diversity to achieve the ultimate goal.

It is encouraging that efforts to link disciplines—to increase transdisciplinary and multidisciplinary thinking and action—are now recognized as valuable. For example, in 1999, NCI, the National Institute on Drug Abuse, and the Robert Wood Johnson Foundation provided funding for the Transdisciplinary Tobacco Use Research Centers. This paradigm shift has now been expanded beyond tobacco control; NCI also has funded several transdisciplinary centers to investigate obesity and energy balance.¹¹⁷ Additionally, the National Institutes of Health (NIH) has recently created the “Roadmap Initiative,” a transdisciplinary and transinstitutional initiative to identify major opportunities and gaps in biomedical research that no single NIH institute could tackle alone.¹¹⁸ The gradual increase in linkage among disciplines could lead to more rapid knowledge discoveries, which could facilitate delivery of interventions.

Transcending or Integrating Diverse Cultures and Missions

Among the barriers to the creation of an integrated system is the reality that many partners and potential partners have different missions, practices, and

cultures. In many cases, priorities overlap or are complementary, but little effort goes into exploring the areas of overlap and complementarity. On the other hand, planned redundancy may have value to ensure that a particular need is fully addressed and that decreased funding to one organization will not jeopardize survival of a critical infrastructure.

Accelerating Transfer from Discovery, to Development, to Delivery

Another major challenge in tobacco control, as in other domains of public health and medical care, is the less than optimal progression from scientific discovery to the development, delivery, and widespread use of interventions. One analysis indicated that 17 years can pass between the time of a discovery and its use in clinical practice.¹¹⁹ This finding indicates a pipeline that is cumbersome and not oriented toward optimizing the flow and use of new knowledge. In this information age, it is time to optimize the progression from discovery to delivery. For example, in 2003, NCI provided \$19 million for research on the treatment of tobacco addiction (C. Backinger, pers. comm.,

Moving from Clinical Trials to Real Life

The problem of effective dissemination and implementation often extends to clinical interventions as well. For example, once the U.S. Food and Drug Administration approved medications to help smokers stop smoking, these drugs were marketed rapidly to health care providers and the public, even though how they would be used in the “real world” was not well understood. The lack of a surveillance system to assess the effectiveness of medications being used to treat tobacco addiction has resulted in some confusion. Many in the scientific and public health communities cite numbers derived not from studies conducted in real-world settings but rather from highly controlled clinical trials. The development of surveillance systems to collect and analyze data on the progression of knowledge as a science-to-practice value chain could ensure that (1) those involved in each stage of discovery, development, and delivery are informed about what has been learned from each stage; and (2) delivery is not an end point but rather a rich environment for discovery through applied science. The process of progression from discovery, to development, to delivery is more interactive than linear.

October 18, 2005). However, insufficient infrastructure exists to ensure that the knowledge gained through this research will be shared systematically with other investigators. Furthermore, not enough effort has been made to develop a network of scientists studying the treatment of tobacco addiction, so that these investigators can rapidly share knowledge of methods and research outcomes.

Despite the existence of Web-based social networks that allow the rapid exchange of information and rapid publication via scientific e-journals, the scientific community has largely held to the practices of the past. In addition, once new knowledge is developed about interventions for clinics and communities, little effort is made to link scientists and community interventionists to determine the most effective strategies for disseminating and implementing the interventions. There are examples of timely, successful transition from discovery to delivery of interventions for tobacco control and development of networked collaboration between scientists and public health practitioners—for example, the proliferation of toll-free telephone quitlines to provide smoking cessation assistance. Unfortunately, these examples demonstrate the potential rather than common experience.

Setting Evidence-Based Priorities

Despite evidence that it is cost effective, disease prevention is not the primary paradigm of the U.S. health care system. The system’s orientation toward diagnosis and treatment of disease, which is fundamental to the training of health care providers, continues because a different paradigm has not gained prominence. The United States spends billions of dollars to care for patients with health conditions caused by tobacco use but does not consistently support preventing these conditions. A greater focus on prevention may be viewed as a zero-sum gain, because it may require decreased spending on diagnosis and treatment in the short term, absent new investments. Changing the status quo is not easy, even in the face of mounting evidence that prevention is a good long-term investment.

Creating a Federation of Systems: Can Tobacco Control Learn a Lesson from the Department of Defense?

In the U.S. military, command and control issues are widely discussed and developed. Krygiel¹¹⁶ defines an environment in which there is no direct command and control (i.e., no top-down hierarchy) as a

federation of systems. For example, the U.S. military operated collaboratively within the command and control structure of the North Atlantic Treaty Organization during the Bosnian War; no single controlling organization existed.¹¹⁶ To function optimally, the military forces had to work together to compromise and develop a coordinated and collaborative mission based on common goals and objectives. This orientation is similar to what exists in tobacco control.

Perhaps the best comparison in tobacco control was the process of developing and implementing the World Health Organization's Framework Convention for Tobacco Control (FCTC). As a result of leadership and collaboration by the World Health Organization, many organizations around the world developed a common goal and worked together to achieve that goal.¹²⁰ The FCTC is an important example of what can be accomplished by developing synchronous networks of organizations or a federation of systems that direct their efforts toward a common outcome. This collaborative effort is also an excellent example of using the fruits of scientific discovery to develop effective policies that can benefit humanity.

Setting Long-Term Goals

Little organized consideration of the long-term goals of the tobacco control movement has occurred. Stakeholder goals may vary widely from reducing the prevalence of smoking to the lowest possible level, to dismantling tobacco companies as they now exist.¹²¹ The long-term goals envisioned by the tobacco companies must also be considered. For example, a strategic analysis by Philip Morris considered the complex interacting influences in the business system, changes in knowledge, network-enabled direct marketing, and a shift in the corporate paradigm toward development as a pharmaceutical company.⁶⁹

Unfortunately, the tobacco control community has not implemented efforts to model the many complex components that support and impede tobacco control efforts, so as to develop a more strategic vision of the future. Such an effort would not be simple, in part because different groups may identify and pursue different long-term strategies. However, exploring these strategies and the structures and functions needed to achieve them has the potential to inform the tobacco control community and supportive policy makers about what can and cannot be achieved. Working backward from various long-term goals would make it possible to better understand which structures and functions are needed to achieve them. The scenarios would likely represent new, highly nonlinear models with complex and dynamic components, requiring large quantities of data over time. By exploring both data-driven and theoretical (or simulation) models, the scientific and public health communities also could encourage the development of data sources that can be used to develop data-driven models, which have the potential to predict outcomes of known interventions.

Summary

Moving tobacco control forward requires the recognition that the landscape today is fundamentally different from that of even 10 years ago. Many significant advances have occurred in tobacco control, but the tobacco industry has responded to these successes with a new level of sophistication. ISIS identified several critical needs and priorities for addressing tobacco and other public health threats in the future:

- Using a transdisciplinary approach
- Transcending or integrating diverse cultures and missions

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- Accelerating transfer from discovery, to development, to delivery
- Setting evidence-based priorities
- Creating a federation of systems (or networks of stakeholders)
- Setting long-term goals

Thus, the tobacco control community needs to set long-term goals that take into account changing tobacco industry tactics. Progress toward improving the translation of discoveries into practice will require moving beyond familiar approaches and toward systems methods that address fundamental issues of complexity, interdependency, knowledge management, and engagement of organizations as a system. Current challenges are related to the complexities and dynamics of the systems in which tobacco control is embedded. Therefore, the solutions must lie in addressing those systems.

ISIS was a pilot effort to better understand the complexities of addressing tobacco use as a major public health threat. However, it also reflects a continuation of the vision delineated in the very first NCI tobacco control monograph to better understand those complexities. Just as the ideas put forth in the first monograph led to new thinking and action on tobacco control, it is believed that the implementation and integration of systems approaches have the potential to further advance tobacco control and improve the public's health.

Conclusions

1. The prevalence of tobacco use and levels of cigarette consumption among adults have dropped considerably since 1950. However, tobacco use remains the nation's leading cause of premature preventable death. The success of efforts to reduce the prevalence of adult smoking to the *Healthy People 2010* goal of 12% or less remains elusive.
2. Increasingly, tobacco use is seen as a population-level health problem that involves forces from the tobacco industry, current tobacco users and nonusers, and the environment.
3. Tobacco control efforts have evolved from a focus on individual interventions toward population-level interventions, as the nature of tobacco use has become better understood. These efforts have evolved into a complex system involving multiple stakeholders and environmental factors, ranging from social attitudes toward smoking to the countervailing efforts of the tobacco industry.
4. Some research findings suggest that systems approaches are critical to further substantive gains in tobacco control. The success of early tobacco control efforts at the population level gives impetus to further exploration of this hypothesis.

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