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NCI Tobacco Control Monograph Series

Monograph 18

Greater Than the Sum

Systems Thinking in Tobacco Control

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

National Institutes of Health

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Introduction

- 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.
- 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.

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Introduction (continued)

- Tobacco control has 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.
- 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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Purpose of Monograph

To examine the value and potential impact of systems thinking for tobacco control, both to improve its outcomes and as a template for strategies to apply these methods to other public health issues.

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Overall Findings

1. Tobacco control is at a crossroads because tobacco use is increasingly recognized as a complex adaptive system involving biological, behavioral, and environmental influences.
2. Systems thinking has the potential to transform tobacco control research, practice, and policy by improving collaboration and by providing a more dynamic and adaptive evidence base for practice and a deeper knowledge about the impact of tobacco prevention and control activities.

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Overall Findings (continued)

3. Systems organizing encourages the transformation to a systems culture by addressing these core issues:
   - vision and paradigm
   - barriers
   - leadership
   - need for an ongoing learning environment for systems thinking

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Overall Findings (continued)

Such an environment encompasses a wide variety of structured group processes, many of which may involve quantitative frameworks. Systems organizing implies a synthesis of the classic linear management processes of planning, organizing, leading, and controlling with a more adaptive environment expressed around concepts of vision, structure, action, and learning.

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Overall Findings (continued)

4. System dynamics encompasses qualitative and mathematical simulation approaches to model dynamic relationships that evolve over time, and can simulate behavior including possible unintended consequences and long-term effects. Efforts to develop and apply systems methods and processes involve theory and research development, mixed-methods systems thinking, and participatory assessment of systems needs.

   At a practical level, the infrastructure for system dynamics is addressed by fostering an ecological perspective on implementation, as well as a systems approach to evaluation.

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Overall Findings (continued)

5. System networks of tobacco control stakeholders form a foundation for a systems environment in tobacco control, replacing “silos” with linkages of people and resources that transcend geography and discipline.

   This process involves building and maintaining stakeholder relationships by creating networks of stakeholders for systems thinking, studying the dynamics and effects of these networks, linking disciplines of stakeholders in tobacco control, and preparing for the impact of demographic change.

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Overall Findings (continued)

6. Systems knowledge management and translation form a key component of systems approaches for tobacco control, examining purpose, people, process, and products within a broader knowledge infrastructure.

   This involves building system and knowledge capacity by expanding public health data, integrating information silos, fostering the skills and culture to affect processes and outcomes, and creating networks for knowledge translation.

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Overall Findings (continued)

7. Integration and synthesis of systems approaches are key to a systems thinking environment for tobacco control, moving toward a more adaptive system that changes public health outcomes. Approaches such as systems organizing, system dynamics modeling, network methods, and knowledge management contain synergies in areas ranging from participatory stakeholder networks to simulation and knowledge environments.

   Achievement of this goal involves creating a vision, developing capacity, building planning models, and establishing meaningful and adaptive evaluation measurements.

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Overall Findings (continued)

8. Capacity building for systems thinking touches on the resources needed for bringing a systems thinking environment to fruition in tobacco control.

   These include fundamental infrastructure issues such as creating networks and linking them with systems knowledge in other fields, as well as specific action items such as creating systems curricula for academia and national professional associations, and holding conferences for systems thinking in public health.

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Key Terms & Definitions

- 4P-KMT — Four P-knowledge management and translation
- ACS — American Cancer Society
- ALA — American Lung Association
- ASSIST — American Stop Smoking Intervention Study for Cancer Prevention
- caBIG — Cancer Biomedical Informatics Grid
- CAS — complex adaptive systems
- CBPR — community-based participatory research
- CDC — Centers for Disease Control and Prevention
- CHP — Consumer Health Profiles
- CISNET — Cancer Intervention and Surveillance Modeling Network

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Key Terms & Definitions (continued)

- COMMIT — Community Intervention Trial for Smoking Cessation
- DHHS — U.S. Department of Health and Human Services
- FCTC — Framework Convention on Tobacco Control
- FY — fiscal year
- GTRN — Global Tobacco Research Network
- ISIS — Initiative on the Study and Implementation of Systems
- KMT — knowledge management and translation
- KTNs — knowledge-translation networks
- LGIs — large-group interventions
- MDS — multidimensional scaling

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Key Terms & Definitions (continued)

- MSA — Master Settlement Agreement and Amendments
- NCI — National Cancer Institute
- NIH — National Institutes of Health
- PLANET — Plan, Link, Act, Network with Evidence-based Tools
- SEER — Surveillance, Epidemiology, and End Results
- SES — socioeconomic status
- SoTC — Strength of Tobacco Control
- TTURC — Transdisciplinary Tobacco Use Research Center

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ISIS Project

- Initiative on the Study and Implementation of Systems (ISIS)
- Funded by the National Cancer Institute to investigate the potential of integrated, systems-based approaches by all stakeholders to change public health outcomes.
- One of the first major coordinated efforts to study and implement a systems thinking perspective.

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ISIS Project (continued)

- ISIS explored the general idea of a systems thinking rubric encompassing a great variety of systems-oriented methodologies and approaches.
- Four approaches were selected for initial investigation because of their applicability to tobacco control and public health:
  - Systems organizing
  - System dynamics
  - System networks
  - Systems knowledge

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ISIS Project (continued)

Table 3.3 Core Areas Examined by ISIS and Goals

Core area	Long-term goals	ISIS case studies
How we organize: Systems organizing	Participatory, stakeholder-based approaches to systems organizing	Concept-mapping studies of local strength of tobacco control factors and of designing for research dissemination
How we understand dynamic complexity: System dynamics modeling	▪ Development of systems models for tobacco control factors and processes for analyzing and evaluating them ▪ Telling the tobacco control "story" in qualitative as well as quantitative terms, so it can reach a wider audience	▪ Causal model for tobacco cessation based on data in clinical and community guides ▪ Quantitative simulation of intervention impacts in different age groups
Who we are: Network analysis	Network-based structures for future collaborative tobacco control efforts	▪ Examination of network issues in the Global Tobacco Research Network ▪ Case study of network analysis in ongoing multistate tobacco control evaluation project
What we know: Knowledge management and knowledge transfer	Infrastructure for knowledge management and transfer in tobacco control efforts, incorporating both explicit and tacit knowledge	Review of current dissemination efforts (e.g., NCI's Cancer Control PLANET initiative)[a] and analysis of knowledge management needs

Note. ISIS = Initiative on the Study and Implementation of Systems; NCI = National Cancer Institute; PLANET = Plan, Link, Act, Network with Evidence-based Tools.

[a]Cancer Control PLANET is an NCI-funded portal providing on-line access to research results, partner organizations, and evidence-based programs and products for cancer control, available at http://cancercontrolplanet.cancer.gov.

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Tobacco Control at a Crossroads: Key Findings

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.

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Tobacco Control at a Crossroads: Key Findings (continued)

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.

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Tobacco Control at a Crossroads: Key Findings (continued)

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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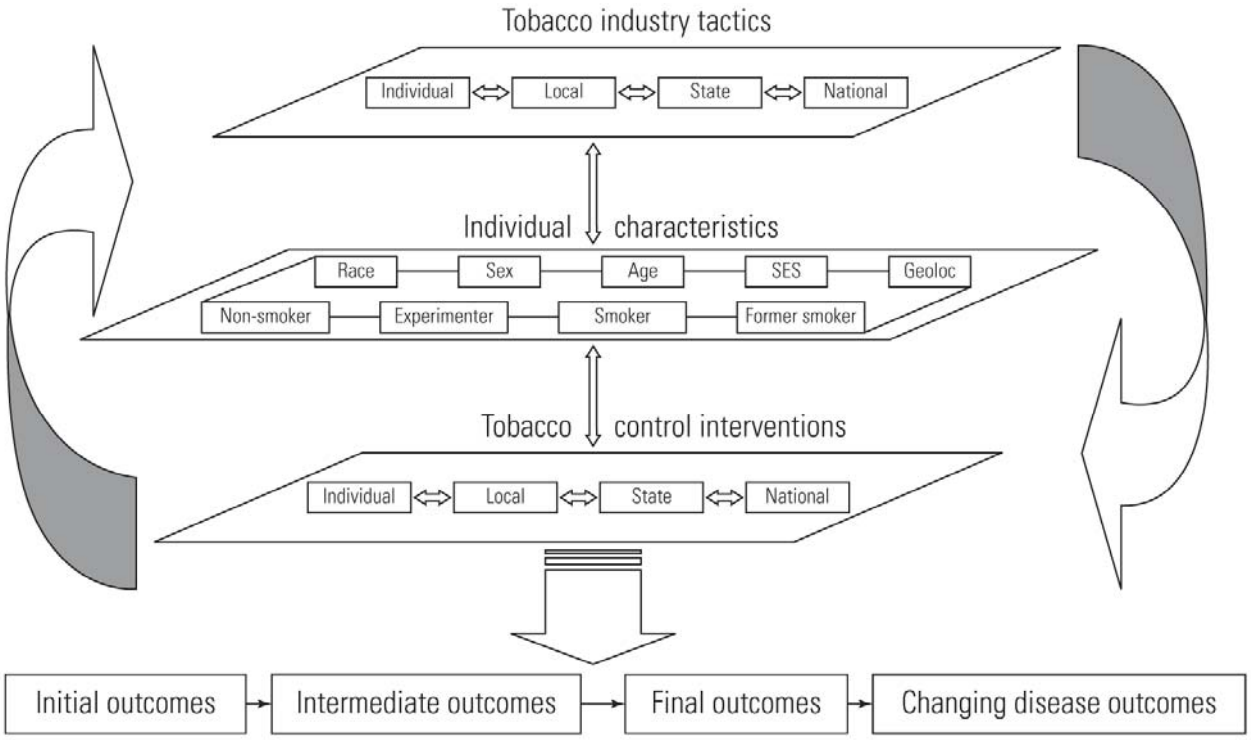
Tobacco Control at a Crossroads

Figure 2.2 Multiple Variables Affecting Tobacco Control and Its Outcomes



Note. SES = socioeconomic status; Geoloc = geographic location. From Institute for Global Tobacco Control. 2002. Evaluating comprehensive tobacco control interventions: Challenges and recommendations for future action. Report of a workshop convened by the Institute for Global Tobacco Control, Johns Hopkins Bloomberg School of Public Health. *Tobacco Control* 11 (2): 140–45. Figure 1. Framework for evaluating comprehensive tobacco control programmes, 141. Reproduced with permission from the BMJ Publishing Group.

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Systems Thinking: Potential to Transform Tobacco Control

Systems Thinking is the use of systems approaches and the general logic that underlies them to view the world.

- It is used to better understand system behaviors and to identify systems principles such as feedback loops, stocks and flows, open versus closed systems, decentralized versus hierarchical systems, and self-organization.

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Systems Thinking: Potential to Transform Tobacco Control (continued)

- A number of scholars have developed frameworks for systems thinking—sets of principles, rules, skills, or ideas. It can be simple and complex, theoretical and practical, scientifically rigorous and philosophically grounded.
- There is no single and correct method of systems thinking.

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Systems Thinking: Key Findings

1. The key challenges in tobacco control and public health today are fundamentally systems problems, involving multiple forces and stakeholders. Systems thinking is an innovative approach to address these challenges and improve health outcomes.
2. Numerous frameworks exist for systems thinking, a concept that encompasses a broad synthesis of systems approaches. These approaches provide a theoretical basis for applying specific systems methods, such as system dynamics modeling, structured conceptualization, and network analysis.

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Systems Thinking: Key Findings (continued)

3. The Initiative on the Study and Implementation of Systems encompassed four key areas of systems thinking, and their integration: how people organize (managing and organizing as a system); how people understand dynamic complexity (system dynamics modeling); who people are (network analysis); and what people know (knowledge management and knowledge transfer).
4. Examination of systems approaches could address key questions and problems faced by the various stakeholder groups.

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Systems Thinking: Key Findings (continued)

5. Potential benefits of systems thinking in tobacco control include:
   - improving collaboration among stakeholders
   - harnessing resources toward evidence-based practice
   - eliminating duplication of effort
   - gaining deeper knowledge about the impact of tobacco control activities

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Systems Thinking

Table 3.1 Richmond's Seven Skills of Systems Thinking

Traditional skill	Systems thinking skill
Static thinking Focusing on particular events	**Dynamic thinking** Framing a problem in terms of a pattern of behavior over time
System-as-effect thinking Viewing behavior generated by a system as driven by external forces	**System-as-cause thinking** Placing responsibility for a behavior on internal actors who manage the policies and plumbing of the system
Tree-by-tree thinking Believing that really knowing something means focusing on the details	**Forest thinking** Believing that to know something requires understanding the context of relationships
Factors thinking Listing factors that influence or are correlated with some result	**Operational thinking** Concentrating on causality and understanding how a behavior is generated
Straight-line thinking Viewing causality as running in one direction, with each cause independent from other causes	**Closed-loop thinking** Viewing causality as an ongoing process, not a one-time event, with effect feeding back to influence the causes and the causes affecting each other
Measurement thinking Searching for perfectly measured data	**Quantitative thinking** Accepting that one can always quantify, even though one cannot always measure
Proving-truth thinking Seeking to prove models to be true by validating them with historical data	**Scientific thinking** Recognizing that all models are working hypotheses with limited applicability

Note. From Richmond, B. 2000. *The "thinking" in systems thinking: Seven essential skills.* Toolbox Reprint series. Waltham, MA: Pegasus Communications. Used with permission.

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Systems Thinking: A Case Study

How can systems thinking and systems approaches apply to real-life situations?

Three stakeholder groups that are especially important for early implementation of systems thinking and approaches in tobacco control:

- **Practitioners:** Stakeholders and managers of "agencies" that deliver state or local programs for prevention and cessation of tobacco use.
- **Researchers:** Scientists and analysts who develop the evidence base for effective tobacco control, such as heads of research institutes or those working at the interface of tobacco control programs and research.

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Systems Thinking: A Case Study (continued)

- **Policy makers:** Politicians and national agency executives who make decisions about policy and strategy.

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Systems Thinking: A Case Study for Practitioners (continued)

Practitioners are often the front line delivering tobacco control interventions. The following questions suggest practitioner issues that could be addressed via systems approaches?

1. How can I cope with competition from other organizations for scarce resources?
2. How do I communicate the positive outcomes my organization has achieved while arguing for continued/additional funding?

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Systems Thinking: A Case Study for Practitioners (continued)

3. How can I maintain trust with my clients when changes in funding levels alter the services I am able to provide?
4. How can I spend more time in the field and less time with administrative details?
5. Where can I find succinct, clear, and practical information on best practices?

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How to Organize: Systems Organizing – Key Findings

1. Systems organizing implies a move away from the classical linear management processes of planning, organizing, leading, and controlling toward a more adaptive, participatory environment expressed here around the concepts of vision, structure, action, and learning:
   - Vision encompasses a move from an environment of leading and managing to one of facilitating and empowering.
   - Structure encompasses a move from organizing to self-organizing.

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How to Organize: Systems Organizing – Key Findings (continued)

- Action encompasses a move from delegation to participation.
- Learning encompasses a move from discrete evaluation to continuous evaluation.

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How to Organize: Systems Organizing – Key Findings (continued)

2. Two concept-mapping projects explored key areas of organizing as a system:
   - One project, examining issues in accelerating the adoption of cancer control research into practice, yielded clusters of action items in areas of research, practice, policy, and partnerships.
   - The other project examined components of strong local and state tobacco control programs and provided the framework for a logic model of process and outcome ranging from near-term to long-term objectives.

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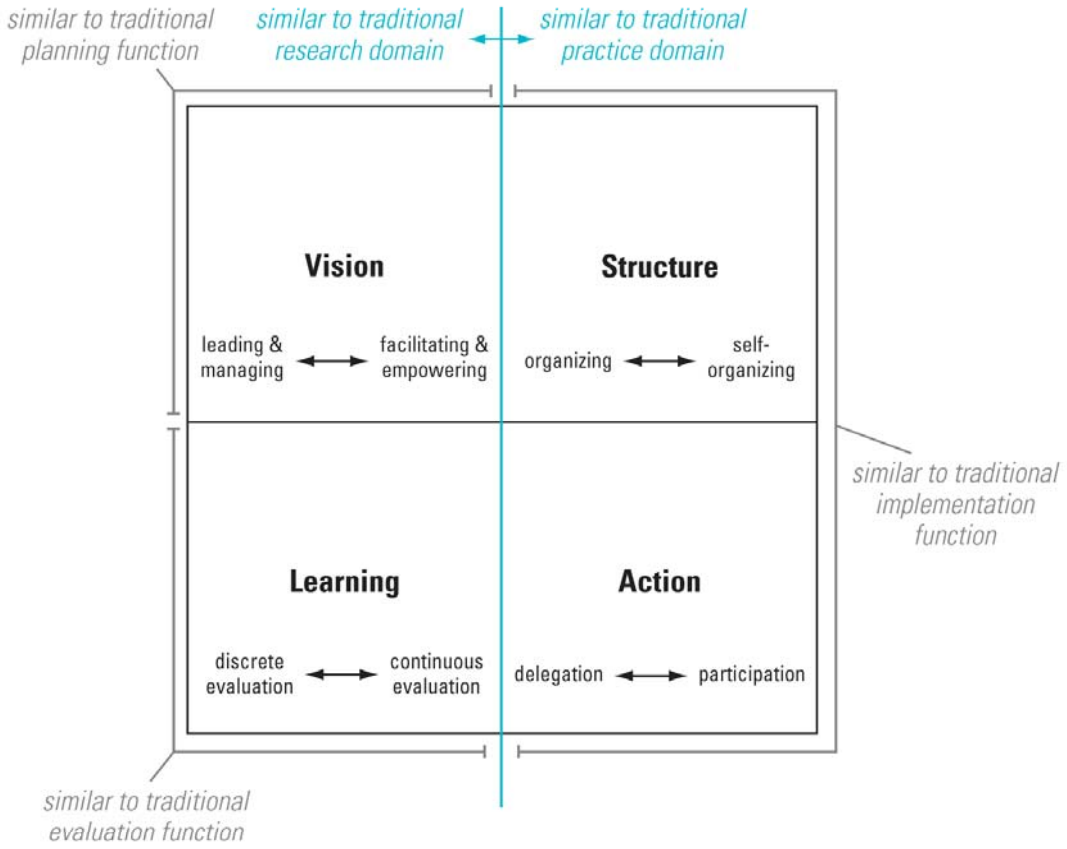
Systems Organizing Model

Figure 4.2 Systems Organizing Model



Note. From Cabrera, D. 2001. *Knowledge Age Operating System: Four principles of project design.* Version 1.0. Loveland, CO: Project N Press. Reprinted with permission.

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Systems Organizing Model (continued)

- **Vision:** From leading and managing to facilitating and empowering
- **Structure:** From organizing to self-organizing
- **Action:** From delegation to participation
- **Learning:** From discrete evaluation to continuous evaluation

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Systems Organizing: Concept Mapping

- Various methods and processes can be applied in systems planning to encourage development of a collective vision.
- Visual models involve the construction and use of maps of ideas. The concept-mapping method is a primary tool for use by individuals, although collaborative use may be possible.

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Systems Organizing: Concept Mapping (continued)

- Collaborative concept mapping:
  - Is a participatory mixed-methods approach that integrates group process activities (brainstorming, unstructured pile sorting, and rating of brainstormed items) with multivariate statistical analyses (multidimensional scaling and hierarchical cluster analysis) to yield both statistical and graphic representations of a conceptual domain.
  - Is designed around a well-informed, group-oriented, decision-making process that drives both planning and evaluation.

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How To Anticipate Change in Tobacco Control Systems

System Dynamics vs. Systems Thinking

One scholar distinguishes system dynamics and systems thinking this way:

"Systems thinking is an approach for studying and managing complex feedback systems, such as one finds in business and other social systems. In fact, it has been used to address practically every sort of feedback system. System dynamics is more or less the same as systems thinking, but [it] emphasizes the usage of computer-simulation tools. System dynamics is based on systems thinking, but [it] takes the additional steps of constructing and testing a computer-simulation model."

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How To Anticipate Change – Key Findings

1. Tobacco control consists of dynamic relationships over time and requires approaches, such as system dynamics modeling, that can address such dynamics.
2. Understanding of tobacco control and public health issues has evolved from simple cause-and-effect studies and logic models to more complex, ecological problems that involve feedback and evolving behavior.
3. System dynamics uses mathematical simulation approaches based on stocks, flows, and feedback loops, which can model system structures and simulate future system behavior, including possible unintended consequences and long-term effects.

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How To Anticipate Change – Key Findings (continued)

4. Demonstration projects, such as the system dynamics simulation of tobacco prevalence and consumption developed for the Initiative on the Study and Implementation of Systems, show the potential to model and simulate future tobacco issues to design more effective interventions.

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How To Anticipate Change – Key Findings (continued)

5. Opportunities are likely to surface for integrating system dynamics modeling and other systems thinking approaches at epistemological and methodological levels. Systems approaches can and should integrate within a larger systems thinking environment encompassing components such as systems organizing, networks, and knowledge management.

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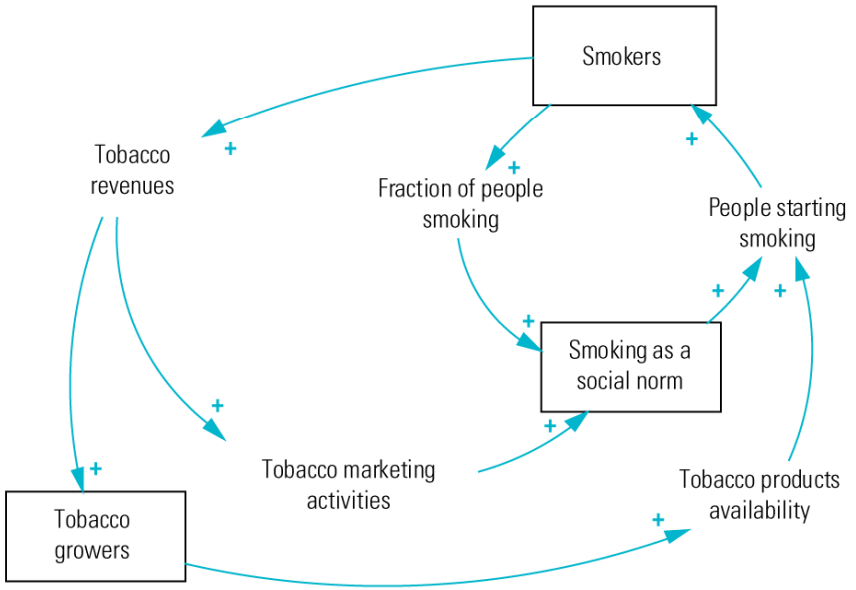
How To Anticipate Change – Causal Map

Figure 5.3 Causal Map Segment, Incorporating Social Norm and Tobacco Grower Factors



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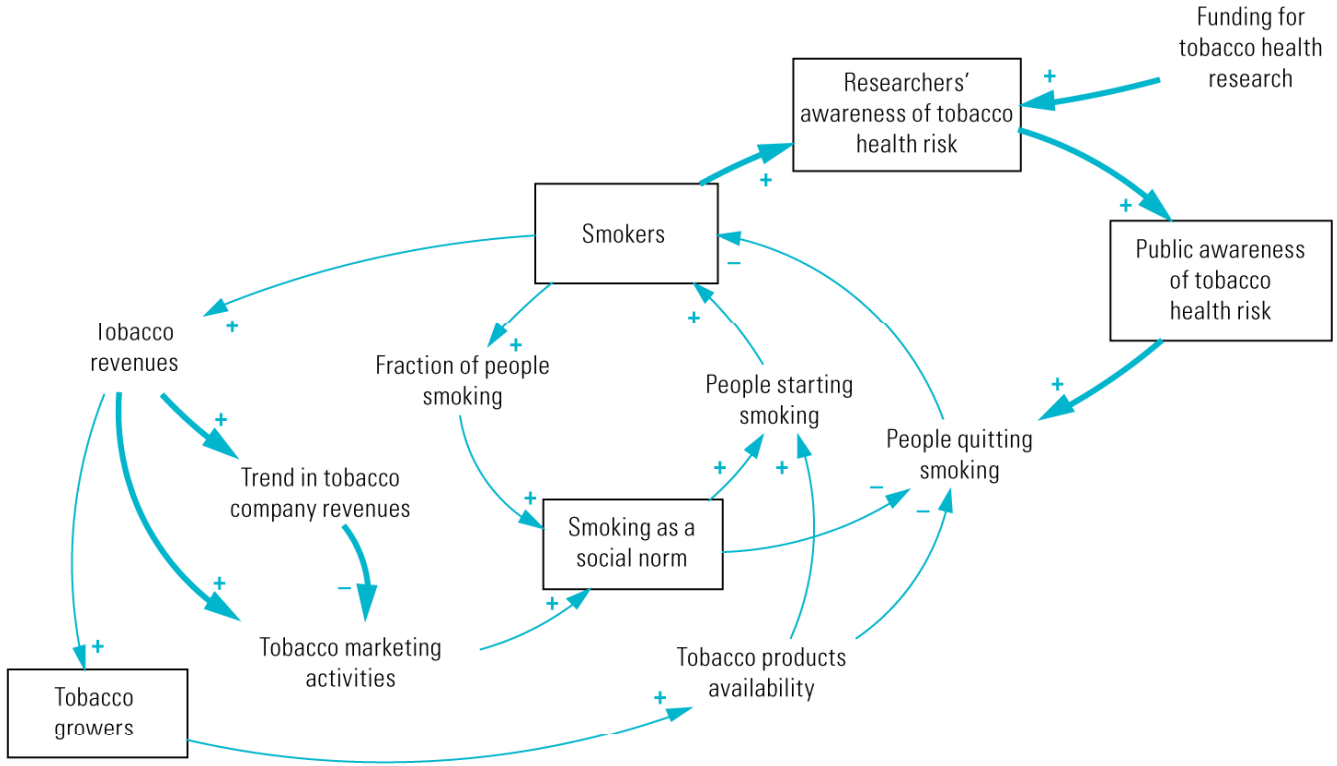
How To Anticipate Change – Causal Map (continued)

Figure 5.4 Expanded Causal Map Segment, Incorporating Awareness of Tobacco Health Risk



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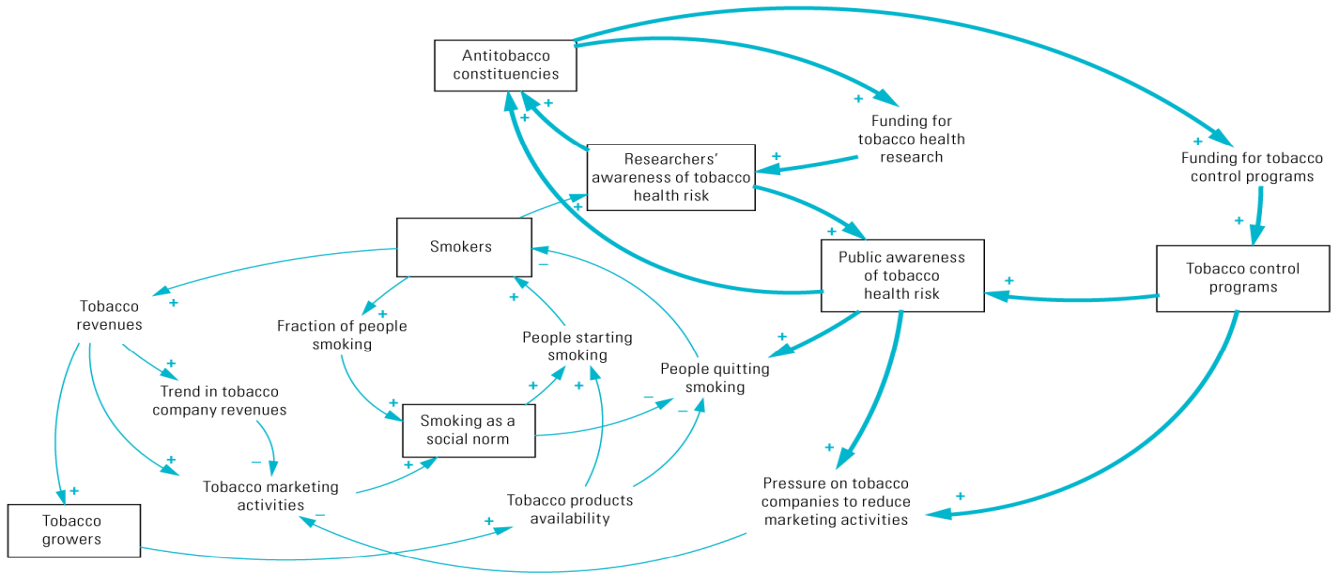
How To Anticipate Change – Causal Map (continued)

Figure 5.5 Causal Map Adding Impact of Antitobacco Constituencies



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Understanding and Managing Stakeholder Networks – Key Findings

1. Solving complex future issues in tobacco control will require replacing silos of information and activity with greater linkage of tobacco stakeholders through networks.
2. Networks of tobacco control stakeholders form a foundation of the systems environment envisioned for the future of tobacco control. Many components of a systems approach are built around the presumption of stakeholder networks that span multiple levels of tobacco control activity and transcend geography and discipline.

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Understanding and Managing Stakeholder Networks – Key Findings (continued)

These components include:

- building organizational capacity
- participatory approaches to planning
- implementation, and evaluation
- optimization of resources and effort
- dissemination of knowledge and best practices

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Understanding and Managing Stakeholder Networks – Key Findings (continued)

3. Network analysis holds the potential for facilitating understanding and strategic management of linkages between stakeholder groups.
4. Numerous theories of network behavior currently coexist, and core concepts that describe networks now have broad acceptance, particularly those related to network attributes and behavior.
5. Network applications in public health are at an early stage, but have shown promise in recent studies:
   - North American Quitline Consortium
   - Global Tobacco Research Network

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Understanding and Managing Stakeholder Networks – Key Findings (continued)

6. Network attributes can serve as a measure of the health of tobacco control efforts.
7. In the future, tobacco control programs could consist of multiple networks with specific functional objectives, linked in turn as part of a “network of stakeholders.”

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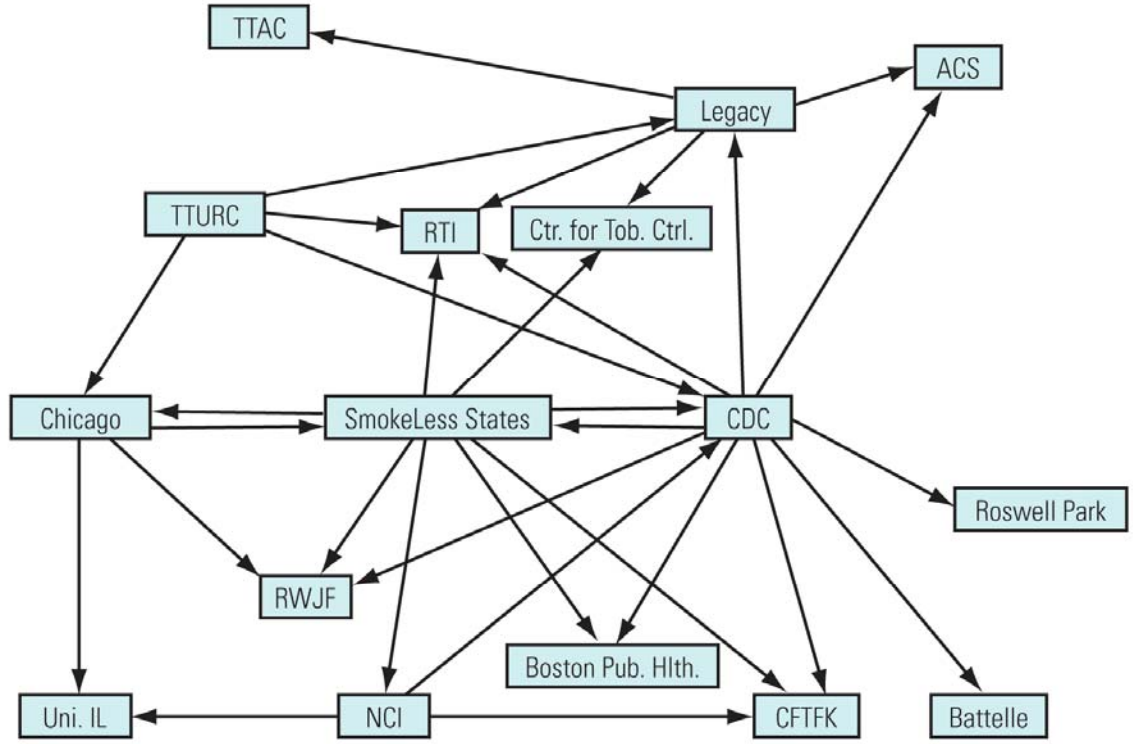
Understanding and Managing Stakeholder Networks

Figure 6.3 Role of Informal Interactions in Referral Patterns



Notes. TTAC = Tobacco Technical Assistance Consortium; ACS = American Cancer Society; Legacy = American Legacy Foundation; TTURC = Transdisciplinary Tobacco Use Research Center; RTI = Research Triangle Institute International; Ctr. for Tob. Ctrl. = Center for Tobacco Control; CDC = Centers for Disease Control and Prevention; RWJF = Robert Wood Johnson Foundation; Boston Pub. Hlth. = Boston Public Health; Uni. IL = University of Illinois; NCI = National Cancer Institute; CFTFK = Campaign for Tobacco-Free Kids.

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What We Know: Managing the Knowledge Content – Key Findings

1. Effective knowledge management is based on a social context revolving around knowledge production, use, and refinement, as well as an ecological context based on audience, motivations, and mechanisms.
2. A formal strategy for knowledge management is essential to the creation of a consistent knowledge environment. One framework defines knowledge capabilities in terms of purpose, people, process, and products, together with a knowledge management and translation infrastructure defined in terms of its underlying organization, technology, information, and finance infrastructures.

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What We Know: Managing the Knowledge Content – Key Findings (continued)

3. A review of resources for tobacco control knowledge at the National Cancer Institute confirmed the existence of extensive resources for tobacco control, combined with growth areas for the future, such as integration, visibility among stakeholders, and knowledge gaps.
4. A concept-mapping project that engaged stakeholders to examine specific information needed for tobacco prevention, control, or research yielded clusters of knowledge categories that helped form the taxonomy for a planned knowledge base for tobacco control.

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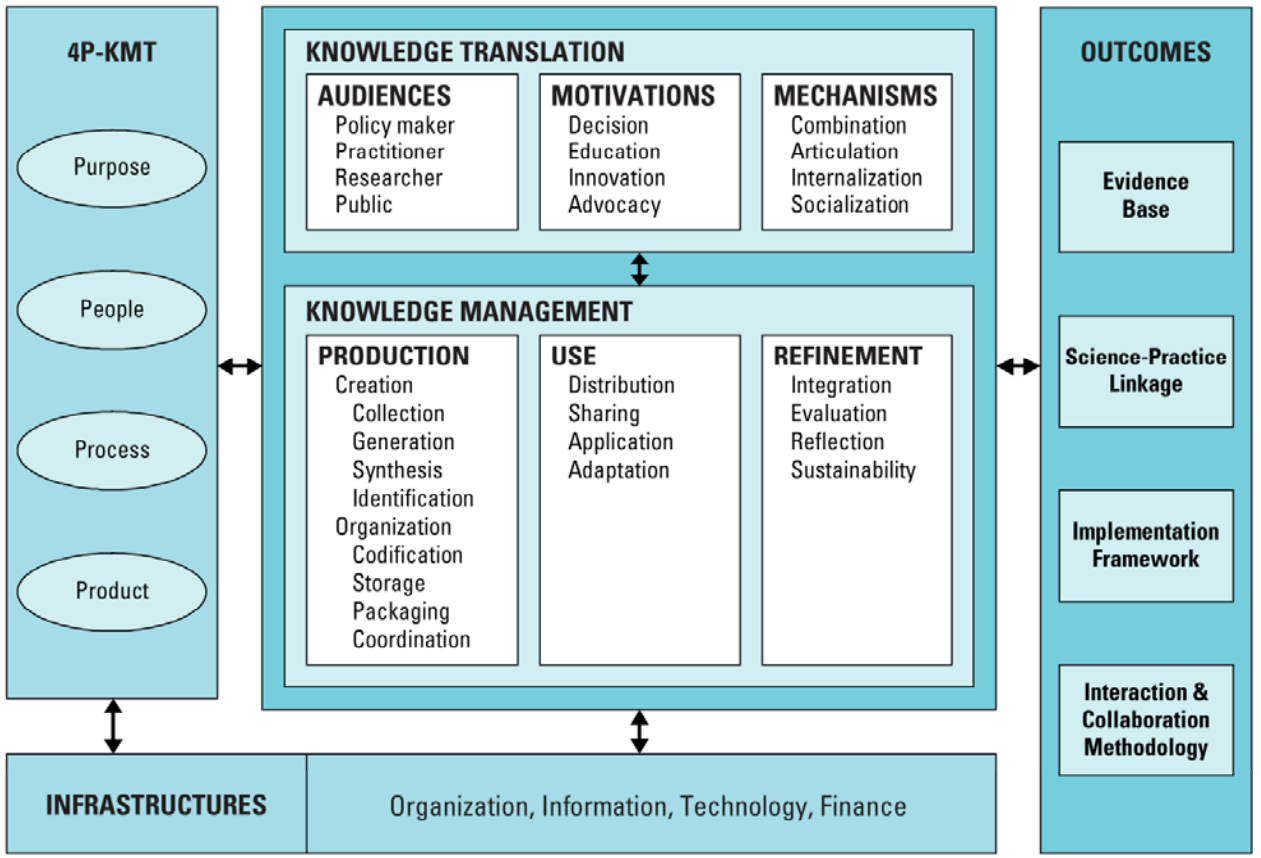
What We Know: Managing the Knowledge Content

Figure 7.5 4P-Knowledge Management and Translation Infrastructures Strategy Map



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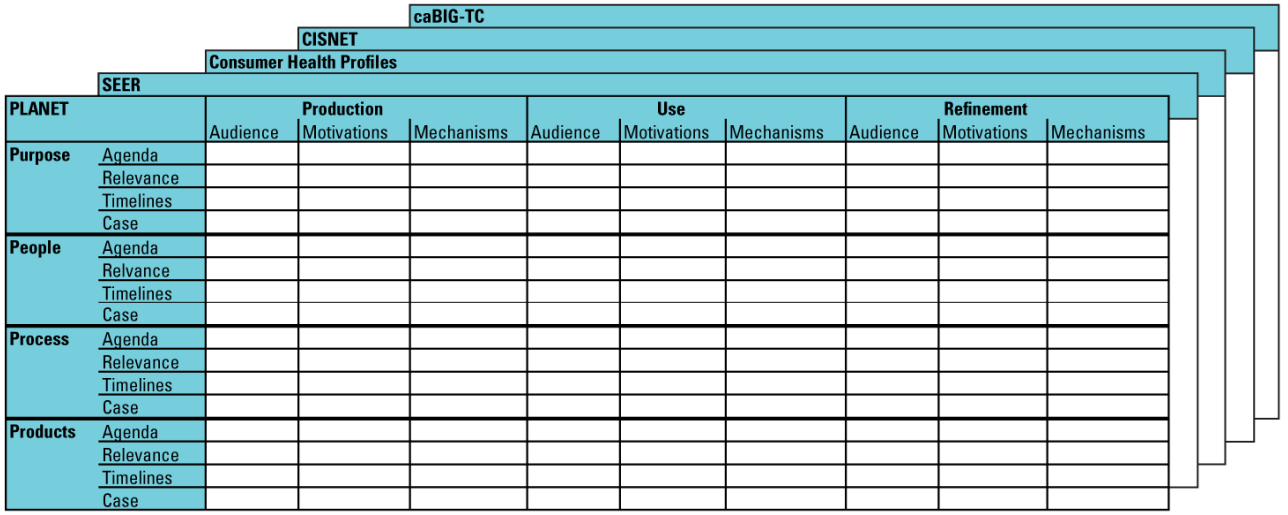
What We Know: Managing the Knowledge Content (continued)

Figure 7.6 4P-Knowledge Management and Translation (KMT) Strategy Maps: Templates for Knowledge Resources Needed in Tobacco Control



PLANET		Production			Use			Refinement		
		Audience	Motivations	Mechanisms	Audience	Motivations	Mechanisms	Audience	Motivations	Mechanisms
Purpose	Agenda									
	Relevance									
	Timelines									
	Case									
People	Agenda									
	Relvance									
	Timelines									
	Case									
Process	Agenda									
	Relevance									
	Timelines									
	Case									
Products	Agenda									
	Relevance									
	Timelines									
	Case									

Notes. caBIG-TC = Cancer Biomedical Informatics Grid; CISNET = Cancer Intervention and Surveillance Modeling Network; SEER = Surveillance, Epidemiology, and End Results; PLANET = Plan, Link, Act, Network with Evidence-based Tools.

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General Conclusions

1. The confluence of trends suggests that systems thinking as an organizing paradigm in public health is increasing. Systems approaches help in grappling with complexity, interconnectedness, rapid change, and uncertainty.

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General Conclusions (continued)

2. Tobacco control constitutes an ideal public health test laboratory for systems approaches. By its very nature, tobacco control needs to be adaptive and ecological and involves complex relationships among a profit-making industry marketing an attractive, addictive, and harmful product; the public health profession; and the population. Systems approaches can elucidate these relationships at a level that guides policy and practice and, more significantly, their evolution.

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General Conclusions (continued)

3. Systems thinking contributes to a better understanding of an environment in which the results of single interventions frequently have unforeseen and unintended negative consequences. Systems methods hold the promise of an environment in which effects and countereffects could be more accurately modeled over time, across all affected stakeholders.

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General Conclusions (continued)

4. The first two years of the ISIS endeavor and reflection on both the outcomes and future directions of systems thinking efforts lead to some initial conclusions about desirable directions for systems thinking in tobacco control specifically and public health more generally. The conclusions revolve around the four broad approaches under study in ISIS:
   - systems organizing
   - system dynamics
   - system networks
   - knowledge management

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Specific Conclusions

Systems organizing: Encouraging transformation to systems culture

- Encourage ongoing evolution of vision and paradigms
- Foster a systems thinking learning environment
- Nurture discussion about shared purpose
- Remove barriers to adopting systems thinking
- Engender systems leadership

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Specific Conclusions (continued)

System dynamics: Developing and applying systems methods and processes

- Encourage and reinforce systems thinking theory and research development
- Foster mixed-methods systems thinking
- Conduct participatory assessments of systems needs Encourage ecological perspective on implementation
- Foster systems evaluation

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Specific Conclusions (continued)

System networks: Building and maintaining stakeholder relationships

- Create multijurisdictional and multilevel networks of stakeholders for systems thinking and action
- Study networks of stakeholders to determine their dynamics and effects
- Encourage a transdisciplinary approach by fundamentally linking specific disciplines
- Prepare for the impact of demographic change

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Specific Conclusions (continued)

Systems knowledge management and translation:
Building system and knowledge capacity

- Build capacity for systems thinking
- Expand public health data to enable systems analyses
- Integrate information silos through development of cyberinfrastructure
- Foster skills and culture to affect processes and outcomes
- Create knowledge-translation networks

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Recommendations

- Create networks of excellence for systems thinking in public health
- Develop a Web presence for systems methods in tobacco control
- Foster development of systems organizing
- Link with systems knowledge in other fields
- Develop a systems curriculum in academia
- Create a leadership program
- Organize a national association and a regular national conference on systems thinking in public health

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Recommendations (continued)

- Remove organizational barriers and build capacity
- Link with local efforts