Developing a theory of the societal lifecycle of cigarette smoking:
Explaining and anticipating trends using information feedback

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Smoking prevalence (cigarettes)

Data sources:
- Cigarettes per capita: http://www.cdc.gov/tobacco/data_statistics/tables/economics/consumption/
- Prevalence: David Mendez & Kenneth Warner, SGR Meeting (July 2010)

New strategies?
- Further reduction
- Steady decline
- Leveling off
- Rebound

Key events:
- WW1
- WW2
- Great Depression
- 1st S.G. Report
- Link to cancer
- Broadcast ban
- Nonsmoker’s Rights Movement
- Clean Indoor Air Laws
- Higher excise taxes
- Nicotine Replacement Therapy (NRT)
- Master Settlement Agreement
- Surgeon General’s Reports
- Etc.
Began with a review of previous System Dynamics studies

- The **MIT model** (Roberts *et al.*, 1982)
  - 1 publication; model *not* available
- The **Tobacco Policy Model** (Tengs, Ahmad, *et al.*, 2001-2005)
  - 7 publications; model *not* available
- The Initiative on the Study and Implementation of Systems – **ISIS Model** (Richardson, 2007)
  - 1 publication; **model available**
- The **New Zealand TPM** (Cavana, Tobias, Bloomfield, 2008 & 2010)
  - 2 publications; **model available**
  - 3 publications; reference manual available (but *not* model)

(The full references are captured in two slides at the end.)
Three Main Points:

- Time horizon – Feedback – Forecast patterns

### Time horizon of interest

<table>
<thead>
<tr>
<th>Year</th>
<th>Cigarettes per capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>0 CpC</td>
</tr>
<tr>
<td>1920</td>
<td>1,500 CpC</td>
</tr>
<tr>
<td>1940</td>
<td>3,000 CpC</td>
</tr>
<tr>
<td>1960</td>
<td>4,500 CpC</td>
</tr>
</tbody>
</table>

- 0 %
- 20 %
- 40 %
- 60 %

### Feedback perspective

- **Forecasted patterns**

- **Data base**

**Major feedbacks captured:**

- Reinforcing feedback of smoking as a social norm
- Balancing feedback due to public awareness of tobacco health risk

**Forecast**

- Post tipping point period of decline
Take away messages from literature review

- Provides a foundation upon which to identify system structure, determinate morbidity and mortality, assess potential impacts of interventions and measure their cost effectiveness
- Demonstrated impact in influencing public health policy and decision making
- Provided insight on information feedbacks, such as:
  - Reinforcing feedback between prevalence and initiation rate
  - Balancing feedback due to awareness of the health consequences of smoking
- All models looked at a relatively short historical period of reference
- None of the models looked at the possibility of an increase in smoking
- There is a path open to expand this body of knowledge, involving:
  - A study of the long-term history of cigarette smoking behavior, to arrive at the structure needed to account for the societal lifecycle of cigarette smoking
  - Emphasis on information feedback, using an Occam’s razor approach
Our feedback-rich concept model

Feedback loops:
1 – Reinforcing
“Initiation loop”
Our feedback-rich concept model

Feedback loops:
1 – Reinforcing
   “Initiation loop”

2 – Balancing
   “Awareness curbs initiation”
Our feedback-rich concept model

Feedback loops:

1 – Reinforcing
   “Initiation loop”

2 – Balancing
   “Awareness curbs initiation”

3 – Balancing
   “Cessation loop”
Feedback loops:

1 – Reinforcing
   “Initiation loop”

2 – Balancing
   “Awareness curbs initiation”

3 – Balancing
   “Cessation loop”

4 – Balancing
   “Losing awareness”
Our feedback-rich concept model

Feedback loops:
1 – Reinforcing
   “Initiation loop”
2 – Balancing
   “Awareness curbs initiation”
3 – Balancing
   “Cessation loop”
4 – Balancing
   “Losing awareness”
5 – Balancing
   “Awareness boosts cessation”
Analysis of the base run: Phase 1

Phase 1: Unconstrained growth

Cigarettes per capita data

4,500 Cigarette/Person
60%

3,000 Cigarette/Person
40%

1,500 Cigarette/Person
20%

0 Cigarette/Person
0%

Simulated endogenously

Year

1900 1920 1940 1960 1980 2000 2020 2040

Smoking prevalence data

60%
40%
20%
0%

Smoking prevalence data

4,500 Cigarette/Person
0.6 Dmnl

3,000 Cigarette/Person
0.4 Dmnl

1,500 Cigarette/Person
0.2 Dmnl

0 Cigarette/Person
0 Dmnl
Analysis of the base run: Phase 2

Phase 2: Awareness of health effects curbs and then topples growth

Cigarettes per capita data
- 4,500 Cigarette/Person (60%)
- 3,000 Cigarette/Person (40%)
- 1,500 Cigarette/Person (20%)
- 0 Cigarette/Person (0%)

Smoking prevalence data
- Simulated endogenously

Year
- 1900
- 1920
- 1940
- 1960
- 1980
- 2000
- 2020
- 2040

Smoking prevalence
- Time to manifest health consequences
- Perceived health consequences
- Perceived benefits from smoking
- Smoking
- Time to forget
- Effect of NB on initiation
- Effect of NB on cessation
- Elasticity of initiation
- Elasticity of cessation
- Initial NB
- Cessation
- Initiation rate
- Time to initiation
- Effect of NB on smoking
- Simulated endogenously

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Analysis of the base run: Phase 3

Phase 3: System is deflated

- 4,500 Cigarette/Person (60%)
- 3,000 Cigarette/Person (40%)
- 1,500 Cigarette/Person (20%)
- 0 Cigarette/Person (0%)

Cigarettes per capita data

Smoking prevalence data

Simulated endogenously

What's next?

Year

1900 1920 1940 1960 1980 2000 2040

2010
Phase 1: Unconstrained growth

Phase 2: Awareness of health effects curbs and then topples growth

Phase 3: System is deflated

Phase 4: Problem "goes away"

Beginning of a new cycle

Cigarettes per capita data

Simulated endogenously

Smoking prevalence data

4,500 Cigarette/Person

60 %

3,000 Cigarette/Person

40 %

1,500 Cigarette/Person

20 %

0 Cigarette/Person

0 %

1900 1920 1940 1960 1980 2000 2020 2040 2060 2080 2100

Year

What if ...

Cigarettes per capita data

Smoking prevalence data

Simulated endogenously
Four “what if” scenarios
(changes implemented in 2010)

Prevalence

Lose focus
Base run
Reduce initiation
Increase cessation
Maintain awareness

Year
1900 1920 1940 1960 1980 2000 2020 2040 2060 2080 2100

Prevalence

0 % 10 % 20 % 30 % 40 %
Why is a feedback-rich model/theory useful?

- It helps to understand and explain historical behavior
- It provides the ability to predict changes in patterns
- It helps to identify leverage points, i.e., locations for the most effective strategic interventions in a system
- If the model is kept sufficiently parsimonious:
  - It helps reveal the fundamental structure
    - “Looks at the forest as opposed to focusing on the trees”
- This kind of model is so general that it could be applied to other problem areas
  - where a behavior has a tendency to grow until it is perceived as unhealthy
Summary

- Previous studies de-emphasized feedback and/or looked at a limited time frame
  - Information feedback is less tangible and more subjective; it is therefore more open to question and less typical of evidence-based empirical analyses
- A feedback-rich concept model proposes a theory of the societal lifecycle of cigarette smoking and fits the data well
  - The goal was not to produce a perfect model or simulation but to underscore the role of time horizon and feedback in explaining the historical smoking behavior in the population and in capturing tipping points endogenously
- A formal analysis shows phenomena composed of different phases of behavior (patterns) with differing feedback loops dominant in each phase
  - The analysis indicates that we find ourselves in the beginning of a very long and gradual phase of “losing awareness” (aka, parable of the “boiled frog”), transitioning from a period where cessation > initiation to a period where initiation > cessation
  - Prevalence could bounce back if people “forget” or resources are placed elsewhere
- Simulated “what if” questions about access, cessation services, and public awareness of the health consequences of smoking cigarettes