Using System Dynamics in Evaluation: A Case Example

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Global Summary of AIDS Epidemic, 2005

- 25 million cumulative deaths worldwide
- 40.3 million people living with HIV/AIDS
- 4.9 million people newly infected
- 3.1 million people died of AIDS
National and Local Epidemic

- 1,039,000 to 1,185,000 persons living with HIV infection in the United States
- 40,000 new infections annually
- 16,200 persons living with HIV infection in Michigan
- 900 new infections annually
Schackman, Gebo, Walensky et al., 2006

“From the time of entering HIV care, per person projected life expectancy is 24.2 years, discounted lifetime cost is $385,200, and undiscounted cost is $618,900 for adults who initiate ART with CD4 cell count <350/[mu]L.”
State of HIV Prevention in U.S. Communities

- Community-based organizations (CBOs) are the primary providers of HIV prevention in most U.S. community settings

- CBOs’ funding sources have begun to prefer and impose evidence-based prevention programs on CBOs
HIV Prevention Evidence-based Programs

- 12 evidence-based programs have been widely disseminated by CDC since 2002
- Over 2,000 agencies have been trained in these programs
- Programs were selected based on efficacy in controlled trials
- Effectiveness of programs has not been established
Problem

- Programs are undergoing widespread dissemination prior to thorough investigation of their effectiveness in communities
Typical Translation Framework

(Adapted from McKelroy et al., 2006)
Purpose of our Model

- To understand the dynamics of implementing evidence-based programs in service delivery settings
- To model common problems reported by providers in delivering these programs
## Intervention Typology

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>TARGET OF CHANGE</th>
<th>DELIVERY</th>
<th>DEBI EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural</td>
<td>Economic resources, policy supports, organizational structures &amp; functions</td>
<td>policy changes, physical environment change</td>
<td>None</td>
</tr>
<tr>
<td>Community</td>
<td>Community social norms</td>
<td>Peer role modeling; social marketing</td>
<td>Mpowerment; POL; Community PROMISE</td>
</tr>
<tr>
<td>Group</td>
<td>Individual behavior</td>
<td>Workshop; Small group discussion</td>
<td>Healthy Relationships; HHRP; 3MV; RAPP; Safety Counts; SISTA; Street Smart; TLC; VOICES/ VOCES</td>
</tr>
<tr>
<td>Individual</td>
<td>Individual behavior</td>
<td>1-on-1 counseling</td>
<td>None</td>
</tr>
</tbody>
</table>
Small-group Workshops

- Face-to-face group sessions
- Limited enrollment (~20 people)
- Average of 8 sessions (range 1-24)
Why system dynamics?

- Focuses on problems
- Orients toward policies and actions
- Uses computer simulation to assess what might happen over time
- Uses any form of available data
Data Sources

- In-depth interviews with a random sample of providers
- Published evaluations
- Results of published meta-analyses
- Dynamic theories of service delivery
Stock and Flow Representation
What are stocks and flows?

- Stocks are accumulations
- Flows are the processes and actions that change the values of the stocks
Client Flow

- People at Risk
- People in the Program
- People who Graduate
Differences in Motivation

- Unmotivated Population
  - negative comments about the program
  - becoming motivated

- Motivated Population
  - return from downstream
  - change without program

- recruitment rate
Differences in Quality of Experience

Good Experience with Program
- having good experience
- probability of good experience
- completing the program
- recruitment rate

Bad Experience with Program
- having bad experience
- completing the program
- dropouts due to bad experience

probability of good experience

recruitment rate

having good experience

having bad experience
Differences in Program Effectiveness

- **Graduates - Good Experience & Effective**
  - input good & effective
  - loss of effectiveness

- **Graduates - Good Experience & Ineffective**
  - input good & ineffective
  - backflow of experience & ineffective
Main Dynamic Hypotheses
Key Loop Structures

- Word of mouth
- Intensity of recruitment efforts
- Controlling the recruitment rate
- Controlling the graduation rate
Recruitment Rate

Intensity of Recruitment Efforts

Recruitment Target

Recruitment Gap

Probability of Good Experience

Program Completion Gap

Word of Mouth

Number of People Finishing the Program

Target Completion Rate

Factors:
1. Intensity of Recruitment Efforts
2. Probability of Good Experience
3. Program Completion Gap

Interaction:
- Recruitment Rate increases with higher Intensity of Recruitment Efforts.
- Recruitment Rate decreases when Recruitment Gap increases.
- Recruitment Rate decreases when Probability of Good Experience decreases.
- Recruitment Rate increases with higher Word of Mouth.
- Recruitment Rate decreases with higher Program Completion Gap.

Target:
- Recruitment Rate
- Number of People Finishing the Program
- Target Completion Rate
Initial Parameterization

- Time horizon of 120 months
- Percentage of motivated people 20%
- Probability of a good experience 0.85
- Probability of changing habits 0.35
- Annual target recruitment rate 200 people
Effect of Target Population Size on Recruitment

![Graph showing the effect of target population size on recruitment over time. The graph plots target recruitment rate against months, with two distinct lines representing different population sizes.]
Comparing Internal Recruitment Determinants
Internal Recruitment Determinants

- Word of mouth
- Intensity of recruitment effort
- Referrals from other providers
Internal Recruitment Determinants
External Recruitment Determinants
Ease of Access to Program

Unmotivated Population
- return from downstream
- net migration unmotivated population
- becoming motivated

Motivated Population
- return from downstream
- net migration motivated population
- change without program
- recruitment rate

Access
Access and Recruitment Rate

Target Population Size = 4,000
Moving Down the Chain: Participants
Monthly Total Number of Participants

[Graph showing the decrease in total participants over months.]

Total Participants

Months
Participant Input and Output Rates

Months

Recruitment Rate

Graduation Rate
Number of Participants having a Good Experience by Control Policy

- Controlling Graduation
- Controlling Recruitment

Months
Moving Down the Chain: Graduates
Number of Graduates Having a Good Experience and Practicing Safer Sex
Number of Graduates Having a Good Experience and Practicing Safer Sex by Program Length

- 2 weeks
- 8 weeks
- 16 weeks

Months
Discussion and Implications
Summary of Results

- Recruitment rates consistently fall below targets
- Ultimately, the number of people who graduate and change behavior is small
Summary of Results

- Access is a major constraining factor in recruitment
- Word of mouth never contributes large numbers of people to recruitment
- There are leaks at every point in the pipeline
Implications

- Advantages of evidence-based small group workshops may be lost because of recruitment challenges and leaks.
- Agencies may have to change the program to increase throughput (e.g., shorten it, increase group size).
But…..

- Some changes may decrease the program’s effectiveness
Implications for Evaluation

- Using system dynamics as an adjunct tool can provide new insight into the process of program implementation
- Modeling can lead to counterintuitive findings
- System dynamics provides a theoretical framework for posing new evaluation questions
- Allows evaluators to explore changes to the system more efficiently than can often be done in real-time evaluations