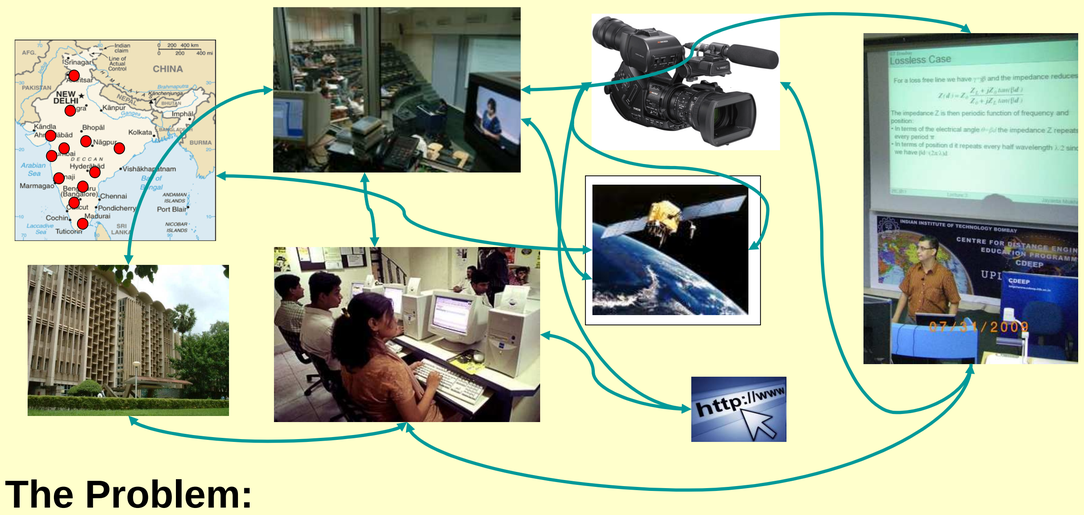
System Dynamics to Analyze a Distance Education Programme

Sahana Murthy, Rohit Gujrati and Sridhar Iyer
Indian Institute of Technology Bombay, Mumbai, India

A distance education programme



The Problem:

Why distance education?
As a means of providing high quality education at low cost to large numbers of students. Universities are making significant investments in starting and running these programmes.

What makes a distance education programme successful?
Planning, marketing, financial management, quality assurance, student retention, faculty development, online course design. But --

What is the problem?
Many interacting factors. No clear theory underlying the success of programmes. Experiments are hard, time consuming. Decisions made on incorrect assumptions.

What is needed?
A theoretical tool to model and analyze the programmes.

System Dynamics as a Solution Method

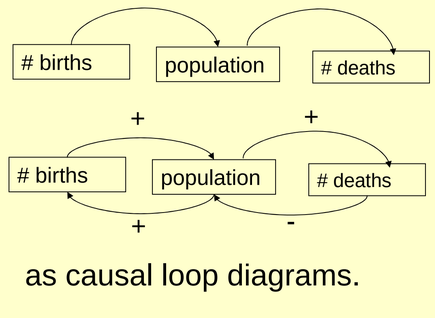
Key Idea - Behaviour of a a complex interacting system is understood by analyzing the overall structure of the system, not just its individual parts.

How does system dynamics work?

- Identify system variables which change in time.
- Identify dependencies between variables.
- How does change in one variable cause a change in another variable? How does that change the third variable? And so on, till ..
- Trace the change back to the original variable.
- Thus identify feedback loops => Change in a variable will affect its own behaviour in the future.

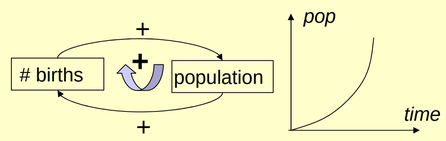
Example - Population

Births, population, deaths, disease

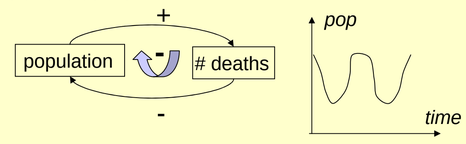


- Feedback structure of complex system represented as causal loop diagrams.

Behaviour is related to structure



Positive feedback loop => Exponential growth



Negative feedback loop => Oscillatory behaviour

- Finally, solve complicated interacting feedback structure using computer simulations.

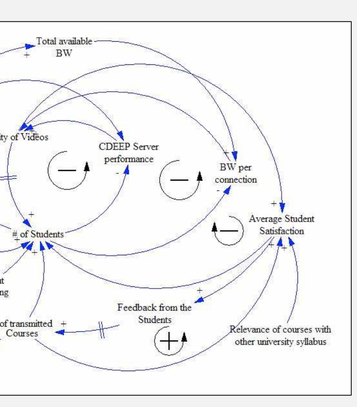
Why system dynamics to study distance education programmes?
A distance education programme is a complex system containing interacting variables -- technological (camera, satellite, www), operational (college administration), economic (financial) and human/social (teacher, student)., Relations between these variables form feedback loops == > classic problem for system dynamics.

The Centre for Distance Engineering Education Programme (CDEEP) at IIT Bombay

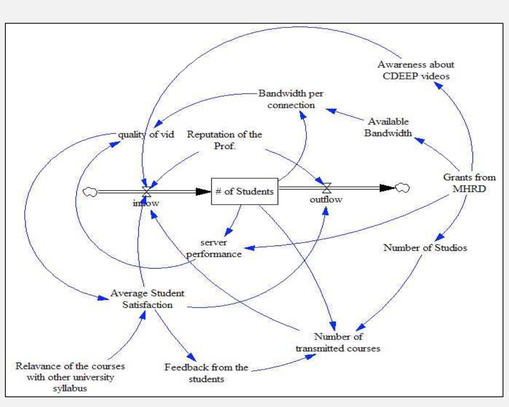
Goal: Make IIT Bombay's high quality courses available to students around the country

CDEEP's Webcast Model

- Live lectures from IITB recorded and transmitted free over the Internet
- Anyone with www can access the lectures at scheduled times



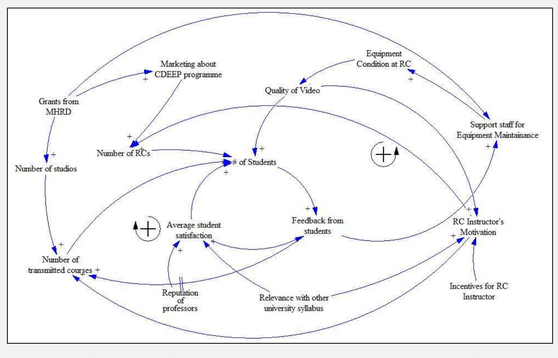
Causal loop diagram for Webcast system



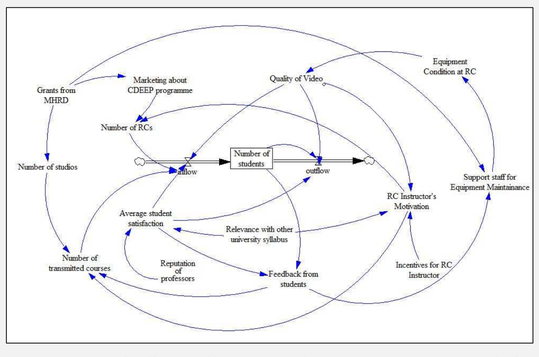
Stock-flow diagram for Webcast system

CDEEP's EDUSAT Model

- Live synchronous transmission of IITB courses via satellite (EDUSAT)
- 72 Institutions (Remote Centres) around India equipped with interactive terminals, two-way live interaction



Causal loop diagram for EDUSAT model



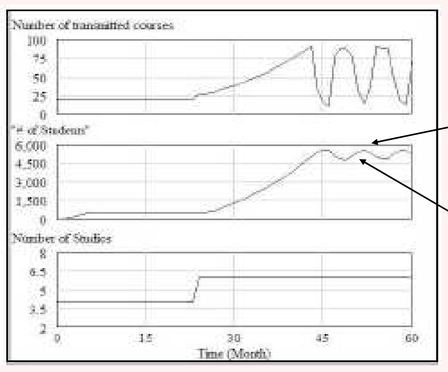
Stock-flow diagram for EDUSAT model

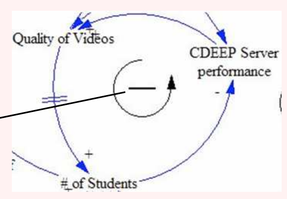
Variables in the model

Central variable	*Technological variables*	*Operational variables*	*Economic variables*	*Social variables*	*Affective variables*
Number of students viewing Webcast lectures (stock)	Quality of video, network bandwidth, equipment	No. of courses transmitted, no. of studios	Annual budget, grants recd. from government	Awareness about CDEEP's activities	Student satisfaction, perception of courses

Results and Discussion

1) Effect of feedback loops - Dependence between number of students, number of studios and number of transmitted courses



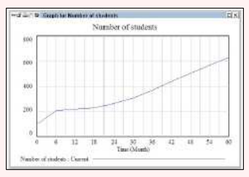


Number of students depends on number of transmitted courses, but is also a cause that affects the number of transmitted courses (if more students participate, it is likely that CDEEP will decide to transmit more number of courses.

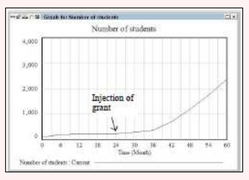
Note the **oscillatory behaviour** when the number of students is large. This is arises from the negative feedback loop involving number of students and server performance.

At some maximum capacity, the server gets overloaded and cannot handle as many requests. This decreases the number of students viewing the Webcast, which further decreases the number of courses. Once the number of students declines to a certain value, the server is able to take in more requests, thereby increasing the number of students.

2) Effect of injecting a one-time grant into the CDEEP system



No extra grants



One-time grant

Predictions of the future behaviour of the system. By injecting a one-time grant into the system, the number of students goes up by a larger factor, than it would have if the CDEEP system ran on its regular budget without extra grants. This result was confirmed by real data.

3)Optimal allocation of funds from grant

Marketing	# courses	Max. # students
100%	No funding for extra courses (10 original courses)	350
None	100% funds, increase icourses to 45	270
40%	60% funds, increase courses to 20	373

Take-aways

- System dynamics makes it possible to even begin to theoretically analyze complex feedback loops – e.g. number of students affecting number of courses, which in turn affects number of students, via other variables.
- Before making policy decisions, identify potential problems from simulation results. For CDEEP, we learned that sufficient attention should be paid to obtaining high quality servers, since server performance could be a bottleneck.
- Simulation results can be used as a predictive tool. System dynamics results helped CDEEP allocate extra funding received in an optimal manner between various aspects of the system (increase courses vs. marketing)
- Limitation of system dynamics. The results are only as good as the model. The model needs to be validated by independent empirical data.