

Bridging Structure and Behavior

A System Dynamics Experience

Ignacio J. Martinez, Ph.D. 2004

Luis F. Luna, Ph.D. 2003

Decision and Policy Sciences

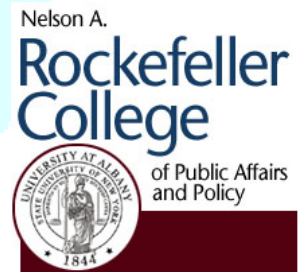
Modeling and Simulation

University at Albany



Grupo Proyectos

Dinámica Empresarial Integral



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Causal-loop Diagramming (ST)

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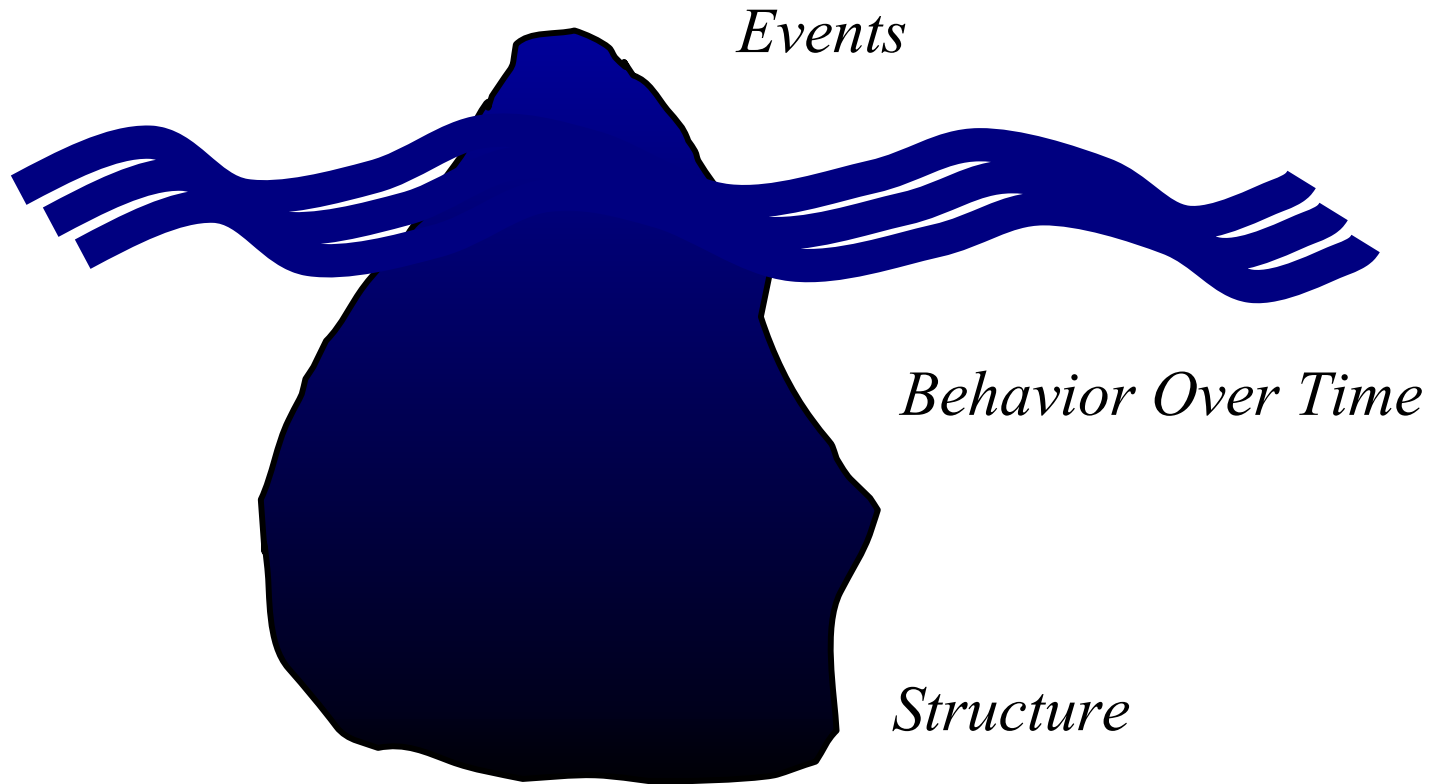


Why System Dynamics?

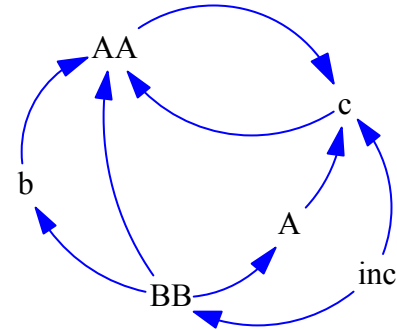
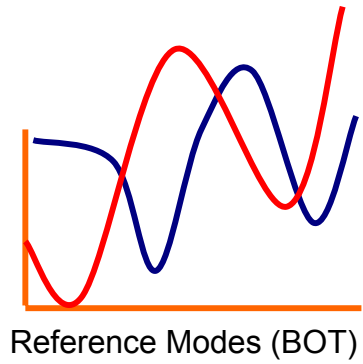
Because System Dynamics links structure (feedback loops) to behavior (BOT Behavior over time).



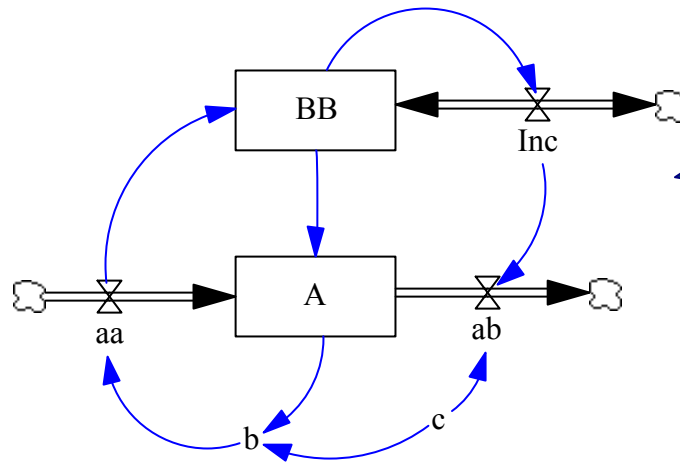
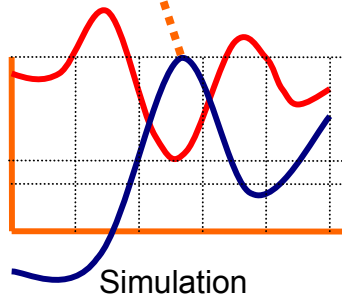
Learning Levels



Roadmap



Validation



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Bathtub Dynamics...

- “The results strongly suggest that highly educated subjects with extensive training in mathematics and science have poor understanding of the most basic concepts of system dynamics, specifically, stocks and flows, time delays, and feedback.”



Bathtub Dynamics...

- “The errors are highly systematic and indicate violation of basic principles, not merely calculation errors. Subjects tend to violate fundamental relationships between stocks and flows, including conservation of matter,...”



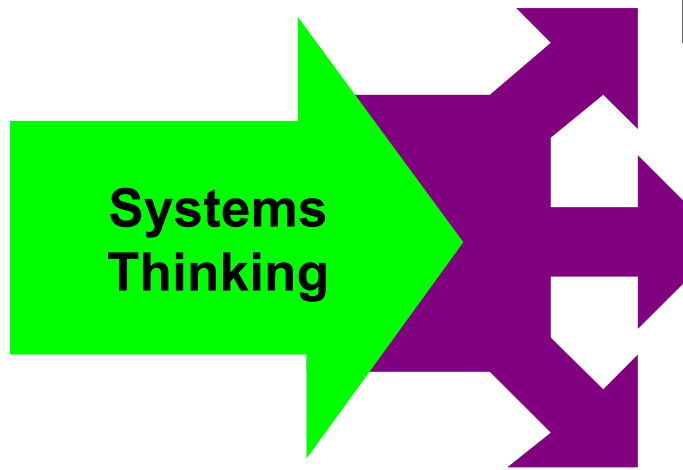
Bathtub Dynamics...

- “It appears that we should spend considerable time on the basics of stocks and flows, time delays, and feedback, with an emphasis on developing intuition rather than the mathematics.”

(Sweeney & Sterman, 2000)



Elements to develop



Causal-loop Diagramming

- Variables.
- Causal links.
- Causal loops.

Story Telling

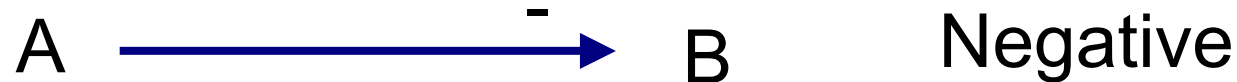
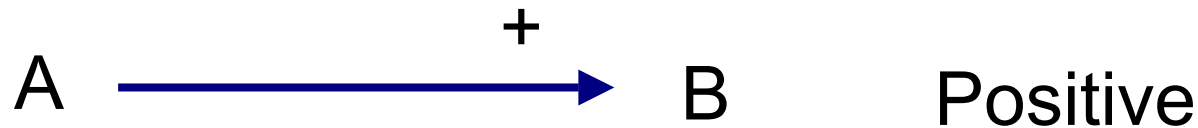
- From the map to the story.

Creating Simple Stories

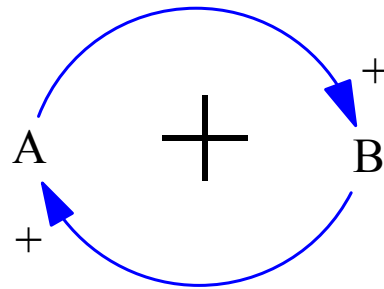
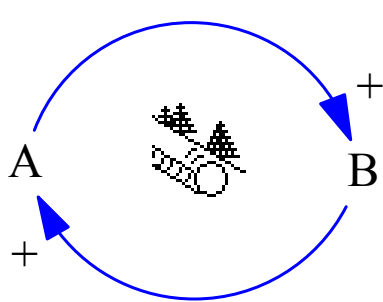
- Service Quality.
- Operational Costs.
- Defective Parts.
- Debt.



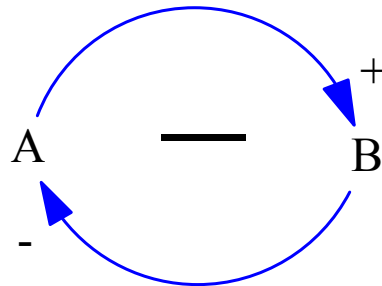
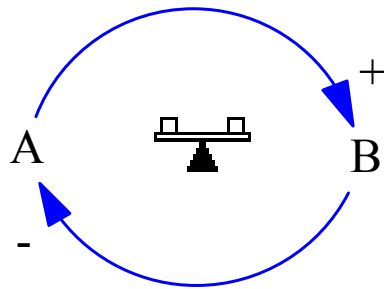
Causal-loop Diagramming



Causal-loop Diagramming



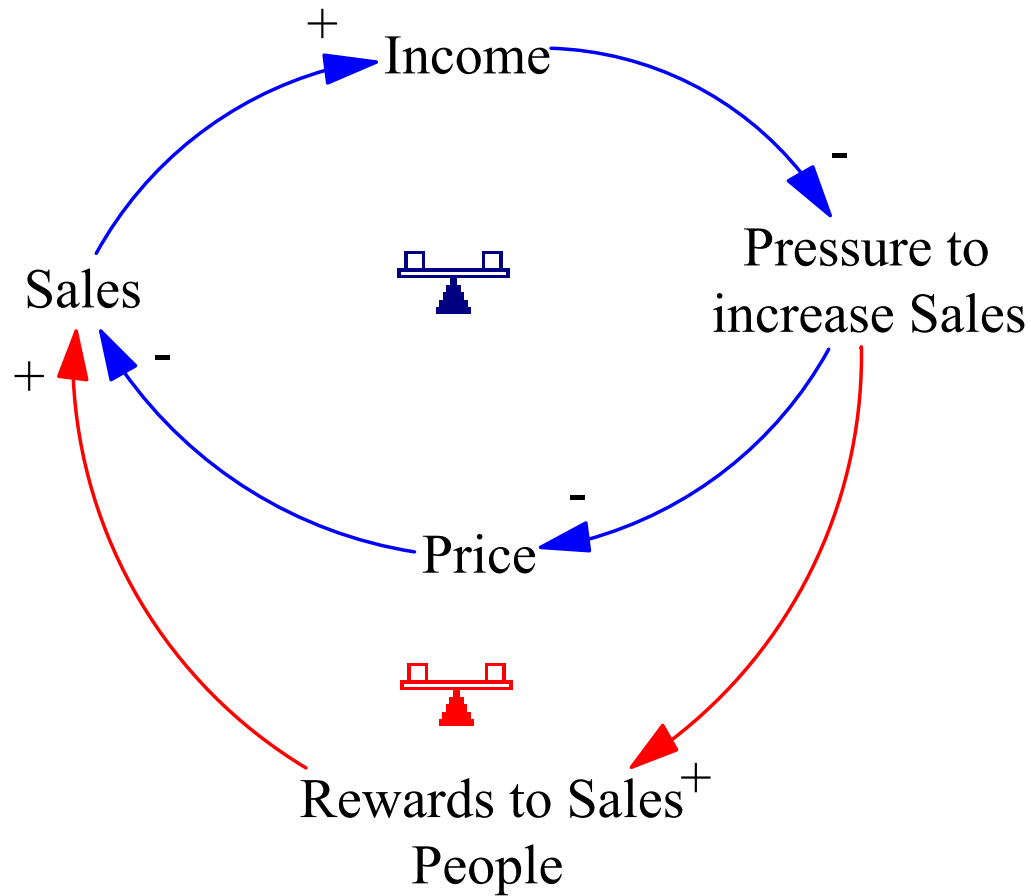
Positive



Negative



Story Telling



Creating Simple Stories

- Service Quality.
- Operational Costs.
- Defective Parts.
 - Debt.
 - Your own...



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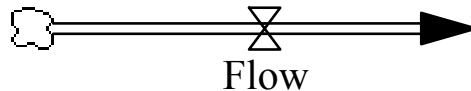
Simulation Model



Stock-and-Flow Diagramming



Accumulation –State of the system



Flow –Growth or depletion of stocks

VAR

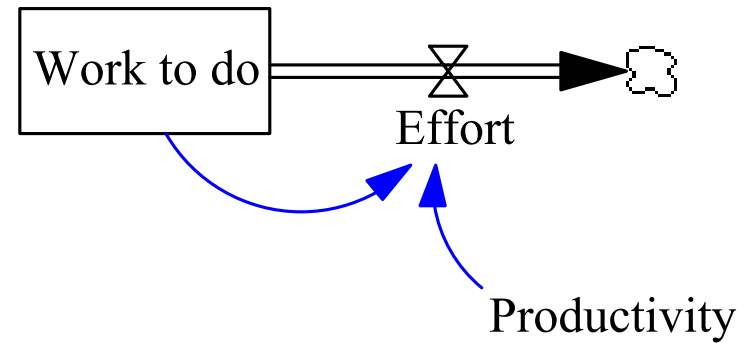
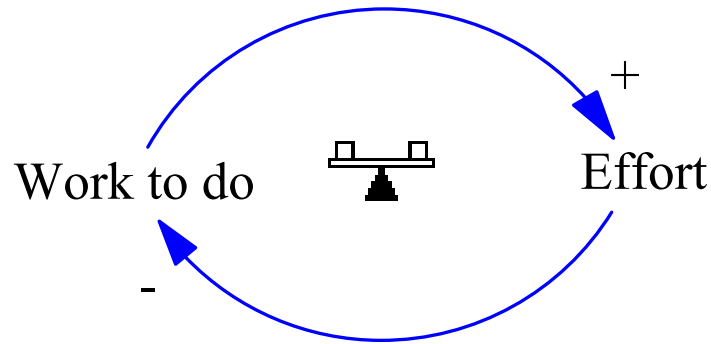
Auxiliary Variables



Cloud –Boundary of the system



Stock-and-Flow Diagramming



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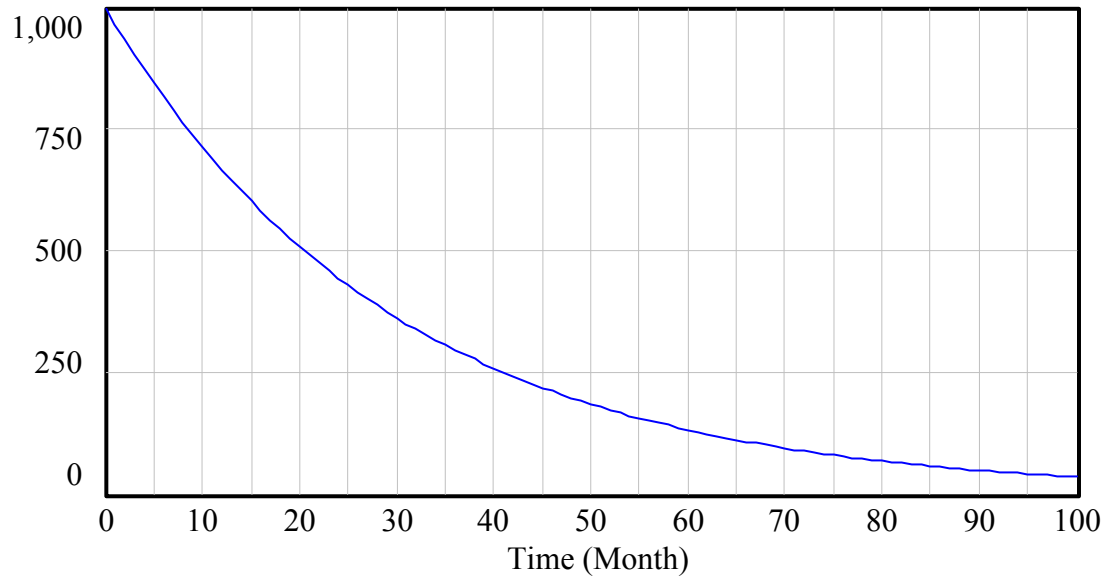
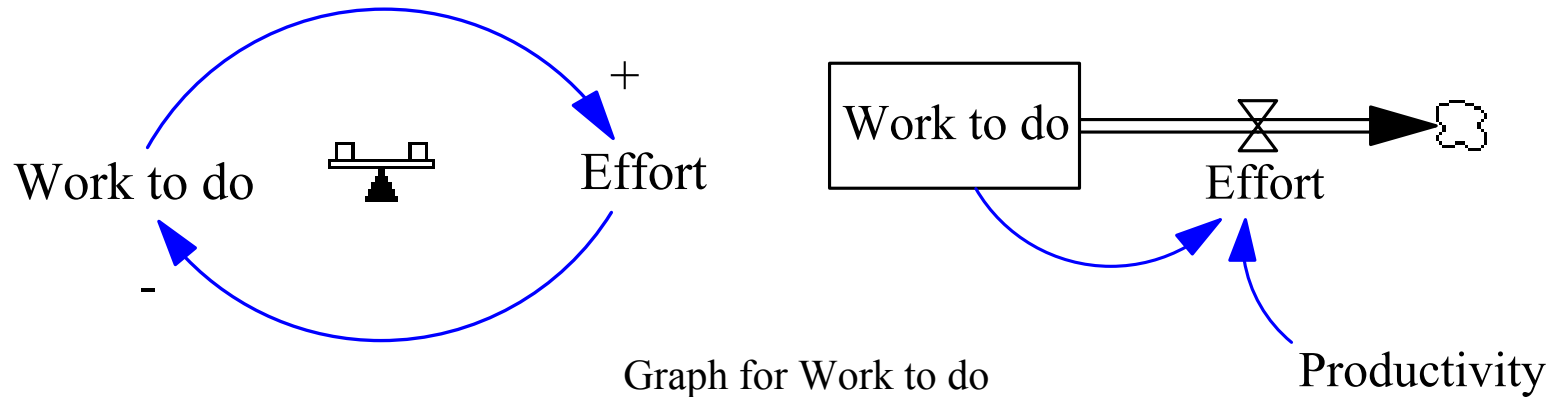
Mapping Exercise

Simulation Model



Structure-Behavior Relationship

Oct 2001

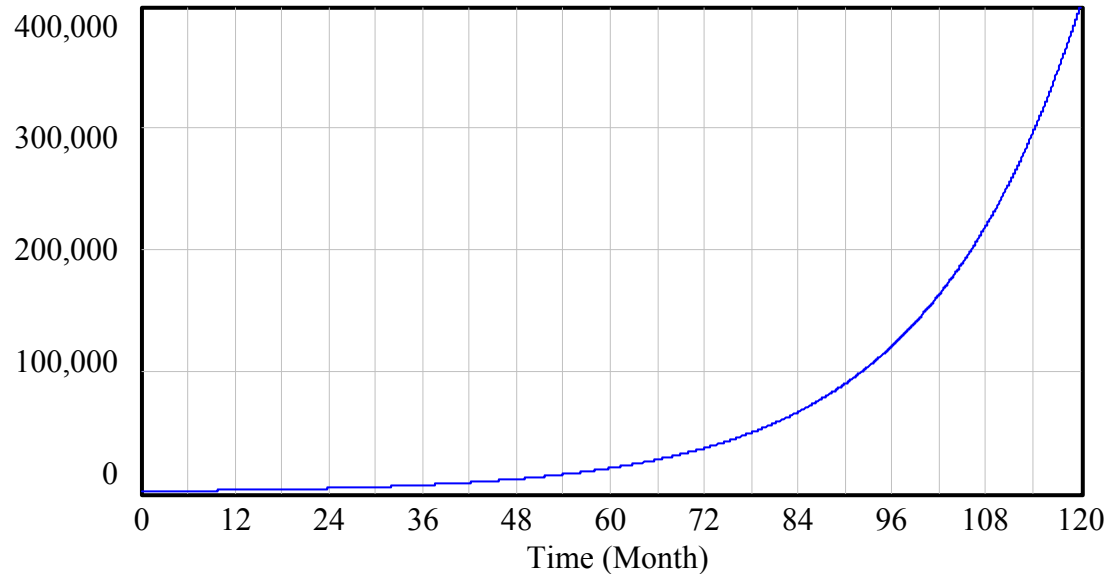
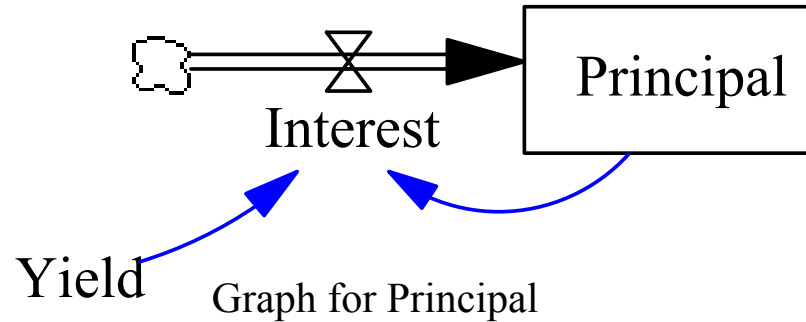


Work to do : base stac _____



Structure-Behavior Relationship

Oct 2001



Principal : base yield 



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Mapping Exercise

- National Courier
Exercise from Kim
and Anderson (1998)
Systems Archetype
Basics.
- Tasks:
 - Identify key variables.
 - Graph the behavior
over time of the
relevant variables.
 - Build a causal-loop
diagram of the case.
 - Explain WHY is
happening WHAT is
happening using the
diagram.



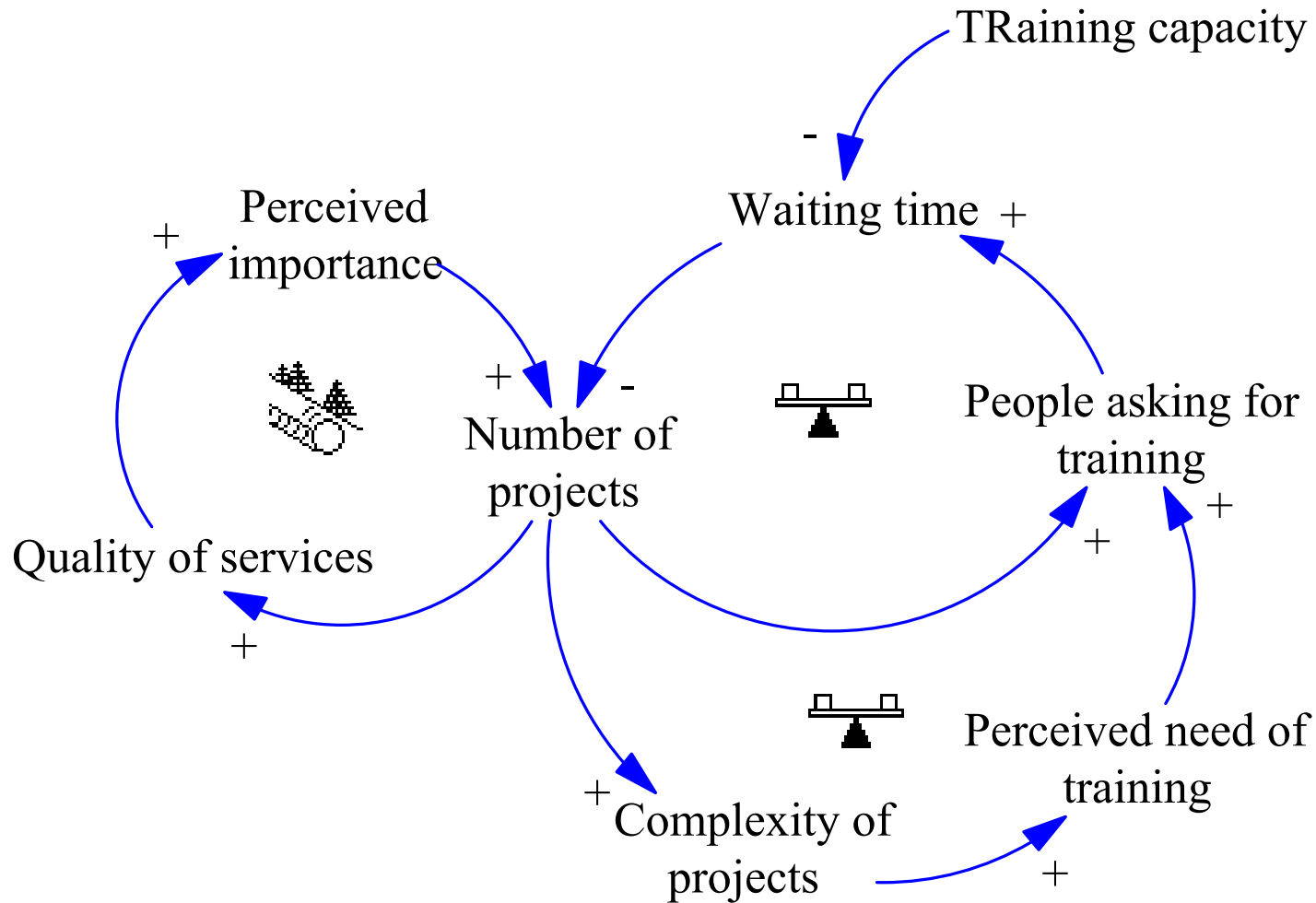
Limits to Quality

National Courier, a package expediting company, implements a quality initiative. After the management speeches, training sessions, and team meetings both line workers and managers begin to initiate some quality improvement projects and then an increase in the actual quality of services, especially tracking and on-time pick-ups. These improvements highlight the importance of the quality initiative and generate motivation to do even more. The company sets up additional quality improvement projects.

As people get involved with the projects, they realize they need more skills related to the issues they are surfacing; for example, financial accounting concepts and operations management. The training department goes into override to find, create, and deliver training, but their staff and their budget are too limited to meet the growing need for training. As a result, staff keeps falling behind in their skills.

Eventually, people become discouraged by their inability to implement or pursue the improvements they want to make. The number of quality improvements projects tapers off, and enthusiasm for the whole idea just fizzles away.





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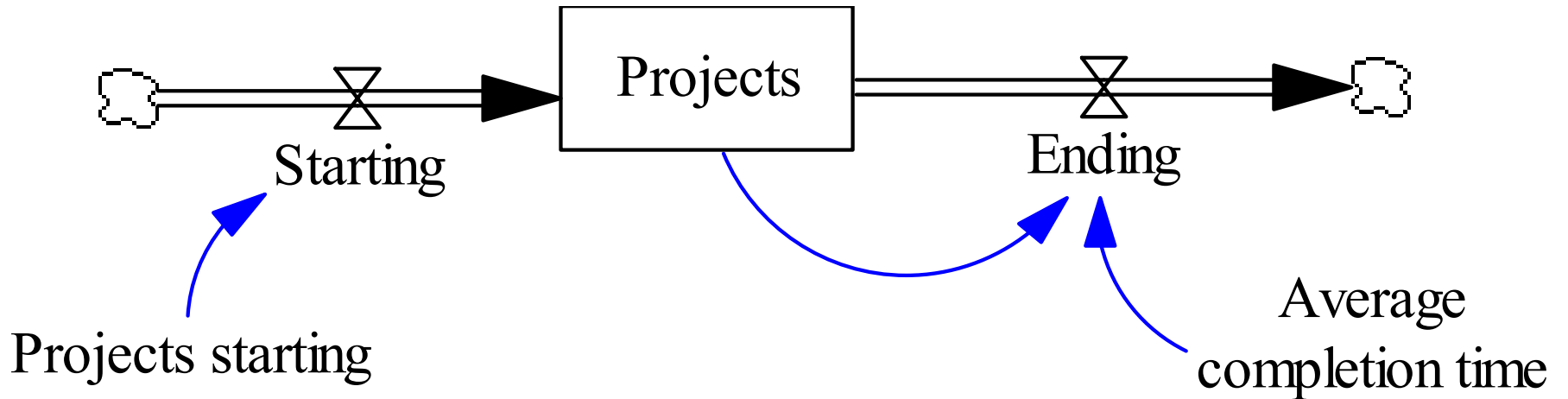


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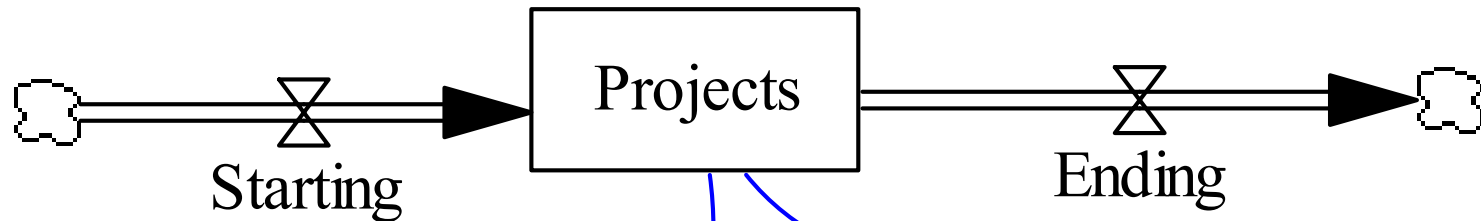
Simulation Model using Vensim



Improvement 1



Improvement 2



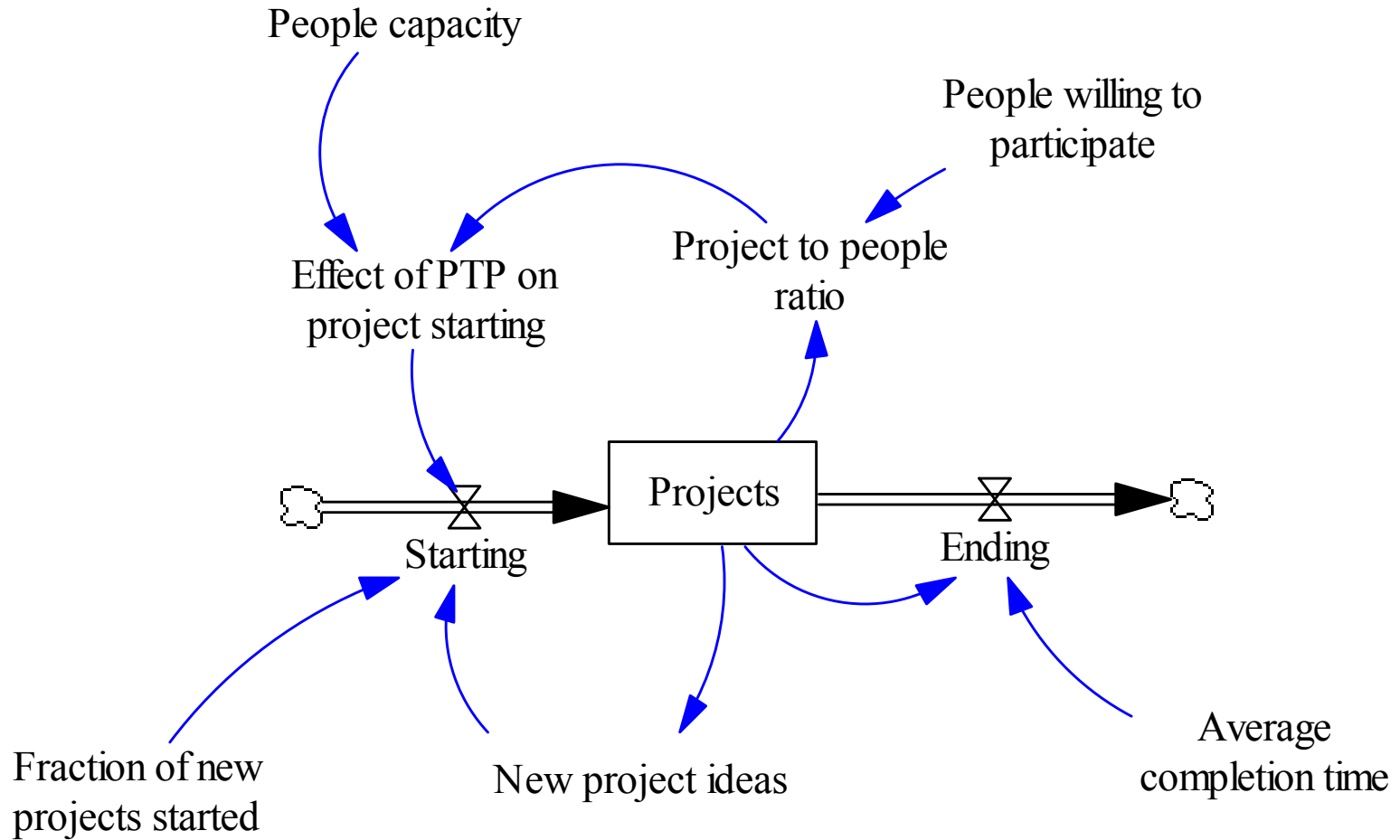
Fraction of new projects started

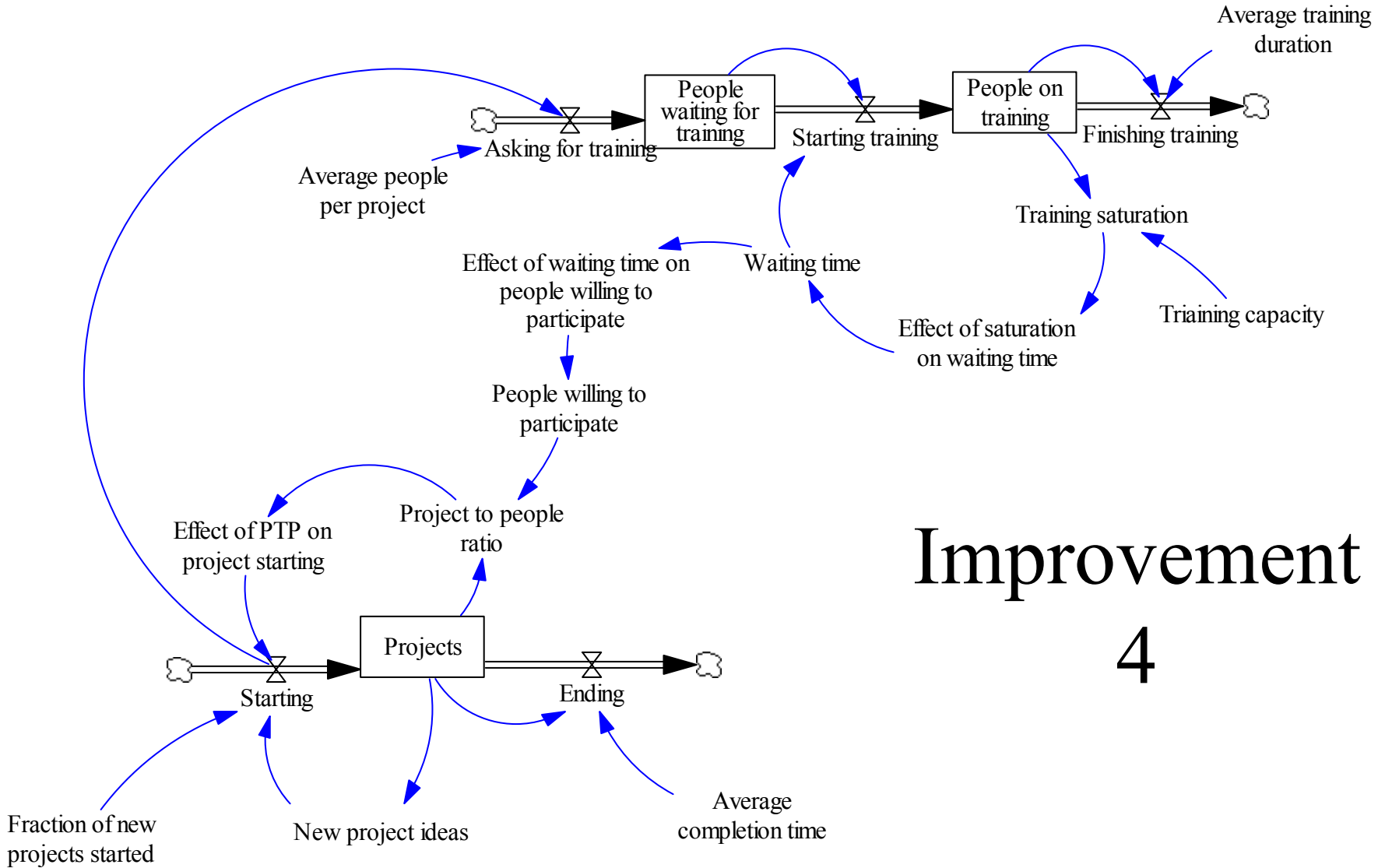
New project ideas

Average completion time



Improvement 3





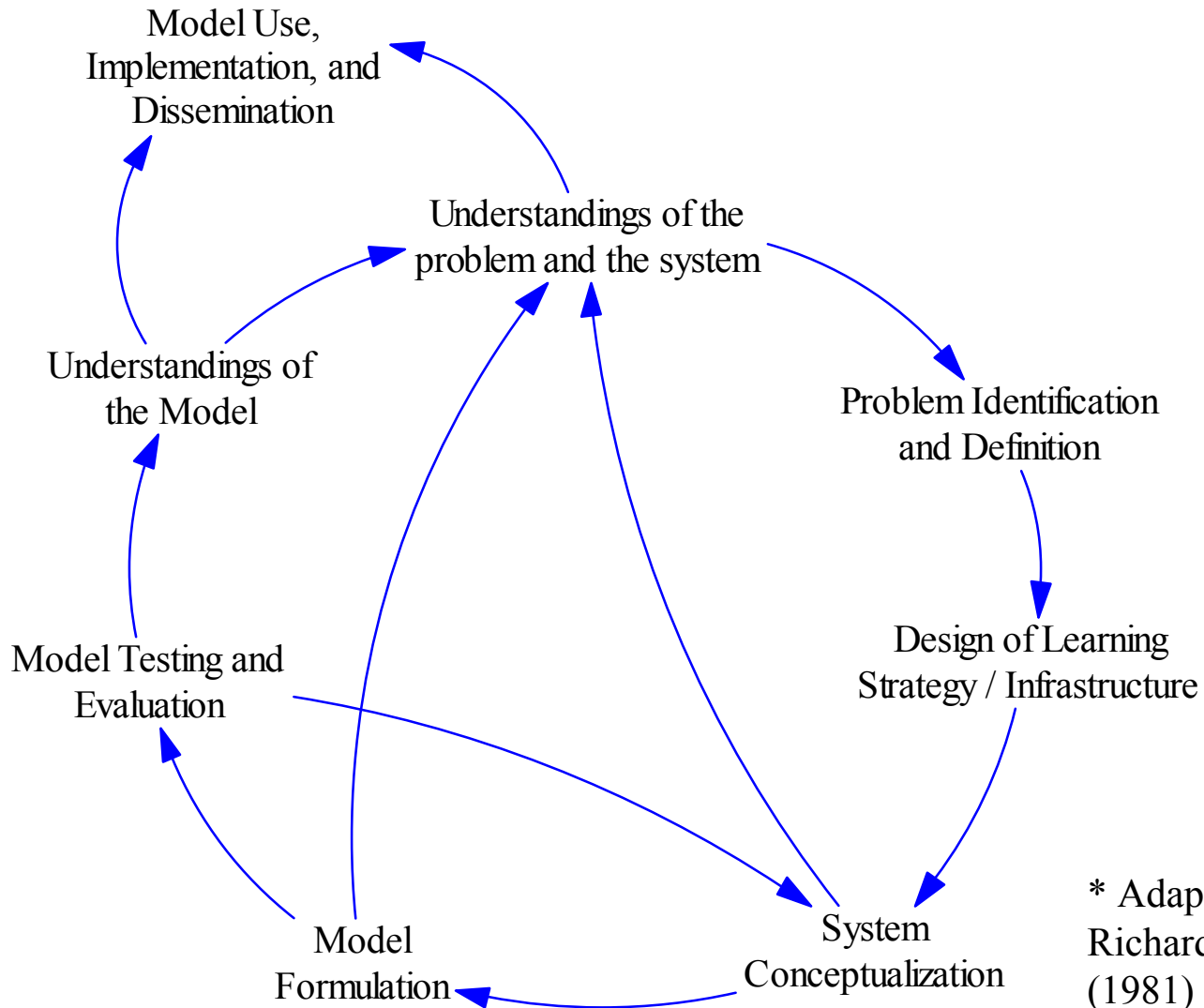
Improvement

4



Overview of the System Dynamics Modeling Approach* as in Martinez and Richardson (2001)

Oct 2001



* Adapted from
Richardson and Pugh
(1981)



Materials prepared specially for:
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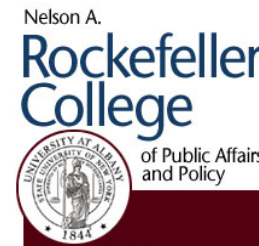
For providing essential elements
for the development of the system
dynamics ideas explored to:

Proyectos Comerciales de México
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Grupo Proyectos



For providing superb, and
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University at Albany



References

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