Figures and Tables excerpted from

Business Dynamics:
Systems Thinking and Modeling for a Complex World

Chapter 3

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Chapter 3: The Modeling Process

• How can useful virtual worlds (models) be created?

• Modeling takes place in the context of real world problem solving, with all its messiness, ambiguity, time pressure, politics, and interpersonal conflict.

• This chapter discusses:

The purpose of modeling
Describes the process of system dynamics modeling
The role of the client

•The modeler's professional and ethical responsibilities

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3.1 The Purpose of Modeling: Managers as Organization Designers

•**The important of purpose in modeling**

•**Top management should act more as designers of organization and less as operator to operate the organization.**

•**Modeling should focus on important problems.**

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3.2 The Client and the Modeler

•Before modeling process starts, modeler should identify the client of the problem and related model.

•The clients are people who should be influenced for the modeling efforts to have impact.

•Modeling should focus on the clients' needs.

•The clients for modeling projects are busy, embroiled in organizational politics, looking out for their careers.

•They care little for the elegance of your theory or cleverness.

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3.2 The Client and the Modeler (Continued)

•Modelers should not automatically accede to clients requests, should require their clients to justify their opinions, ground their views in data, and consider new viewpoints.

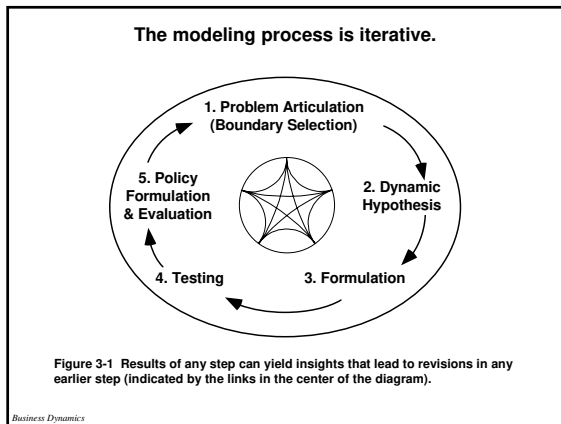•Unfortunately, far too many clients are not interested in learning but using models to support conclusions.

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Steps of the Modeling Process

• Modeling is a creative process.

• The first step is to find out what the problem is and who the real client is.

• Although modeling is inherently creative but there are some iterative steps that most modelers follow.
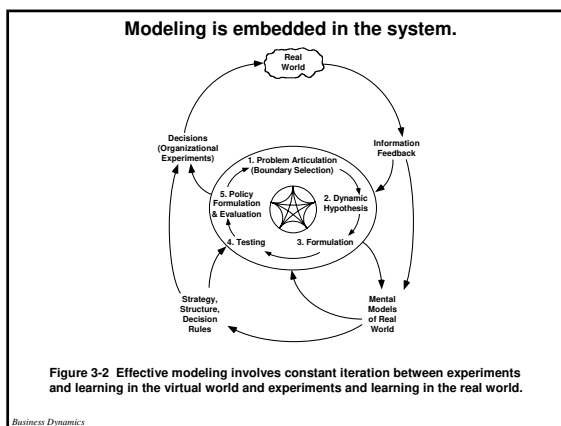
•Modeling is a feedback process

Figure 3-1

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The modeling process is iterative.

1. Problem Articulation (Boundary Selection)

5. Policy Formulation & Evaluation

2. Dynamic Hypothesis

4. Testing

3. Formulation

Figure 3-1 Results of any step can yield insights that lead to revisions in any earlier step (indicated by the links in the center of the diagram).

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• Modeling is embodied in the larger cycle of learning and action constantly take place in organizations.

Figure 3-2

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Modeling is embedded in the system.

Real World

Decisions (Organizational Experiments)

Information Feedback

1. Problem Articulation (Boundary Selection)

5. Policy Formulation & Evaluation

2. Dynamic Hypothesis

4. Testing

3. Formulation

Strategy, Structure, Decision Rules

Mental Models of Real World

Figure 3-2 Effective modeling involves constant iteration between experiments and learning in the virtual world and experiments and learning in the real world.

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Overview of the Modeling Process

Problem Articulation: The Importance of Purpose

• A clear purpose is the most important ingredient for a successful modeling study.

• Modeler should identify the real problem and not just the symptom of the difficulty.

• Model is a simplified version of the reality. Simplification is made based on purpose.

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Overview of the Modeling Process

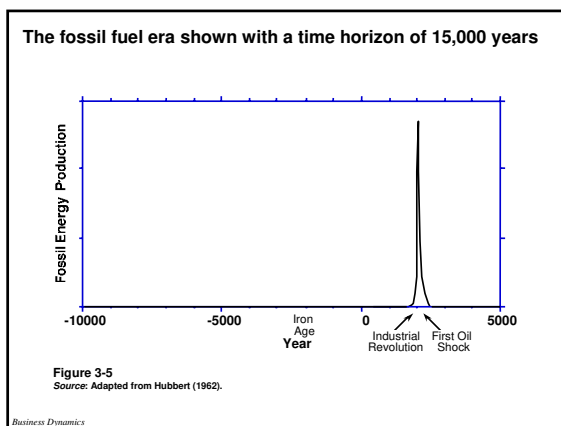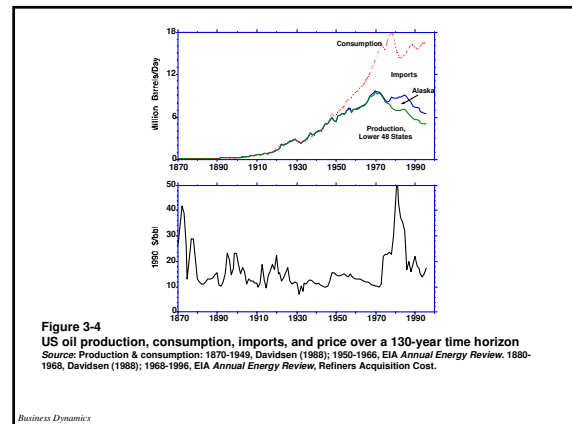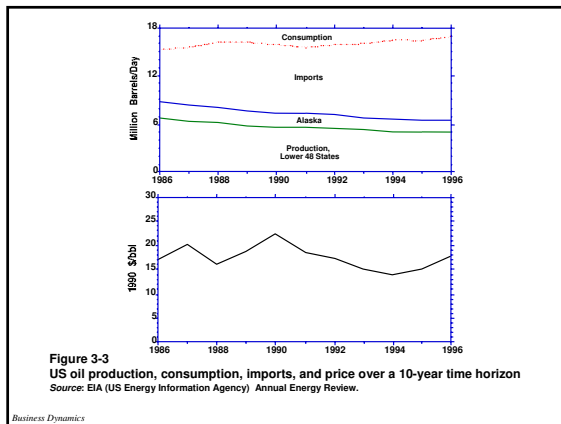**Problem Articulation: The Importance of Purpose**

• Always model for a problem. Never model a system.

• Two of the most useful processes to identify a problem are:

  ➢ Establishing reference mode.

  ➢ Setting the time horizon.

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Reference Modes

Time Horizon
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   The time horizon should extend far enough back in history to show how the problem emerged and describe its symptoms.

▪ · It should extend far enough into the future to capture the delayed and indirect effects of potential policies.

▪· The choice of time horizon dramatically influences your perception of the problem.
        Figures 3-3 and 3-4 and 3-5

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Figure 3-3
US oil production, consumption, imports, and price over a 10-year time horizon
Source: EIA (US Energy Information Agency) Annual Energy Review.

Figure 3-4
US oil production, consumption, imports, and price over a 130-year time horizon
Source: Production & consumption: 1870-1949, Davidsen (1988); 1950-1966, EIA *Annual Energy Review*. 1880-1968, Davidsen (1988); 1968-1996, EIA *Annual Energy Review*, Refiners Acquisition Cost.

The fossil fuel era shown with a time horizon of 15,000 years

Figure 3-5
Source: Adapted from Hubbert (1962).

Formulating a Dynamic Hypothesis

• A dynamic hypothesis is a working theory of how the problem arose.

❑ Endogenous Explanation

❑Mapping System Structure

➢ Model Boundary Chart

• It identifies the scope of the model by listing which key variables are included endogenously, which are exogenous, and which are excluded from the model.

Formulating a Dynamic Hypothesis (Continued)
➢ Subsystem Diagram

• Forrester's corporate model (background).

• Reference mode

     Figure 3-6
• Subsystem diagram for Forrester's corporate model.
          Figure 3-7

• Subsystem diagram for model of a semiconductor firm and its quality improvement program.
          Figure 3-8
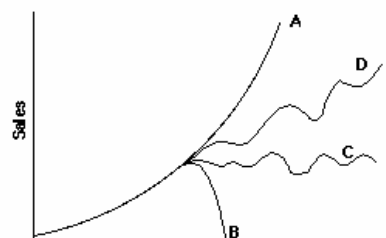
Formulating a Dynamic Hypothesis (Continued)

Figure 3-6
Source: Adapted from Forrester (1964).

Subsystem diagram for Forrester's corporate growth model
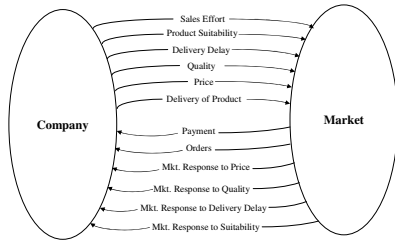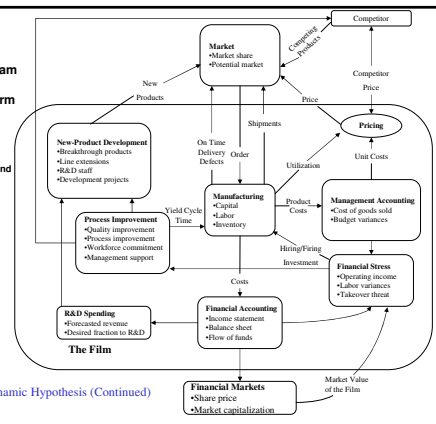

Figure 3-7
Source: Adopted from Forrester (1964).

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**Figure 3-8
Subsystem diagram
for model of a
semiconductor firm
and its quality
improvement
program**
Source: Adapted from
Sterman, Repenning, and
Kofman (1997).

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➢Causal Loop Diagrams

➢ Stock and Flow Maps

➢ Policy Structure Diagrams

Formulating a Simulation Model

Testing

Policy Design and Evaluation

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