The Modeling Pyramid: From Design to Production

CMG2000 Session 4404, December 13, 2000
http://www.simalytic.com/CMG00/4404ppt.pdf

Dr. Tim R. Norton
Simalytic Solutions, LLC
719-635-5825
e-mail: tim.norton@simalytic.com
http://www.simalytic.com
Agenda

◆ Introduction
  ○ Modeling through the Application Life Cycle

◆ Role of Modeling Techniques
  ○ General Modeling Tools
  ○ Specialized Tools for Modeling

◆ The Modeling Pyramid
  ○ Modeling Pyramid Levels
  ○ Modeling Pyramid Implementation

◆ Conclusion
Introduction

◆ Value of Modeling to Management
  ● Binary Condition (valuable or worthless)
  ● Understanding Political Situation Key
    ✓ Improve the business based on real measurement objectives
    ❌ Frustration with modeling cost and effort when the answer is already known (hidden agendas)
  ● Modeling Pyramid assumes existing value at one level
    ◆ Objective: Increase value by relating models from adjacent Application Life Cycle stages
Life Cycle Stages

- **Application Design Models**
  - Understanding application characteristics

- **Implementation Models**
  - Understanding application behavior

- **Deployment Models**
  - Understanding the relationship between the application and the environment
Life Cycle Stages

- **Production Models**
  - Understanding the relationship between application load and resource requirements

- **Planning Models**
  - Predicting future resource requirements

- **Enhancement Models**
  - Predicting the impact of application changes
Application Life Cycle

Design
Application Life Cycle

Function - UML
Performance - SPE

Design
Application Life Cycle

Design ➔ Implementation
Application Life Cycle

Design

Implementation

Component performance
Scalability predictions
Application Life Cycle

Design → Implementation → Deployment
Application Life Cycle

Design → Implementation → Deployment

Environment impact Measurement - ETE
Application Life Cycle

- Design
- Implementation
- Deployment
- Production

Component utilization
Business response time
Application Life Cycle

Planning → Design → Implementation → Deployment → Production
Application Life Cycle

Design → Implementation → Deployment → Production → Planning

Utilization prediction
Budget impact
Application Life Cycle

Design  Implementation  Deployment  Production  Planning  Enhancement
Application Life Cycle

- Design
- Implementation
- Deployment
- Production
- Planning
- Enhancement
- New features
- Replacement
Application Life Cycle

- Design
- Implementation
- Deployment
- Production
- Enhancement
- Planning
Application Life Cycle

Models

- Design
- Implementation
- Deployment
- Enhancement
- Production
- Planning
Application Example

◆ Modeling an Order Entry Application
  ● Mail-order catalog company
  ● Customers call and place orders
  ● Operators use Order Entry Application
  ● Response time impacts customer satisfaction
  ● Resource capacity limits business growth
  ● Increased transaction rates based on Marketing plans for new customers and new products
  ● New function: replacing paper shipping reports with an on-line transaction
Application Life Cycle Example

Design
Application Life Cycle Example

UML defines workloads
SPE predicts design performance
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Design

order transaction
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Design

order transaction

Implementation
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Implementation
Measurement and prediction of transaction performance

Design
order transaction
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Design

Implementation

Measurement and prediction of transaction performance

order transaction

order tran performance
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Implementation
Measurement and prediction of transaction performance

Design

Implementation

Deployment

order transaction
order transaction performance
Application Life Cycle Example

- **Design**: UML defines workloads, SPE predicts design performance.
- **Implementation**: SPE predicts design performance.
- **Deployment**: Measurement and prediction of transaction performance.
- Prediction of overall application with new transaction function.
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Design

Implementation

Measurement and prediction of transaction performance

Order transaction

Deployment

Order function performance

Prediction of overall application with new transaction function
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Design

Implementation
Measurement and prediction of transaction performance

Deployment
Prediction of overall application with new transaction function

Production
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Implementation
Measurement and prediction of transaction performance

Deployment
Prediction of overall application with new transaction function

Production
Prediction of utilization of each component and overall business response time
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Design

Implementation

Measurement and prediction of transaction performance

Order transaction performance

Deployment

Prediction of overall application with new transaction function

Order function performance

Production

Prediction of utilization of each component and overall business response time

Order system performance
Application Life Cycle Example

- **Planning**: Prediction of utilization of each component and overall business response time
- **Implementation**: Measurement and prediction of transaction performance
- **Deployment**: Prediction of overall application with new transaction function
- **Design**: UML defines workloads, SPE predicts design performance
- **Production**: Prediction of utilization of each component and overall business response time
Application Life Cycle Example

- UML defines workloads
- SPE predicts design performance

**Design**
- Order transaction performance

**Implementation**
- Measurement and prediction of transaction performance

**Deployment**
- Prediction of overall application with new transaction function
- Order function performance
- Order system performance

**Production**
- Prediction of utilization of each component and overall business response time

**Planning**
- Prediction of system based on business forecast

© 2000 Tim R. Norton
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Implementation
Measurement and prediction of transaction performance

Design
Order transaction
Order transaction performance

Deployment
Prediction of overall application with new transaction function

Production
Prediction of utilization of each component and overall business response time

Order volume performance
Order system performance

Planning
Prediction of system based on business forecast
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Design

Implementation

Measurement and prediction of transaction performance

Deployment

Prediction of overall application with new transaction function

Production

Prediction of utilization of each component and overall business response time

Enhancement

Planning

Prediction of system based on business forecast
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Implementation
Measurement and prediction of transaction performance

Deployment
Prediction of overall application with new transaction function

Enhancement
Revised transaction with new features

Prediction of system based on business forecast

Planning
Prediction of utilization of each component and overall business response time
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Design

Implementation
Measurement and prediction of transaction performance

Deployment
Prediction of overall application with new transaction function

Production
Prediction of utilization of each component and overall business response time

Enhancement
Revised transaction with new features

Planning
Prediction of system based on business forecast
Application Life Cycle Example

UML defines workloads
SPE predicts design performance

Design

Implementation
Measurement and prediction of transaction performance

Deployment
Prediction of overall application with new transaction function

Production
Prediction of utilization of each component and overall business response time

Enhancement
Revised transaction with new features

Planning
Prediction of system based on business forecast
Modeling Techniques

◆ General Modeling Tools

○ Simulation
  - Tokens represent individual transactions
  - Examples:
    ▲ DES - Discrete Event Simulation
    ▲ Continuous Simulation - System Dynamics

○ Analytic
  - Mathematical description of the average transaction
  - Examples:
    ▲ M/M/1 Models
    ▲ Queuing Network Models
Modeling Techniques

◆ Specialized Tools for Modeling
  ○ UML - Unified Modeling Language
  ○ ETE-RT - End-To-End Response Time
  ○ SPE - Software Performance Engineering
  ○ Simalytic Modeling Technique
  ○ Business Models - System Dynamics
  ○ Node Models
  ○ Platform-Centric Models
The Modeling Pyramid

◆ **Strategic Level**

- Overall view to move an organization forward
  - Marketing or Business Plan
  - Projections by business area

- Order Entry Example:
  - Customer growth
  - Product line growth
  - Replace paper catalog/orders with online functions
  - Metrics:
    ▲ # customers, # products, # orders, etc.
The Modeling Pyramid

◆ **Business Level**
  - Detailed view of business processes
    - Models predict how the entire process reacts to changes
  - Order Entry Example:
    - Staff to support additional customers
    - IT growth to support additional products/services
    - Metrics:
      ▲ # calls, # operators, # telephone lines, etc.
The Modeling Pyramid

◆ Application Level

- Detailed view of how the application functions
  - Models predict how the application reacts to changes

- Order Entry Example:
  - Number of OE transactions supported
  - OE transaction response time changes with growth
  - Impact of replacing Shipping paperwork with an online function

- Metrics:
  ▲ # transactions, tran response time, user think time, etc.
The Modeling Pyramid

- **System Level**
  - Broad view of all applications using specific hardware
    - Models predict system performance and application interactions
  - Order Entry Example:
    - Impact of other loads on OE database
    - Interference caused by system backups
    - Metrics:
      - # DB queries, processor utilization, memory load, etc.
The Modeling Pyramid

◆ **Infrastructure Level**
  - Detailed view of the interconnections in the system
    - Models predict environment performance and interactions between systems
  - Order Entry Example:
    - RT impact of message latency to Shipping server
    - Impact of transaction growth on message latency
  - Metrics:
    - # DB I/Os, # network I/Os, I/O response time, etc.
The Modeling Pyramid

◆ Component Level

- Most detailed view of underlying hardware
  - Models predict hardware performance for component selection
  - Components of one system may be systems themselves (i.e. network gateways or disk subsystems)

- Order Entry Example:
  - RT impact of router or network segment upgrade
  - Metrics:
    - # packets, # router hops, packet latency, etc.
The Modeling Pyramid
The Modeling Pyramid

More General Models
The Modeling Pyramid

More General Models

Strategic
The Modeling Pyramid

More General Models

Strategic

Business
The Modeling Pyramid

More General Models

- Strategic
- Business
- Application
The Modeling Pyramid

More General Models

Strategic

Business

Application

System
The Modeling Pyramid

More General Models

- Strategic
- Business
- Application
- System

Infrastructure
The Modeling Pyramid

More General Models

- Strategic
- Business
- Application
- System
- Infrastructure
- Component
The Modeling Pyramid

More General Models

- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models
The Modeling Pyramid

More General Models
- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models

Top Down
The Modeling Pyramid

More General Models

- Strategic
- Business
- Application

More Detailed Models

- System
- Infrastructure
- Component

Top Down

Bottom Up
The Modeling Pyramid

More General Models
- Strategic
- Business
- Application
- System
- Infrastructure

More Detailed Models
- Component

Direction:
- Top Down
- Bottom Up
- Inside Out
The Modeling Pyramid

More General Models
- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models

Top Down
Bottom Up
Inside Out
Outside In
The Modeling Pyramid

**Modeling Pyramid Implementation**

- **Top Down**
  - Start at the most general (Strategic) level
  - Connect the metrics:
    - Output of upper level
    - To input of lower level
  - Progress to the detailed (Component) level
    - Stop when the business question is answered
    - Avoid increased detail for its own sake
The Modeling Pyramid

More General Models
- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models

Top Down
The Modeling Pyramid

More General Models

- Strategic
- Business
- Application

More Detailed Models

- System
- Infrastructure
- Component

Top Down # customers
The Modeling Pyramid

More General Models

- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models

Top Down

# customers

# calls
The Modeling Pyramid

More General Models
- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models

Top Down

# customers
# calls
# transactions
The Modeling Pyramid

More General Models
- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models

Top Down

- # customers
- # calls
- # transactions
- # DB queries
The Modeling Pyramid

More General Models

- Strategic
- Business
- Application
- System
- Infrastructure

Component

More Detailed Models

# customers
# calls
# transactions
# DB queries
# I/O’s
The Modeling Pyramid

More General Models

- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models

# customers → # calls → # transactions → # DB queries → # I/O's

Top Down

Increasing Detail
The Modeling Pyramid

- **Modeling Pyramid Implementation**
  - **Bottom Up**
    - Start at the most detailed (Component) level
    - Connect the metrics:
      - output of lower level
      - to input of upper level
    - Progress to the general (Strategic) level
      - Stop when the technical question is answered
      - Avoid speculation outside of the business objectives
        - A server upgrade would support 100x more customers when the business plan projects 3x growth.
The Modeling Pyramid

More General Models

- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models

Bottom Up
The Modeling Pyramid

More General Models

- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models

Bottom Up

I/O RT
The Modeling Pyramid

More General Models

- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models

Bottom Up

.query RT

I/O RT
The Modeling Pyramid

More General Models
- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models
- I/O RT
- query RT
- tran RT
- call RT

Bottom Up
The Modeling Pyramid

More General Models
- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models
- I/O RT
- tran RT
- query RT
- call RT
- customers supported

Bottom Up
The Modeling Pyramid

More General Models
- Strategic
- Business
- Application
- System
- Infrastructure
- Component

More Detailed Models
- I/O RT
- query RT
- tran RT
- call RT
- customers supported

Increasing Generalization

Bottom Up
The Modeling Pyramid

- **Modeling Pyramid Implementation**
  - **Inside Out**
    - Start at a middle (Application) level
    - Quickly addresses Application issues
    - Lacks initial strategic direction or component detail
  - **Outside In**
    - Start at Top and Bottom levels simultaneously
    - Strategy defined while detailed work gets started
    - Unlikely that the two efforts will actually meet
The Modeling Pyramid

**Modeling Pyramid Implementation**

- **The Spiral**
  - Start with general assumptions for all levels
  - Challenge the assumptions:
    - Use the model at one level to challenge the models at the adjacent levels
    - Roll up to the Strategic Level to keep business focus
  - Refine at each level only when and as needed
  - Overall view (like a street map) where detail is added as needed (city center) and assumptions are used elsewhere (straight line between cities) unless that’s a problem (mountain roads).
The Order Entry Model
The Order Entry Model

New Calls → Call Backlog → # Operators needed → Calls Completed
The Order Entry Model

- New Calls
- Call Backlog
- # Operators needed
- Calls Completed
- OE Application
The Order Entry Model

New Calls → Call Backlog → # Operators needed

OE Application → OE System → Shipping System
The Order Entry Model

New Calls → Call Backlog → # Operators needed → Calls Completed

OE Application

OE System

Server

Network

Shipping System
The Order Entry Model

New Calls \rightarrow Call Backlog \rightarrow \# Operators needed \rightarrow Calls Completed

OE Application

OE System

Server

Network

LAN

Shipping System
The Order Entry Model

New Calls → Call Backlog → # Operators needed → Calls Completed

OE Application

OE System

Server

Network

LAN

Router

Router

Router

Shipping System
Conclusion

Modeling Pyramid is a Technique to:

- Apply a uniform strategic direction to all modeling activities
- See application progression from birth to death
- Get objective information for business decisions
- Focus technical efforts on business issues
- Investigate the relationships between levels
- Use appropriate tools at each level
- Enhance each model level only as needed
Questions