Developing a Repeating Model Using the Structured Spreadsheet Modelling and Implementation Methodology

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Presentation Plan

- Genesis
- SSMI
- Repeating Sub-model
- Structured Implementation
- Characteristics of the SSMI Methodology
- Q&A
Genesis

- Teaching Decision Support Systems courses (1980’s and 1990’s)
  - Undergraduates
  - MBAs
- Reference book: Modern Decision Making, Samuel Bodily, 1985
  - Implement models using IFPS
- Gradually adapted to Lotus 1-2-3 and Excel
Instead of teaching Excel, I teach how to use Excel.
Typical Process
Spreadsheet Analysis, Design and Implementation

User

Logical and mechanical errors

Excel manipulations

Computer

Disk

Time

Physical Model
### Typical Process

**Spreadsheet Analysis, Design and Implementation**

![Spreadsheet Image]

Source: Hermans, Felienne (2014): Enron Spreadsheets and Emails. figshare. [http://dx.doi.org/10.6084/m9.figshare.1221767](http://dx.doi.org/10.6084/m9.figshare.1221767)
Model or Model?
Model or Model?

It can be an accounting system;

Used for simulation and forecasting;

Or presented as a dashboard.
Model or Model?

A spreadsheet is a model of the real world.

The Formula Diagram and the Formula List are the Conceptual Model of the spreadsheet.
Model or Model?

In Information Systems, we use a **Conceptual Model**.

- Describes what the user **needs**, without references to the technology used to implement it.
Structured Spreadsheet Modelling and Implementation

- Developer
  - Domain knowledge
  - Spreadsheet knowledge
  - Logical errors

- Same or another developer
  - Mechanical errors

- Computer
  - Spreadsheet file
  - Excel manipulations
  - Disk

- Conceptual and Logical Models
  - Formula Diagram and Formula List

- Physical Model
  - Time
Structured Modelling

Two categories of variables, with sub-categories:

|                  | Behind-the-Scene | Interface |
|------------------|------------------|-----------|
| Constants        |                  |           |
| Calculated       |                  |           |

- Constants
  - Parameter
  - Input

- Calculated Variable
  - Output
Example

- Marco sells widgets in three regions:
  - {East, South and North}
- Past demand = {48%, 23%, 29%}
- Delivery Cost = {50$, 80$, 60$}
- Unit manufacturing cost = 120$
- Demand = 367000 × 1.009^{−\text{Price}}
### South Region

| Variable            | Description                                      | Type     | Definition                                      |
|---------------------|--------------------------------------------------|----------|-------------------------------------------------|
| Price               | Average price of widgets                         | Input    |                                                 |
| Profit South        | Profit of the South region                       | Output   | = Revenue South - Total Cost South               |
| DemParA             | First Demand function parameter                  | Parameter| 367,000                                         |
| DemParB             | Second Demand function parameter                 | Parameter| 1.0009                                          |
| Fixed Cost          | Fixed cost of manufacturing the widgets           | Parameter| 2,500,000$                                      |
| Mfg Cost            | Cost of manufacturing one widget                  | Parameter| 120$                                            |
| Dist South          | Proportion of the Demand sold in the South region | Parameter| 49%                                             |
| Delivery Cost South | Cost of delivery of widgets in the South region   | Parameter| 50$                                             |
| Demand              | Demand of widgets, formula given by the market research specialist | Calculated| = DemParA * DemParB * Price                      |
| Demand South        | Portion of the Demand sold in the South region   | Calculated| = Demand * Dist South                           |
| Total Cost South    | Total Cost of selling widgets in the South region | Calculated| = Fixed Cost South + Variable Cost South        |
| Fixed Cost South    | Portion of the Fixed cost allocated to the South region | Calculated| = Fixed Cost * Dist South                        |
| Variable Cost South | Variable Cost of the widgets sold in the South region | Calculated| = Demand South * Unit Cost South                |
| Unit Cost South     | Unit cost of one widget in the South region       | Calculated| = Mfg Cost + Delivery Cost South                |
| Revenue South       | Revenue of the South region                       | Calculated| = Demand South * Price                           |
Other Regions
Other Regions

What if…

‣ 10 provinces?
‣ 50 states?
‣ 100 departments?

How big?
Structured Implementation

- Three-tier architecture: single-purpose worksheets
  - Parameters
  - Model
  - Interface
- Emulate SE Modules with precise block structure
- Extensive use of names
Worksheet for
Single-Value Parameters

Every **cell** is named
Worksheet for Multiple-Value Parameters

Every **row** is named
Worksheet for
Single-Value Calculated Variables

The definition block:

Simple reference formulas to named variables

Definition formula referencing the cells directly above

Every cell containing a definition formula is named
Worksheet for
Multiple-Value Calculated Variables

The definition block:

Every row containing a definition formula is named

Simple reference formulas to named variables

Definition formula referencing the cells directly above
Worksheet for
Multiple-Value Calculated Variables
Worksheet for Multiple-Value Calculated Variables

| A | B | C | D | E |
|---|---|---|---|---|
| Repeated sub-mode | South | | | |
| Region | Total Demand | Distribution | Regional Demand | Price |
| | 13,062 | 48% | 6,270 | 375 $ |
| | Revenue | 2,351,110 $ |
| | Mfg Cost | 120 $ |
| | Delivery Cost | 50 $ |
| | Unit Cost | 170 $ |
| | Regional Demand | 6,270 | | |
| | Unit Cost | 170 $ | | |
| | Variable Cost | 1,065,837 $ |
| | Total Fixed Cost | 2,500,000 $ |
| | Distribution | 48% | | |
| | Regional Fixed Cost | 1,200,000 $ |
| | Variable Cost | 1,065,837 $ |
| | Total Cost | 2,265,837 $ |
| | Revenue | 2,351,110 $ |
| | Total Cost | -2,265,837 $ |
| Profit | 85,274 $ |

| A | B | C | D | E |
|---|---|---|---|---|
| Repeated sub-mode | South | East | North |
| Region | Total Demand | Distribution | Regional Demand | Price |
| | 13,062 | 48% | 6,270 | 375 $ |
| | Revenue | 2,351,110 $ | 1,126,574 $ | 1,420,462 $ |
| | Mfg Cost | 120 $ | 120 $ | 120 $ |
| | Delivery Cost | 50 $ | 80 $ | 60 $ |
| | Unit Cost | 170 $ | 200 $ | 180 $ |
| | Regional Demand | 6,270 | 3,004 | 3,788 |
| | Unit Cost | 170 $ | 200 | 180 $ |
| | Variable Cost | 1,065,837 $ | 600,839 $ | 681,822 $ |
| | Total Fixed Cost | 2,500,000 $ | 2,500,000 $ | 2,500,000 $ |
| | Distribution | 48% | 23% | 29% |
| | Regional Fixed Cost | 1,200,000 $ | 575,000 $ | 725,000 $ |
| | Variable Cost | 1,065,837 $ | 600,839 $ | 681,822 $ |
| | Total Cost | 2,265,837 $ | 1,175,839 $ | 1,406,822 $ |
| | Revenue | 2,351,110 $ | 1,126,574 $ | 1,420,462 $ |
| | Total Cost | -2,265,837 $ | -1,175,839 $ | -1,406,822 $ |
| Profit | 85,274 $ | -49,266 $ | 13,640 $ |
Calculating a Single-Value Variable from a Multiple-Value Variable
Calculating a Single-Value Variable from a Multiple-Value Variable

|   | B | C | D |
|---|---|---|---|
| 1 | Model |   |   |
| 2 |   |   |   |
| 3 | DemParA | 376000 |   |
| 4 | DemParB | 1.009 |   |
| 5 | Price | 375 $ |   |
| 6 | Total Demand | 13061.7 |   |
| 7 |   |   |   |
| 8 | Region | South | East | North |
| 9 | Profit | 85,274 $ | -49,266 $ | 13,640 $ |
| 10 | Total Profit |   |   |
| 11 |   |   |

Excel formula: `=SUM(9:9)`

Total Profit: 49,649 $
**Interface Flexibility**

| Original Version | SSMI Version |
|------------------|--------------|
| ![Excel Sheet](image1.png) | ![Excel Sheet](image2.png) |

**DCF Model**

**Working Capital Schedule**

| Year | Current Assets | Non-Cash Current Assets |
|------|----------------|-------------------------|
| 2012 | $3,833         | $11,079                 |
| 2013 | $3,582         | $9,403                  |
| 2014 | $4,427         | $11,718                 |

**EBITDA Calculation**

| Year | EBITDA | EBITDA Calculation |
|------|--------|--------------------|
| 2015 | $14,638| $14,638 - $12,291 |
| 2016 | $15,347| $15,347 - $15,347 |
| 2017 | $16,990| $16,990 - $16,990 |

**Capex**

| Year | Capex | Capex Calculation |
|------|-------|-------------------|
| 2015 | $11,027| $10,523         |
| 2016 | $10,957| $10,957         |
| 2017 | $11,408| $11,408         |
| 2018 | $11,733| $11,733         |

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SSMI International
Interface Flexibility

SSMI Version

Behind-the-Scenes
Characteristics of the SSMI Methodology

- **Spreadsheet documentation**: Formula Diagram and Formula List
  - Overview of relationships
  - Facilitates peer review
  - Facilitates hand-off of the model
Characteristics of the SSMI Methodology

‣ Rule 1: only **one mathematical operator or function per formula**

‣ References in the definition block are made by name
  • Easier to **understand** their meaning

‣ The definition formula uses the cells directly above, making it easier to verify.
  • There is **never** any need to use absolute or mixed cell references
Characteristics of the SSMI Methodology

‣ No daisy-chains

‣ Instead of copying many formulas one by one, we copy all the formulas once

‣ Verifying an implementation can be done by re-copying column B and seeing where changes happen
In Development

- Repeating sub-model with time periods.
- Modelling techniques for special cases.
Q&A
Thank you!