Accounting System Dynamics
(Module 6 & 7)

Instructor
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Module Overview

It is essential for business people to understand the structure of financial reports consisting of income statement, balance sheet and cash flow statement. With the application of stock-flow concept of simple dynamics, the understanding of financial reports becomes very simple and easy. This method is proposed by Prof. K. Yamaguchi as accounting system dynamics – a foundation of business modeling in this course.
Suggested Reading (A)

Money and Macroeconomic Dynamics – Accounting System Dynamics Approach –
by Kaoru Yamaguchi, 2013

Chapter 3: Accounting System Dynamics
Suggested Reading (B)

“Financial Statements”
by Thomas Ittelson, Career Press, 1998
Learning Subjects

1. Principle of Accounting System Dynamics
2. Accounting System Dynamics Simplified
   - Household Account Booking -
3. Accounting System Dynamics in Action
Accounting in Crisis: Enron
Special-Purpose Entities (SPEs)

✓ Normally, once a company owns 50% or more of another, it must consolidate it under the 1959 rules.

✓ The controversial exception is that outsiders need invest only 3% of an SPE’s capital for it to be independent and off the balance sheet.

✓ It 1990, accounting firms asked the SEC to endorse the 3% rule that had become a common, though unofficial practice in the ’80s.
Accounting in Crisis: Enron
Special-Purpose Entities (SPEs)

✓ The SEC didn’t like the idea, but it didn’t stomp on it, either -- fumbles by the Securities & Exchange Commission and the Financial Accounting Standards Board.

✓ The SEC asked the FASB to set tighter rules to force consolidation of entities that were effectively controlled by companies.

FASB = Financial Accounting Standards Board
1. Accounting System Dynamics

This method was originally presented in the following paper:

System Dynamics Applied to Accounting

Hydraulic Metaphor:

Stock and Flow Diagram:

Integral Equation:

Differential Equation:

Business Dynamics by John D. Sterman, McGraw-Hill Companies, 2000, p.194

わかりる！図解キャッシュフロー
久保豊子著、ダイアモンド社
2000年、p. 111

Cash through Operation
Cash through Investment
Cash through Finance
Principle 1. System as a Collection of Stocks

System can be described by a collection of state variables, called *stocks* in system dynamics, whose levels or volumes are measured at a *moment in time*. 
Principle 2. Stock-Flow Relation

Levels of a stock can only be changed by the amount of \textit{flows} measured for a \textit{period of time}.

The amount of flow that increases the stock is called \textit{inflow}, while the one that decreases it is called \textit{outflow}.
Principle 3. Information Feedback

The amount of inflows and outflows is directly or indirectly determined either by the information obtained from the stocks through their feedback loops, or parameters obtained outside the system.

Balance sheet is a collection of stocks only, while income statement and cash flow statement consist of inflows and outflows of the stocks in balance sheet.

_The balance sheet reports the aggregate effect of transactions at a point in time, whereas the income statement, statement of retained earnings, and statement of cash flows report the effect of transactions over a period of time._

### Balance Sheet as a System of Stocks

<table>
<thead>
<tr>
<th>Assets (Current Assets)</th>
<th>Liabilities (Current Liabilities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>Accounts Payable</td>
</tr>
<tr>
<td>Accounts Receivable</td>
<td>Accrued Expenses</td>
</tr>
<tr>
<td>Inventories</td>
<td>Current Portion of Debt</td>
</tr>
<tr>
<td>Prepaid Expenses</td>
<td>Income Taxes Payable</td>
</tr>
<tr>
<td>Other Assets</td>
<td>Long-Term Debt</td>
</tr>
</tbody>
</table>

**Shareholders' Equity**

- Capital Stock
- Retained Earnings

**Net Fixed Assets**

- Book Value of PP&E

**Fixed Assets**

- Other Assets
Principle 5. Double Entry Rule of Bookkeeping

All transactions in the accounting system are recorded as inflows and/or outflows of stocks in the balance sheet so that each transaction causes two corresponding stocks to change simultaneously in balance.

For this purpose, each transaction is booked twice on both debit and credit sides. Inflows of assets and outflows of liabilities and shareholders' equity are booked on the debit side, while outflows of assets and inflows of liabilities and shareholders' equity are booked on the credit side.
Double Entry Rule of Bookkeeping as Debit and Credit

Debit                                Credit

- Increase in Assets - Decreased in Assets
- Decrease in Liabilities - Increase in Liabilities
- Decrease in Equity - Increase in Equity
- Costs, Expenses and Dividends - Revenues.
Double Entry Rule of Bookkeeping as Debit and Credit

Debit

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in Assets</td>
<td>Decrease in Liabilities</td>
</tr>
<tr>
<td>Decreased in Assets</td>
<td>Decrease in Liabilities</td>
</tr>
</tbody>
</table>

Credit

<table>
<thead>
<tr>
<th>Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Stock</td>
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<tr>
<td>Decrease in Equity</td>
</tr>
<tr>
<td>Increase in Equity</td>
</tr>
<tr>
<td>Retained Earnings</td>
</tr>
<tr>
<td>Costs, Expenses and Dividends</td>
</tr>
<tr>
<td>Revenues</td>
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Debit: inflow ↔ Credit: outflow

Transactions within assets are classified in this category. For example, an increase in Fixed Assets by the purchase of PP&E is balanced by the decrease in Cash by its payment.
Double Entry Rule of Bookkeeping for Book Value

- Cash
- PP&E Purchase
- Book Value of PP&E
- Depreciation
- Accumulated Depreciation
Double Entry Rule of Bookkeeping as Debit and Credit(2)

Debit: outflow <-> Credit: inflow

Transactions within liabilities and equity are classified here. For example, a decrease in Retained Earnings caused by an increase in operating expenses such as sales & marketing expenses is balanced by the increase in Accrued Expenses.
Double Entry Rule of Bookkeeping as Debit and Credit(3)

Debit:inflow <-> Credit:inflow

Transactions in this category cause both Assets and Liabilities/Equity to increase. For instance, an increase in net sales causes both Accounts Receivable and Retained Earnings to increase.
Double Entry Rule of Bookkeeping as Debit and Credit(4)

Debit: outflow <-> Credit: outflow
Transactions here cause both Assets and Liabilities/Equity to decrease. For instance, payment of Accounts Payable causes both Cash and Accounts Payable to decrease.
Principles of Accounting System Dynamics

Principles 1 through 5 obtained from system dynamics and accounting system constitutes the Principle of Accounting System Dynamics.
2. Accounting System Dynamics Simplified

[Diagram of accounting system dynamics]
2.1 Cash Flow of Household Account

Cash Flow Diagram:

- **Cash Inflow**
  - Wages
  - Bonuses
  - Windfall Income
  - Benefit/Grant
  - Rent/Rental Income
  - Dividends

- **Cash Outflow**
  - Food
  - Clothes
  - Housing Rent
  - Utilities
  - Phones
  - Transportation
  - Education
  - Medical Care and Health
  - Social expenses
  - Recreation
  - Furnishings
  - Insurances
  - Miscellaneous Expenses
  - Taxes

- **Net Cash Flow**
- **Initial Deposits**
- **Cash Deposits**
2.2 Financial (Interest) System

- Interest Rate
- Months per Year
- Interest
- Cash Inflow
- Cash Outflow
- Wages
- Bonuses
- Windfall Income
- Benefit/Grant
- Initial Deposits
- Net Cash Flow
- Cash/Deposits
- Taxes
- Education
- Medical Care and Health
- Social expenses
- Recreation
- Furnishings
- Insurances
- Transportation
- Miscellaneous Expenses
- Dividends
- Income
- Rent/Rental Income
- Food
- Clothes
- Housing Rent
- Utilities
- Phones
- Recreation
- Expenditures
- Miscellaneous Expenses
2.3 Loans

Cash/Deposits

Debts

Borrowing

Principal and Interest Repayment

Automobiles

Purchase of a Car

Cash Inflow

Cash Outflow

<Expenditures>

<Taxes>

<Income>

<Interest>

<Amount of Loan>

<Initial Deposits>

Installment Plan

Desired Loan

Loan Period (Months)

Per Month

Amount of Loan

Time for Loan

Loan Interest

Loan Interest Rate

<Months per Year>
2.4 Personal Financial Management: Equity

Cash/Deposits

Cash Inflow

Purchase of a Car

Cash Outflow

Automobiles

Debts

Principal and Interest Repayment

Borrowing

Installment Plan

Desired Loan

Loan Period (Months)

Amount of Loan

Time for Loan

Loan Interest

Loan Interest Rate

<Months per Year>

Amount of Loan

<Initial Deposits>

Per Month

Personal Equity (Net Assets)

<Income>

<Interest>

<Expenditures>

<Taxes>

<Income>

<Interest>

<Initial Deposits>

<Amount of Loan>
2.5 Personal Financial Management: Depreciation

- Cash/Deposits
- Debts
- Borrowing
- Principal and Interest Repayment
- Automobiles (Purchase of a Car)
- Personal Equity (Net Assets)
- Installment Plan
- Desired Loan
- Loan Period (Months)
- Loan Interest Rate
- Loan Interest Per Month
- Amount of Loan
- Months per Year
- Initial Deposits
- Amount of Loan
2.6 Income Statement

- Personal Equity (Net Assets)
  - Taxes
  - Benefit/Grant
  - Wages
  - Bonuses
  - Windfall Income

Expenditures:
- Medical Care and Health
- Education
- Recreation
- Social expenses
- Transportation
- Utilities
- Miscellaneous Expenses
- Insurances
- Debts
- Loan Interest
- Depreciation
- Automobiles

Income:
- Wages
- Bonuses
- Windfall Income
- Rent/Rental Income
- Dividends
- Benefit/Grant

Interest:
- Interest Rate
- Cash/Deposits

Initial Deposits

<Initial Deposits>
2.7 Simulation of Household Account

- **Cash/Deposits**
  - Time (Month): 0, 24, 48, 72, 96, 120
  - Yen: 0, 60,000, 102,050, 144,135, 186,255, 228,410, 270,600, 312,826, 355,086, 397,382, 439,713, 482,080, 524,482, 566,919, 609,391, 651,899, 694,442, 737,021, 779,635, 822,285, 864,970, 907,691, 950,447

- **Debts**
  - Time (Month): 0, 30, 60, 90, 120
  - Yen: 0, 2 M, 1.966 M, 1.933 M, 1.9 M, 1.866 M, 1.833 M, 1.8 M, 1.766 M, 1.733 M, 1.7 M, 1.666 M, 1.633 M, 1.6 M, 1.566 M, 1.533 M, 1.5 M

- **Personal Equity (Net Assets)**
  - Time (Month): 0, 24, 48, 72, 96, 120
  - Yen: 0, 60,000, 102,050, 144,135, 186,255, 228,410, 270,600, 312,826, 355,086, 397,382, 439,713, 482,080, 524,482, 566,919, 609,391, 651,899, 694,442, 737,021, 779,635, 822,285, 864,970, 907,691, 950,447

- **Automobiles**
  - Time (Month): 0, 36, 72, 108
  - Yen: 0, 2 M, 1.5 M, 1 M, 500,000, 0, 0, 0

- **Wages**
  - Time: 0, 600,000

- **Food**
  - Time: 0, 120,000

- **Clothes**
  - Time: 0, 30,000

- **Social expenses**
  - Time: 0, 30,000

- **Windfall Income**
  - Time: 0, 100,000

- **Desired Loan**
  - Time for Loan: 1, 60

- **Installment Plan**
  - Loan Interest Rate: 1, 3

- **Depreciation Rate**
  - Time (Month): 0, 12
3. Accounting System Dynamics in Action
Transactions (Startup)

You have just incorporated (in Delaware) and invested $50,000 of your own money into the company: AppleSeed. When you formed the company you bought 50,000 shares of "founder's stock" at $1 per share for a total investment of $50,000 in cash.
Transactions

① A group of investors is willing to exchange their $1.5 million in cash for stock certificates representing 150,000 common shares of AppleSeed Enterprises, Inc. Thus, after this sale to the investor group there will be 200,000 shares outstanding. They will own 75% of AppleSeed and you will own the rest.

② Book all payroll-associated company expenses totaling $6,230 including salary, employer's contribution to FICA (Social Security) and various insurance expenses. Issue yourself a payroll check for $3,370 (your $5,000 monthly salary minus $1,250 in federal and state withholding tax and $380 for your own contribution to FICA).

(FICA = Federal Insurance Contribution Act of 1937)
Transactions

③ Borrow $1 million to purchase an all-purpose building. This term note will run for 10 years, calling for yearly principal payments of $100,000 plus interest at a rate of 10% per annum.

④ Purchase 100,000 square foot building and land for $1.5 million in cash. This facility will serve as AppleSeed Enterprises' headquarters, manufacturing facility and warehouse.

.................................................................
Income Statement
# List of Transaction Data

<table>
<thead>
<tr>
<th>Cash (Receipts)</th>
<th>Account Receivable</th>
<th>Account Payable</th>
</tr>
</thead>
<tbody>
<tr>
<td>T: Account Receivable Paid</td>
<td>T: Customer Order</td>
<td>T: Raw Material Purchase</td>
</tr>
<tr>
<td>T: Long-Term Borrowing</td>
<td>T: Depreciation</td>
<td>T: All Other Overhead</td>
</tr>
<tr>
<td>T: Principal Payments</td>
<td>T: Scrapped Cases</td>
<td>T: Sales &amp; Marketing (AP)</td>
</tr>
<tr>
<td>T: New Issue of Shares</td>
<td>T: Insurance Premium Paid</td>
<td>T: Research &amp; Development</td>
</tr>
<tr>
<td>T: Par Share Dividend</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data: Price Change</th>
<th>Inventories</th>
<th>Accrued Expenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>T: Production</td>
<td>T: Completion</td>
<td>T: Payroll-associated Fringes and Taxes</td>
</tr>
<tr>
<td>T: Completion</td>
<td>T: Scrapped Cases</td>
<td>T: Sales &amp; Marketing (AE)</td>
</tr>
<tr>
<td>T: Wages</td>
<td>T: Depreciation</td>
<td>T: General &amp; Administrative (AE)</td>
</tr>
<tr>
<td>T: PP&amp;E Purchase</td>
<td>T: Scrapped Cases</td>
<td></td>
</tr>
<tr>
<td>T: Other Assets Purchase</td>
<td>T: Scrapped Cases</td>
<td></td>
</tr>
<tr>
<td>T: Account Payable Paid</td>
<td>T: Scrapped Cases</td>
<td></td>
</tr>
<tr>
<td>T: Accrued Expenses Paid</td>
<td>T: Scrapped Cases</td>
<td></td>
</tr>
<tr>
<td>T: Current Debt Paid</td>
<td>T: Scrapped Cases</td>
<td></td>
</tr>
<tr>
<td>T: Income Taxes Paid</td>
<td>T: Scrapped Cases</td>
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</tr>
<tr>
<td>T: Insurance Premium</td>
<td>T: Scrapped Cases</td>
<td></td>
</tr>
<tr>
<td>T: Interest Expenses</td>
<td>T: Scrapped Cases</td>
<td></td>
</tr>
</tbody>
</table>
Ratio Analysis

Liquidity Ratios
- Current Ratio
  - Current Assets
  - Current Liabilities
- Quick Ratio
  - Cash
  - Accounts Receivable
  - Current Liabilities

Asset Management Ratios
- Inventory Turnover
  - Cost of Goods Sold
  - Inventories
- Account Receivable Turnover
  - Net Sales
  - Accounts Receivable

Profitability Ratios
- Return on Assets (ROA)
  - Net Income
  - Assets
- Return on Equity (ROE)
  - Net Income
  - Shareholders' Equity

Gross Margin (Gross Profits)
- Gross Margin
- Net Sales

Leverage Ratios
- Debt-to-Equity
  - Current Portion of Debt
  - Long-Term Debt
  - Shareholders' Equity
- Debt Ratio
  - Current Portion of Debt
  - Long-Term Debt
  - Assets
Ratio Analysis Simulations

Liquidity Ratios

Current Ratio : run
Quick Ratio : run

Asset Management Ratios

Inventory Turns : run
Asset Turn Ratio : run

Profitability Ratios (1)

"Return on Assets (ROA)" : run
"Return on Equity (ROE)" : run

Leverage Ratios

"Debt-to-Equity" : run
Debt Ratio : run

Profitability Ratios (2)

"Return on Sales (Profit Margin)" : run
"Gross Margin (Gross Profits)" : run
Cash Flow Analysis

Net Cash Flow

- Net Borrowings
- Sale of Capital Stock
- Cash Disbursements
- Purchase of Capital Stock
- Dividends Paid to Stockholders
- Prepaid Expenses Incurred
- Income Taxes Paid
- PP&E Purchase
- Debt Payment

Net Income

Cash Flow from Operations

Time Delay of Account Receivable

Time Delay of Account Payable

Cash

Net Cash Flow

Time (Month)

Cash : run Dollars/Month
Cash : Accounting Dollars

Net Cash Flow from Operations

Time (Month)

Net Cash Flow : run Dollars/Month
Net Cash Flow from Operations : run Dollars/Month
Net Income : run Dollars/Month