ABSTRACT

It should be time to study and apply a mathematical accounting model which is easier understanding and auditing, and more accurate and reliable. The paper distinctly describes the three accounting's concepts or models: physical accounting model, double-entry system model, and mathematical accounting model, and their relationship. The physical accounting model naturally exists since business emerging and is the base of all other accounting's models. The physical accounting model is actually consisted of every transaction which is based on a principle: exchange of equal values. The double-entry system model, which is still used all over the world, uses a logical method to most keep recording transactions accurate. Its main characters are: T account with Debit and Credit, chart of accounts, all accounts divided to two classes of permanent and temporary accounts, and trial balance. The mathematical accounting model is based on a basic expanding accounting equation and has developed following main characters: mathematical axiom principle, dynamic accounting equation, sub-equation of dynamic accounting equation, the five classes of the accounts which are the permanent accounts and have same positions, structures of financial statements, and account flow statement. The same parts of the double-entry system and mathematical accounting models are to use or satisfy the basic accounting equation at the beginning of a fiscal year and the ending of a fiscal year, but the difference of them is that the two accounting models take the different ways to reach the ending of the fiscal year.

Keywords: physical accounting model, double-entry system accounting model, and mathematical accounting model

1. Introduction of Mathematical Accounting Model

It should be time to study and apply the mathematical accounting model which is easier understanding and auditing, and more accurate and reliable. Meanwhile, accounting students should take a course of database, such as Access or SQL Server at least, in the digital times.

Three important accounting's concepts or models and the relationships between them must be understood clearly. The three accounting's concepts or models are the physical accounting model, the double-entry system model, and the mathematical accounting model.

1.1 Physical Accounting Model

First, what is the physical accounting model? Since business emerging, the physical accounting model naturally exists. The physical accounting model is the base of all other accounting's models and is consisted of every transaction. These transactions are naturally based on a principle: exchange of equal values. By using of mathematical language, every transaction based on the exchange of equal values means every sub-equation, which actually implies a basic accounting equation.

1.2 Double-Entry System Model

For knowing and understanding the business performance, people has tried to build many accounting models to record and summarize the economic events in fact, such as an owner of a corner grocery store who might use a very simple accounting's model to record his or her transactions. Just like a saying that all roads lead to Rome.

Without effective computing tools, the double-entry system model actually uses a logical method to most keep recording transactions accurate, so this double-entry system accounting model has gradually become popular in the world. Even with computer and database having had huge development, the double-entry system model is still used all over the world now. It has following main characters:

- T account with Debit and Credit. The principle of the exchange of equal values implies the sum of the

Debit is equal to the sum of the Credit in a transaction here.

- Chart of accounts, which is the framework for the entire database of the current accounting software.
- All the accounts which are divided to two classes of accounts: permanent and temporary accounts. The Assets, Liabilities, and Owner's equity are the permanent accounts, and the Revenues and Expenses are the temporary accounts which would be closed at the end of every fiscal year. So the Revenues and the Expenses accounts are merged into the Owner's Equity in the basic accounting equation. Its basic accounting equation is: Assets = Liabilities + Owner's Equity
- The basic accounting equation with rules and effects on each type of account:

Assets = Liabilities + Owner's Equity

Assets = Liabilities + Capital – Drawings + Revenues - Expenses

Dr.	Cr.	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.
+	-	-	+	-	+	-	+	-	+	+	-

- General journal, then post to ledger.
- Trial balance. The trial balance calculation is an obvious symbol of deviating from the basic accounting equation because the sum of the debit or credit (the two sides' amounts of T accounts) is normally not equal to the sum of the total assets or total liabilities and equity (the two sides' amounts of the dynamic accounting equation). Only at the end of a fiscal, the double-entry system checks the recording information by use of the basic accounting equation.

1.3 Mathematical Accounting Model

Final concept is the mathematical accounting model. It is very important that the basic accounting equation must be an expanding form, which is: Assets = Liabilities + Equity + Incomes – Expenses, in the mathematical

accounting model. Based on the basic accounting equation, the mathematical accounting model has developed following main characters:

- Mathematical axiom principle.
- Dynamic accounting equation.
- Sub-equation of the dynamic accounting equation. Every transaction is a sub-equation which is also called general equation.
- All accounts which are divided to five classes of the accounts that are all the permanent accounts and have same position, which is a very important factor to develop the mathematical accounting model. The Assets are the first class of accounts, the Liabilities are the second class of accounts, the Equities are the third class of accounts, the Incomes are the fourth class of accounts, and the Expenses are the fifth class of accounts.
- Structures of financial statements.
- Concept of account flow statement

The mathematical accounting model is based on following mathematical axiom.

If $a + b = c + d$,

$e + f = g + h$,

Then $a + b + e + f = c + d + g + h$

The mathematical axiom is the nucleus and framework of the mathematical accounting model, and is across all process of accounting. Meanwhile, the mathematical axiom also guarantees the recording accounting information correct and accurate.

In the mathematical accounting model, it is more important or a great advantage that increasing or decreasing's meaning of all accounts' balance is as same as people's normal custom. The increasing of an account's balance

is the "+" and the decreasing of an account's balance is the "-" for all accounts of the asset, or liability, or equity, or income, or expense.

The basic accounting equation is rewritten and categorized, and then we get following dynamic accounting equation.

Assets (1) = Liabilities (2) + Equity (3) + Incomes (4) – Expenses (5)

In this equation, there are 5 classes of accounts, and of course, there are many accounts in each class. So, above dynamic accounting equation can be rewritten as expanding dynamic accounting equation, again.

Assets (1) (Cash + Inventory + …) = Liabilities (2) (Account Payable + Notes Payable + …)
+ Equity (3) (Share Capital + Retained earnings + …)
+ Income (4) (Revenues + Other Revenues + …)
– Expenses (5) (Cost of Sales Sold + Interest Expenses + …)

In fact, every transaction is a sub-equation of the dynamic accounting equation. The general equations are consisted of all sub-equations. If adding a sub-equation to previous dynamic accounting equation, then we get a new dynamic accounting equation at the special time point. If we image that the accounting is the straight railway system, then every transaction is a railway sleeper, and train is the dynamic accounting equation and goes straight ahead. Any accounts do not need be closed. The financial statements are only the results of the moving and uniting the terms in the dynamic accounting equation at a special time point.

Then, what is the relationship between the accounting's double-entry system model and the mathematical accounting model? The Figure 1 can clearly show the answer, and explain the problem.

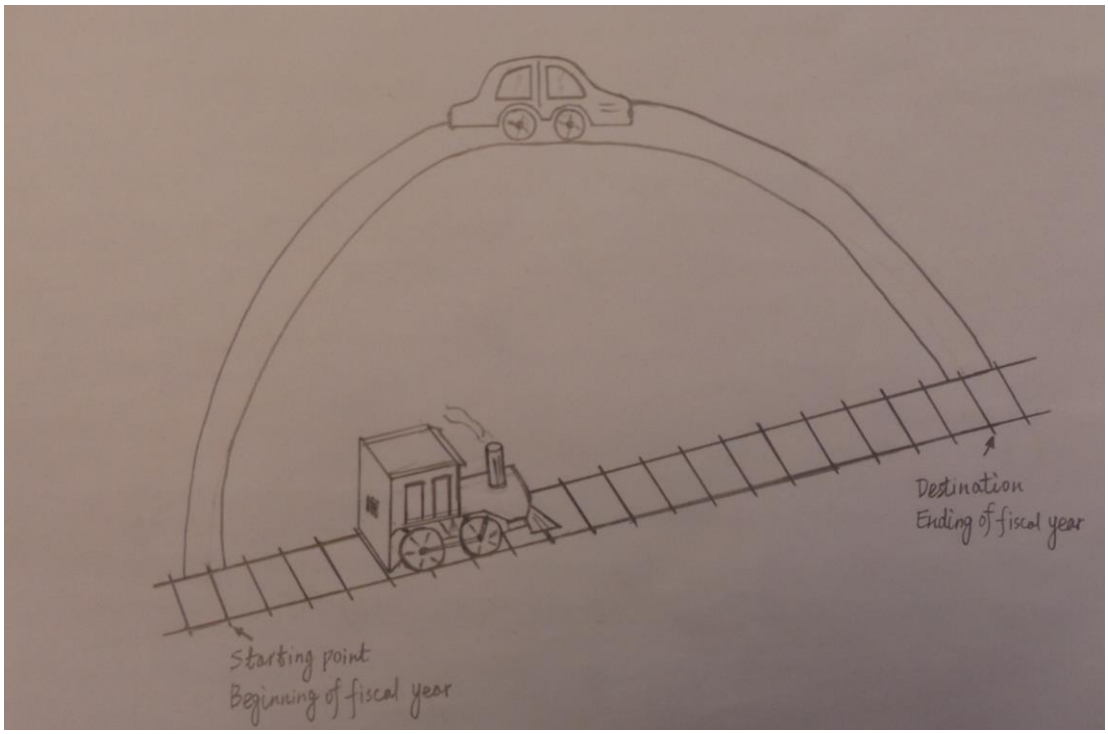


Figure 1 Same parts and difference of two accounting models

If you think that the time of a fiscal year is a stretch of rail, then the starting point of the rail is regarded as the beginning of the fiscal year and the destination of the rail is regarded as the ending of the fiscal year. The same parts of the two accounting models are to use or satisfy the basic accounting equation at the starting point of the rail (the beginning of the fiscal year) and the destination of the rail (the ending of the fiscal year), but the two accounting models take the different ways to reach the destination from the starting point.

The mathematical accounting model drives on the rail track all time until reaching the destination. The every railway sleeper is a sub-equation, which is also called as a general equation in the MathAccounting software. The train is the dynamic accounting equation. The train is driving on the railway, which means that the every sub-equation is being added to previous dynamic accounting equation by using mathematical axiom to get final dynamic accounting equation at the ending of the fiscal year.

The accounting's double-entry system model leaves the rail track at the starting point after checking the requirement of the basic accounting equation, and takes the other road to reach the destination. The road is consisted of the all T accounts with debit and credit, the general journalizing transactions, and the chart of accounts which is the framework of this model. The car is consisted of posting to ledger accounts and trial balance calculating. After reaching the destination, the all ledger accounts must be again checked to satisfy the requirement of the basic accounting equation.

In the mathematical accounting model, following five transactions can be written by using five sub-equations.

- Investment by owners. On January 2, 2014, Ping Wang, Hua Li and Mike Newsome decide to open a RR trade business, so Ping Wang invests $4,000 cash in business, and Hua Li and Mike Newsome each invest $3,000 cash in business. The sub-equation can be written as following:

  Cash (1): 10000 = Share Capital (3): 4000 + Share Capital (3): 3000

  + Share Capital (3): 3000

This sub-equation is also the dynamic accounting equation on January 2, 2014(in other word, the first dynamic accounting equation is “0 = 0” for a new company), which can be rewritten as

Cash (1): 10000 = Share Capital (3): 10000

- Purchase of supplies by cash. On January 3, 2014, RR purchases some supplies by $193 cash from AA company, then the sub-equation is

  Cash (1): -193 + Supplies (1): 193 = 0

  Adding this sub-equation to previous dynamic accounting equation, we get a new dynamic accounting equation on January 3, 2014, which is

  Cash (1): 9807 + Supplies (1): 193 = Share Capital (3): 10000

- Cash payment for Hua Li’s taxi fee expense. On same day, Hua Li takes taxi to carry on the supplies by $47 cash, then the sub-equation is

  Cash (1): -47 = - Travelling expenses (5): 47

  The new dynamic accounting equation on same day after adding the transaction is

  Cash (1):9760 + Supplies (1): 193 = Share Capital (3): 10000 - Travelling expenses (5): 47

- Purchase of inventory by some cash and other on credit. On January 5, 2014, RR purchases $3,670 inventory by $670 cash and other on credit from A1 company (phone number: 987654321), then the sub-equation is

  Cash (1): -670 + Inventory (1): 3670 = Account payable (2): 3000

  The new dynamic accounting equation On January 5, 2014 is

  Cash (1): 9090 + Supplies (1): 193 + Inventory (1): 3670 = Account payable (2): 3000

  + Share Capital (3): 10000 - Travelling expenses (5): 47

- Sales for some cash and other on credit. On January 5, 2014, RR sells $1,900 inventory to B1

Company (phone number: 123456789) for sales of $2,530, and receives cash 300, then the sub-equation is

Cash (1): 300 +Inventory (1): -1900 + Account receivable (1): 2230 = Sales (4): 2530

- Cost of sales (5): 1900

The new dynamic accounting equation on same day after adding this transaction is

Cash (1): 9390 + Supplies (1): 193 + Inventory (1): 1770 + Account receivable (1): 2230

= Account payable (2): 3000 + Share Capital (3): 10000 + Sales (4): 2530

– Travelling expenses (5): 47 – Cost of Sales (5): 1900

In a word, for first transaction, the sub-equation is also a dynamic accounting equation on January 2, 2014. Adding second transaction to this dynamic accounting equation, then we get a new dynamic accounting equation on January 3, 2014. Repeating same thing, we get a new dynamic accounting equation on January 5, 2014, which is

Cash (1): 9390 + Supplies (1): 193 + Inventory (1): 1770 + Account receivable (1): 2230=

Account payable (2): 3000 + Share Capital (3): 10000 + Sales (4): 2530

– Travelling expenses (5): 47 – Cost of Sales (5): 1900

The total assets are $13,583, and total sum of liabilities, equity, Income, and expenses are $13,583, too. By moving and uniting the terms from the final dynamic accounting equation at a time point, we can easily get income statements, balance sheet, cash flows statement, and so on.

Of course, real business is more complicate than this example, and moreover many accounts have multi-level subaccounts, such as the travelling expenses account which may have three-level subaccounts (different factories, different departments, and different persons). In fact, there is obviously an account which has a one-level subaccount in this example. Do you find it? It is share capital account which is consisted of the three

one-level subaccounts: Capital-Ping Wang, Capital-Hua Li, and Capital-Mike Newsome.

For dealing with more complicate business, effective computing tool of SQL Database must be used. For meeting the requirement of SQL Database, the above basic dynamitic accounting equation must be rewritten by mathematical language. It is

$$X1 = X2 + X3 + X4 - X5$$

Here X1 is assets, X2 is liabilities, X3 is equity, X4 is income, and X5 is expenses

The expanding dynamic accounting equation is

$$(X11 + X12 + X13 + \ldots) = (X21 + X22 + X23 + \ldots) + (X31 + X32 + X33 + \ldots) + (X41 + X42 + X43 + \ldots) - (X51 + X52 + X53 + \ldots)$$

All terms in the above equation are called the parent accounts, and would appear on financial statements.

If an account, such as X12, has the one-level subaccounts, then these subaccounts are X121, X122, X123, and so on.

If an account, such as X41, has two-level subaccounts, then its one-level subaccounts are X411, X412, X413, and so on. The one-level subaccounts may have their two-level subaccounts. For a one-level subaccount, such as X412, its two-level accounts are X4121, X4122, X4123, and so on.

If an account, such as X53, has three-level subaccounts, then its one-level subaccounts are X531, X532, X533, and so on. The one-level subaccounts may have their two-level subaccounts. For a one-level subaccount, such as X533, its two-level accounts are X5331, X5332, X5333, and so on. For a two-level subaccount, such as X5331, its three-level subaccounts are X53311, X53312, X53313, and so on. From theory, an account can have the infinite-level subaccounts.

So, for a company with many three-level subaccounts, the expanding dynamic equation is very huge and very complicate. Do not worry about it. The computer can do the difficult calculating and categorizing work behind

the screen. You must only understand a basic principle. When a sub-equation, which is checked to be correct, is added to previous dynamic accounting equation, the all terms of the sub-equation would add to its relevant parent accounts and subaccounts respectively.

There is a problem which must be technically solved. If a parent account X11 has more than 10 one-level subaccounts, such as the twelfth one-level subaccounts X1112, this one-level subaccount X1112 may be confused with a two-level subaccount X1112 of the one-level subaccount X111 by computer. So any parent accounts and their multi-level subaccounts are represented by using of two digital numbers if the maximum account's number of the parents or their multi-level subaccounts is less than 100.

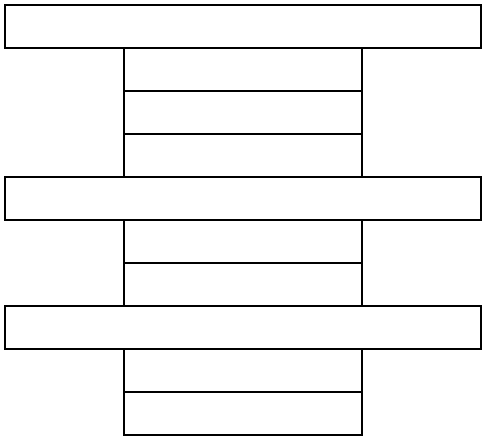
The expanding dynamic accounting equation is rewritten as:

$$(X101 + X102 + X103 + \ldots + X199) = (X201 + X202 + X203 + \ldots + X299) + (X301 + X302 + X303 + \ldots + X399) + (X401 + X402 + X403 + \ldots + X499) - (X501 + X502 + X503 + \ldots + X599)$$

If parent account X199 has 99 one-level subaccounts, then its 86^{th} one-level subaccount is X19986 and 99^{th} one-level subaccount is X19999.

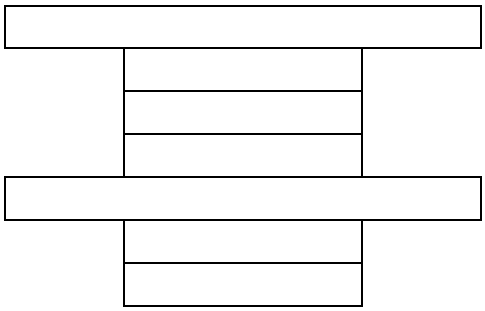
The parent accounts would appear on balance sheet and income statements, so I design the structures of the balance sheet and income statements, seeing the figure 2.

ASSETS **101**



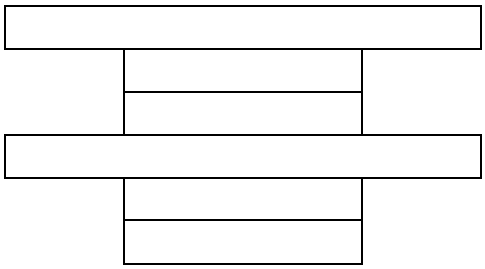
Total assets

LIBILITIES **201**



Total liabilities

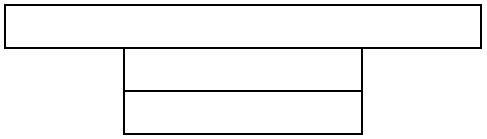
SHAREHOLDERS' EQUITY **301**



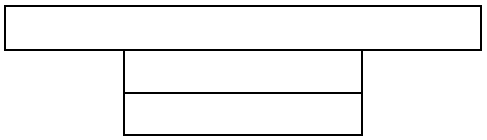
Total shareholders' equity

Total liabilities and shareholders' equity

401

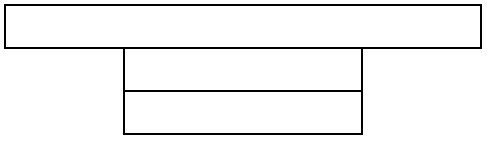


Total



Total

Gross Margin **451**



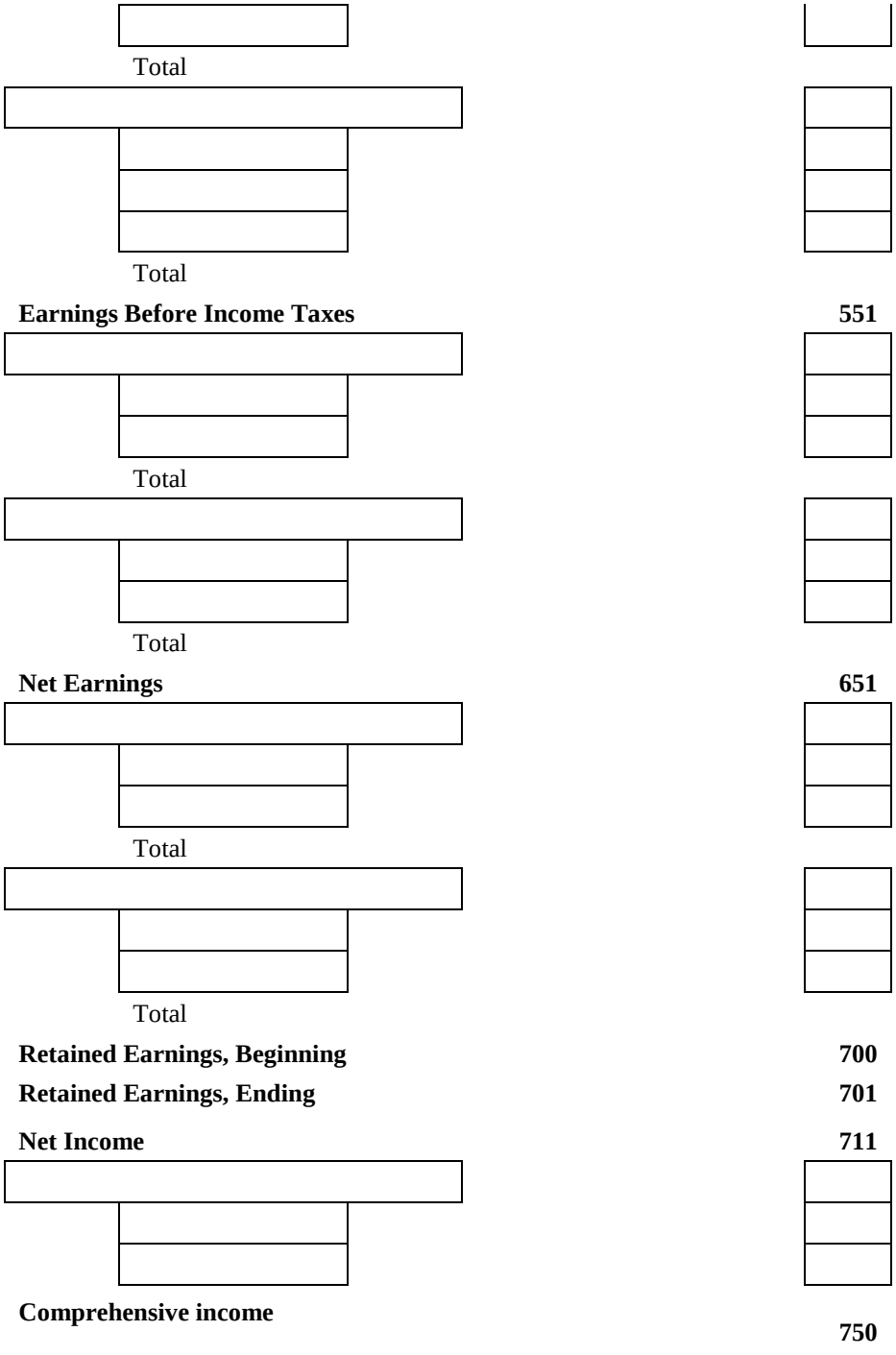


Figure 2 Structures of Balance sheet and Income statements

To design own balance sheet and income statement, a user can enter subtotal name into the big box at the left of the figure 2 and row number into the right box. And the user can also enter account name into the small box at the left of the figure 2 and the account's row number into the right box. Obviously, the two row numbers cannot be same. The two row numbers must not be sequence, but they must be in the same scope, such as a scope of 201 to 301. Because the each scope is enough for all possible accounts, we recommend that the row number of the new subtotal name would be even number and the new account's row number would be odd number. If a company has any incomes that do not pay tax or any expenses that cannot be deducted, you can put them under income taxes expenses. Their row numbers should be between 600 and 650.

The subtotal names and account names would appear in the income statements and balance sheet in the order of the numbers user entered.

For previuous first transaction, a user can enter the "Current Assets" into the big box at the left of the figure 2 and the number "103" or other appropriate number you like into the right box. Then the user can enter the account of the "Cash" into the small box at the left of the figure 2 and the number "104" into the right box. And the user can enter the "Owners' Capital" into the big box at the left of the figure 2 and the number "303" or other appropriate number you like into the right box. Then the user can also enter the account of the "Share Capital" into the small box at the left of the figure 2 and the number "304" into the right box.

For Cash account, it should not have subaccounts. However, I can use the tool of subaccount concept to build the cash flows statement. The figure 3 shows the structure of cash flows statement.

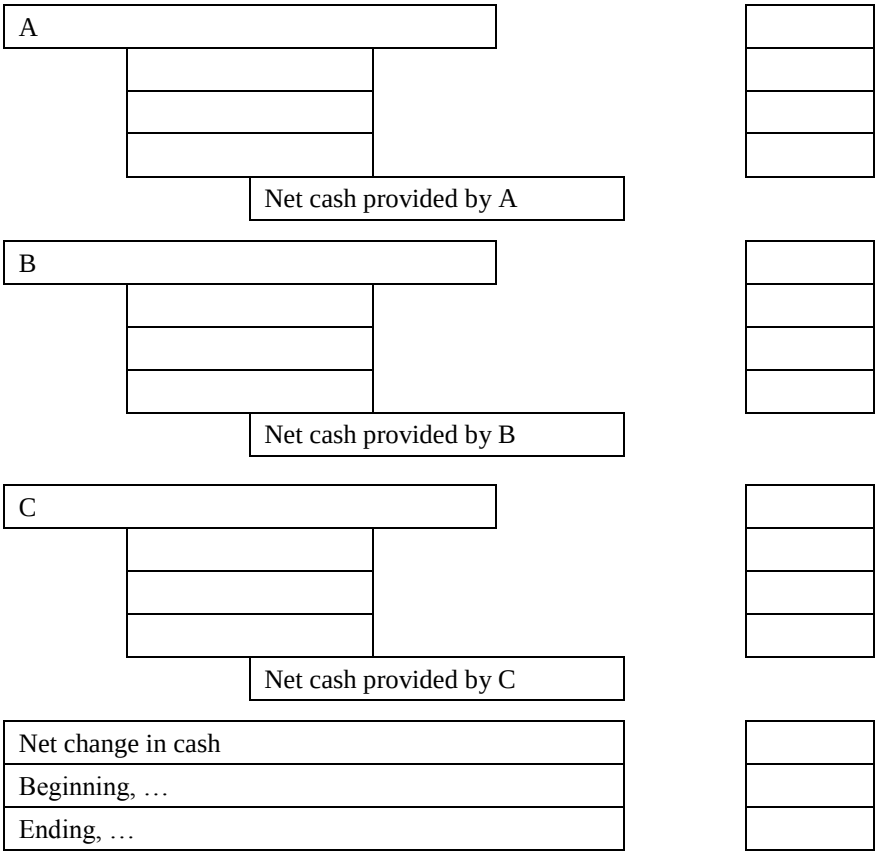


Figure 3 Structure of Cash Flow Statement

The cash account has three one-level subaccounts: operating activities, investing activities, and financing activities. Of course, any one-level subaccount can have unlimited two-level subaccounts. The contents of the left big boxes in the figure 3 are one-level subaccounts names, and the contents of the left small boxes are two-level subaccounts names; the contents of the right boxes are all two-level subaccounts balances which can be gotten from database automatically. For example, if cash pays a supplier for inventory, then the one-level subaccount is the "Operating activities" and its two-level subaccount is the "Cash payments to suppliers". If cash pays for machinery, then the one-level subaccount is the "Investing activities" and its two-level subaccount is the "Cash payments of machinery". The one-level subaccounts of the "Operating activities" and the "Investing activities" would appear in the A and B boxes respectively. The two-level subaccounts of the "Cash payment to suppliers" and the "Cash payments of machinery" would appear in the left small boxes under A and B respectively. So you can also design your style of cash flows statement following this template. At the ending of a fiscal year, you can get the cash flows statement just clicking a box. It is so easy.

From this idea, I can get a new concept: account flow statement if an account has the two-level subaccounts. If number of the one-level subaccounts is more than three, then the top three one-level subaccounts would appear on the account flow statement.

For the Account Receivable and the Account Payable, they only have different customers and different suppliers respectively. Because different customer or different supplier's telephone number is sole, I can use the tool of subaccount concept again to think the customers or suppliers' telephone numbers are the one-level subaccounts of the Account Receivable or the Account Payable.

So far, a new account has at most following items that user must enter:

- Transaction Date
- General ID

- Explanation
- Class (1-5)
- MultiSubaccount name (Its entering form of “A1>A2>A3”)
- Amount
- Subtotal Name (Including its row number and its entering form of “subtotal name, its row number”)
- Reference (Account row number, or Account Receivable or Account Payable’s General ID)

Of course, more information must be entered for a new customer or supplier. The information includes customer or supplier’s name, postal code, city, state, and country.

The figure 4 shows a sample of a transaction’s original proof. In filling in a transaction’s original proof, you must change the amounts to the negative amounts for all fifth class accounts.

The figure 5 - figure 9 show the previous five transactions’ original proofs respectively.

Transaction Original Proof							
Transaction Date:						General ID	
Explanation:							
No.	Account Name	Class	MultiSubaccount Name	Left Amount	Right Amount	Subtotal Name	Ref
1							
2							
3							
4							
5							
6							
7							
8							
Total							
Customer or Supplier's Name			Postal Code	City	State	Country	

Person Handling: Manager:

Date: Date:

Figure 4 Transaction Original Proof

Transaction Original Proof							
Transaction Date: 1/2/204						General ID	1
Explanation: Ping Wang, Hua Li and Mike Newsome decide to open a RR trade business							
No.	Account Name	Class	MultiSubaccount Name	Left Amount	Right Amount	Subtotal Name	Ref
1	Cash	1	Investing activities>Cash receipts from owners	10000		Current assets,103	104
2	Share capital	3	Capital-Ping Wang		4000	Owners'capital,303	304
3	Share capital	3	Capital-Hua Li		3000		
4	Share capital	3	Capital-Mike Newsome		3000		
5							
6							
7							
8							
Total				10000	10000		
Customer or Supplier's Name			Postal Code	City	State	Country	

Person Handling: Manager:

Date: Date:

Figure 5 First Transaction Original Proof

Transaction Original Proof							
Transaction Date: 1/3/2014						General ID	2
Explanation: Purchase of supplies							
No.	Account Name	Class	MultiSubaccount Name	Left Amount	Right Amount	Subtotal Name	Ref
1	Cash	1	Operating activities>Cash payment for operating expenses	-193			
2	Supplies	1	N	193		Current assets,103	106
3							
4							
5							
6							
7							
8							
Total				0	0		
Customer or Supplier's Name			Postal Code	City	State	Country	

Person Handling: Manager:

Date: Date:

Figure 6 Second Transaction Original Proof

Transaction Original Proof							
Transaction Date: 1/3/2014						General ID	3
Explanation: Cash payment for Hua Li's taxi fee expense							
No.	Account Name	Class	MultiSubaccount Name	Left Amount	Right Amount	Subtotal Name	Ref
1	Cash	1	Operating activities>Cash payment for operating expenses	-47			
2	Travelling expenses	5	Purchase Department-Travelling>Hua Li-Travelling		-47	Operating and administrative expenses,453	454
3							
4							
5							
6							
7							
8							
Total				-47	-47		
Customer or Supplier's Name			Postal Code	City	State	Country	

Person Handling: Manager:

Date: Date:

Figure 7 Third Transaction Original Proof

Transaction Original Proof							
Transaction Date: 1/5/2014						General ID	4
Explanation: RR purchases $3,670 inventory by $670 cash and other on credit from A1 company (phone number: 987654321)							
No.	Account Name	Class	MultiSubaccount Name	Left Amount	Right Amount	Subtotal Name	Ref
1	Cash	1	Operating activities>Cash payment to suppliers	-670			
2	Inventory	1	Inven1>inven11>inven111	1650		Current assets,103	108
3	Inventory	1	Inven1>Inven11>Inven112	900			
4	Inventory	1	Inven1>Inven12>Inven121	520			
5	Inventory	1	Inven1>Inven12>Inven122	330			
6	Inventory	1	Inven1>Inven13	270			
7	Account payable	2	987654321		3000	Current liabilities,203	204
8							
Total				3000	3000		
Customer or Supplier's Name			Postal Code	City	State	Country	
A1			A2	A3	A4	A5	

Person Handling: Manager:

Date: Date:

Figure 8 Fourth Transaction Original Proof

Transaction Original Proof							
Transaction Date: 1/5/2014						General ID	5
Explanation: RR sells $1,900 inventory to B1 Company (phone number: 123456789) for sales of $2,530, and receives cash 300							
No.	Account Name	Class	MultiSubaccount Name	Left Amount	Right Amount	Subtotal Name	Ref
1	Cash	1	Operating activities>Cash receipts from customers	300			
2	Inventory	1	Inven1>Inven11>Inven111	-910			
3	Inventory	1	Inven1>Inven11>Inven112	-520			
4	Inventory	1	Inven1>Inven12>Inven121	-300			
5	Inventory	1	Inven1>Inven12>Inven122	-170			
6	Account receivable	1	123456789	2230		Current assets,103	110
7	Sales	4	Xiao Zhou-Sales		2530	Revenues,403	404
8	Cost of sales	5	N		-1900	Cost,431	432
Total				630	630		
Customer or Supplier's Name			Postal Code	City	State	Country	
B1			B2	B3	B4	B5	

Person Handling: Manager:

Date: Date:

Figure 9 Fifth Transaction Original Proof

On January 28, 2014, RR Company receives $1,500 cash from B1 Company (phone number: 123456789) with the General ID 5.

Here you must pay attention for this transaction. In fact, when you receive the $1,500 cash, you know that B1 Company pays the cash of the General ID 5. However, the computer does not know that, so you must tell the computer of which transaction the customer pays the cash. Here, I borrow the Reference box to enter the General ID of the previous related transaction, which can be gotten from the previous transaction original proofs and is the “5”.

Maybe you ask why I do not use the customer’ phone number as a judging standard. Because RR Company may sell the inventory to this customer for several times and the General ID of a transaction is sole, I must choose the General ID as the judging standard. The figure 10 shows the sixth transaction original proof. The Reference box in the row of the account receivable must be entered by the previous relevant General ID “5” which is bold.

The account payable is as same as the account receivable.

Transaction Original Proof							
Transaction Date: 1/28/2014						General ID	6
Explanation: RR Company receives $1,500 cash from B1 Company (phone number: 123456789) with the General ID 5							
No.	Account Name	Class	MultiSubaccount Name	Left Amount	Right Amount	Subtotal Name	Ref
1	Cash	1	Operating activities>Cash receipts from customers	1500			
2	Account receivable	1	123456789	-1500			**5**
3							
4							
5							
6							
7							
8							
Total				0	0		
Customer or Supplier's Name			Postal Code	City	State	Country	

Person Handling: Manager:

Date: Date:

Figure 10 Receiving Transaction Original Proof

2. Accounting Future

In the great data time, centered management of accounting is an inexorable trend. Every business company can log in the centered database by using of its business number. The centered management of accounting has many advantages, such as less false accounts and less evading a tax.

Based on above mathematical accounting model, I have developed the MathAccounting Software by use of the Visual Basic 2012 language and the SQL Server 2012 database (seeing website www.mathaccounting.com). The two key functions of the MathAccounting Software can help governments of various levels to reach the centered management of accounting.

In addition, the functions of the human resource and inventory management can be directly developed in the MathAccounting Software. If all one-level subaccounts (different departments) of the parent account "Salary expenses" are designed to have the 9,999 two-level subaccounts which are the different employees' names, then human resource department can also use the MathAccounting Software to deal with work of the human resource management by the SQL Server authorizing. The inventory management is similar to the human resource management.

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