

 Supporting Material is available for this work. For more information, follow the link from the Table of Contents to "Accessing Supporting Material".

**A Study of Connect Dynamic Data Source to Improve the
Simulate Technique for the System Dynamics**

1 Introduction

1.1 Study the background and motive

Remember the evolution of the current of thought of the management in recent years, analyze by traditional divided into classes and categories and alone already and gradually, change into current whole thinking, by the Jay of M.I.T. W.

Forrester the System Dynamics that professor develop, main is helping the governor while considering problem and decision, in addition to considering the problem of the section of the system each of, still notice these problems the operation of the mechanism of the system and pass after postponing, influence toward whole system.

The tradition model of the System Dynamics by two main part constitute:

- **Model Component** :Can be divided in to accumulate the **label variables**, **rate variables**, **variable** and **data stream** etc., It describe the causal relationship of the elements of the system.
- **Simulate Parameter** : the constant or data used by model. Do not include the formula.

In the tool of the simulation of the dynamics of the system of the tradition- as STELLA, iThink, Vensim and etc. of PowerSim-, parameter is and model component together store in model, and the importation and modification of the parameter, is also an usage to the input tools provide by the simulation tools, model of the system dynamics is in simulate process, and can't obtain the data of the simulation from the exterior of the model; The result that also can't will imitate - for example, each variable is outside the value of each period- store in the exterior of the model.

But in regard to actual situation application, the closed interface of the traditional

simulate tools of system dynamics is not support the demand in decision of the enterprise today. First, The environment of the enterprise of today will change at any time because of factor of the exterior, a year ago the estimate done, may must check these factors in today whether would to predict result contain any influence because the war, natural calamity and politics and technical environmental changed. And enterprise is in usually operate process, also may want at any time according to current data - as material, funds and finance etc. - the estimate that be the short date to the future. The model of the system dynamics can use the result of the past project, but the data of the simulation must input again completely, and can't use current data of the dynamic state of the enterprise. If the model had several hundred variables , It will suffer very big restrict on the usage.

Besides, in the analytical of the policy and scenario, the traditional tool of the simulation of system dynamics is while simulate each policy or scenario, must reset the data, execute the simulation process, then minute down to the result. Project in the policy or scenario considered is more much, resetting the number of times of the parameter more multifarious . If all complete with the hand, will be a work of fragmentary and high rate of the mistake. It is limited the usage of the repetition of the model that tedious input data procedure and closed data format. Therefore, when the project end, it usually look in dark file room that the model spend cost and wisdom. It is huge squander in the resource and person usage of the enterprise.

But if we move the data the tradition model of the system dynamics to exterior of the model, becoming independent data source. The model obtain to data from the exterior data source in simulate process. The result can also store in exterior data source. in the structure :

- Manager can used the online data of the enterprise, obtaining the result of the

simulate of the short date.

- When the environment changed, manager can used online data of the enterprise, check the influence of the past result because the environment changed.
- In the policy or scenario simulation. User can store the parameter of each policy or scenario in exterior data source, and used the data execute simulate process.

Main purpose of this research, at inquire into how to strengthen related structure of the technique of simulation of system dynamics with the dynamic data source, and according to study the result develop simulation tool, toing be used as to configure the identification of the benefit.

1.2 The purpose of study

The purpose of the study is :

- Research the structure of how to strengthen the technique of system dynamics simulation to use dynamics data source.
- Design the simulation tools to provide to read and write exterior data source, check the possibility of support enterprise operation.

2 The structure of how to strengthen the technique of system dynamics simulation to use dynamics data source

2.1 Combine the model of system dynamics with dynamics data

In regard to the mode of the system dynamics combine with the dynamics data,

Can be divided into three aspect :

- The model of system dynamics **read from** dynamics data.
- The model of system dynamics **write to** dynamics data.
- The structure of strengthen the model of system dynamic to use dynamics data.

2.1.1 The model of system dynamics read from dynamics data

The model of system dynamics read from dynamics data in the state :

- **Set the initial value of variable**

When the start of simulation, the model read from dynamics data. The data read one time on whole simulate process. It is usually usage with the analysis of policy or scenario.

It is divided into three level the analysis of policy or scenario :

- **Adjust the flow of the model.**
- **Increment or decrease the element of the model.**
- **Adjuse the value of variable.**

In changing the data in the system, we would usually use data to describe the policy or scenario – for example, the amount of loan, the enforce and abolish year of the law, the total of employ worker, etc., - .

We can store the value of describe the polic y or scenario in the exterior

data source. The model of system dynamics read from data source in start simulation and output the result of each policy of scenario.

- **Set the value of variable on the start of phase**

In each phase simulate beginning, the model read value from exterior data source. Its characteristic has:

- Because each phase before simulating will read once, read frequency with simulate the length of time and different. Simulate time to grow more, the data reads more frequent.
- The model is random read data for to simulate the random factor in real world probably.

According to above need, the way of the model of system dynamics read from exterior data source have :

- **Repeat -**
Read same record when read exterior data.
- **Sequence-**
Read exterior record in sequence.
- **Random-**
Read exterior record in random.

2.1.2 The model of system dynamics write to dynamics data

In regard to on the other hand, the model of system dynamics read from dynamics data in the state :

- **Write to new data source**

The model write the result of simulate to a new data source. Its characteristic has:

- The data source is empty.
- Direct append data record. Do not need seek key value.

The method is collection simulate value. And use in others information system(For example Decision Support System etc.,) analyze.

- **Fill empty field in database**

The model write the result of simulate to the data record of data key match with record key. Its characteristic has:

- The data source is not empty.
- The model should seeking key value before write data.

If it have part element value is unknown in the simulate project. We can store the project value in a database and execute simulate. The tools will simulate to base on the data and fill result to empty data.

According to above need, the way of the model of system dynamics write to exterior data source have :

- **Single append –**

The model append data record after simulate ending.

- **Multiple append –**

The model append data when the condition is true. The condition have :

- Each simulate phase begin.
- Specific simulate phase begin.
- The value of specific variable out the range.

- **Single fill –**

The model fill data to match record after simulate ending.

- **Multiple fill –**

The model fill data to match record when the condition is true. The

condition have :

- Each simulate phase begin.
- Specific simulate phase begin.
- The value of specific variable out the range.

2.1.3 Strengthen the model of the dynamics of the system with the data of the dynamic state it configures basic need

In addition to providing the above of reading way, the model of the dynamics of the system integrate with the database, must still meet following need:

- **Looser coupling**

If just move the data of the emulation in the model of the dynamics of the system out the model, and store in lone source of the data, Also can't let the model of the dynamics of the system reach first need of this research here - Provide to carry on the function of the emulation with the data of the dynamic state. For canning let the model of the dynamics of the system link the business enterprise in the source of the data of every kind of different type, The request of the conjunction that is at both, must meet following need:

- The source of the data must can establish, safeguard and move alone in addition to, do not need the usage imitates the importation of the tool and manages the interface.
- The model must can link and move in addition to various different databases.
- Model in of basic dollar piece the - if accumulate the quantity, amount of rate and win to lie the variable etc.- can not access the database directly.

- **It do not use the article of the database in the model**

In addition to data form Table , the model do not link other article of the database, and the form of the data also wants to become an article alone in the model, toing maintain the flexibility of the model. Its main purpose is:

- Let model and source of the data caned be independent each other.
- Avoid being database the construction changes, the model also wants along with change.
- At do not link the situation of the source of the data, the model needs only least modification can immediately carry on the emulation.

2.2 The mode of the dynamics of the system combine with the data of the dynamic state the structure

According to above need, the suggestion of this research configures to traditional dynamics model of the system, carrying on to change the followingly:

- **Element of the " source of the data" of the increment:**

Increase the element of the " source of the data" in model of the dynamics of the system, be used as the " window way" of the model of the dynamics of the system and conjunction of the data of the exterior. That element is main to define following data:

- ◆ Describe the source of the data that model link with the SQL.
- ◆ While imitating every time, the model reads the way of the data.
- ◆ While imitating every time, the model writes in the way of the data.

- **The change of the source of the data of the variable:**

The source of the data of the variable of the model of the dynamics of the system of the tradition, can be divided into two types: the calculate type of the luck or function of the form. In this study the model of the programming, the source of the variable is in addition to the above both, also canning define to read from the article of the source of that data that variable.

The structure of the dynamics of the system of the programming of this research is shown as diagram below:

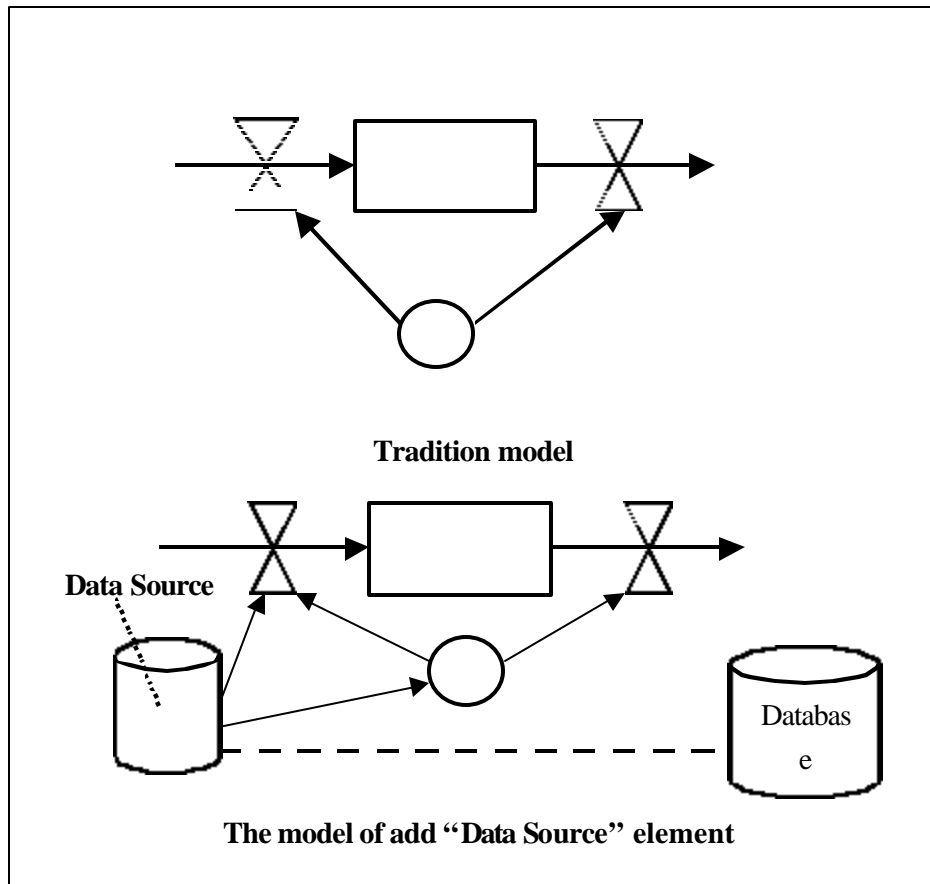


figure 3.1 The mode of the dynamics of the system combine with the data of the dynamic state the structure

Configure the dynamics of the system of the coordination and database with this, main consideration lies in:

- **Source of the data and separation of the model of the dynamics of**

the system .

- **The data uses again.**

3 The system that provide the dynamic state the data to access the function the dynamics imitates the tool- Maria

3.1 Brief introduction

The Maria studies the structure of the system of the programming according to this, its data for providing the dynamic state developed accesses the system of the function the dynamics the emulation the tool, Its function and special features includes:

- Provide and STELLA, the iThink drags along close byly the put type establishes the method of the model. User can from the dollar piece dish top select the article, and drag to the model again drawing board top establish the model.
- Add the article of the source of the data, be used as the window way that model of the dynamics of the system and exterior data source link. The model can obtain the data from the source of the data of the exterior through the article of the source of the data, imitating the data to also deposit the source of the data by the source of the data.
- Using the interface of ADO that Microsoft develop is used as and the interface of the software that source of the data link. Can link the source of the data of various types.

3.2 Dollar piece structure

In the program in Maria, with the structure of the direction(Object Orient) of the article, the each dollar that describe the model of the dynamics of the

system piece, Its each article inherits the relation,such as figure, 4.1 show:

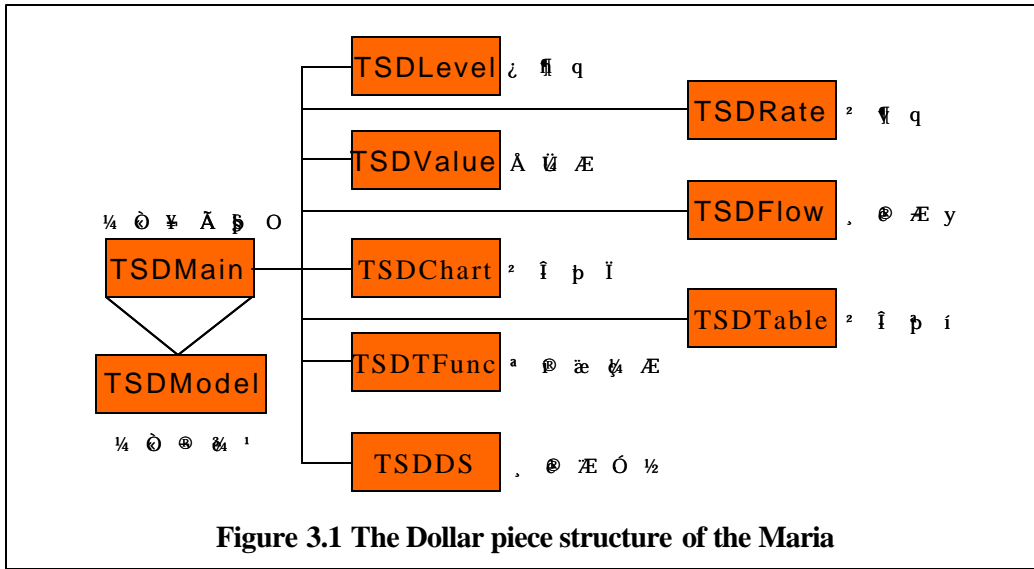


Figure 3.1 The Dollar piece structure of the Maria

3.3 System structure

Main appearance of the Maria,such as figure,4.2 show:

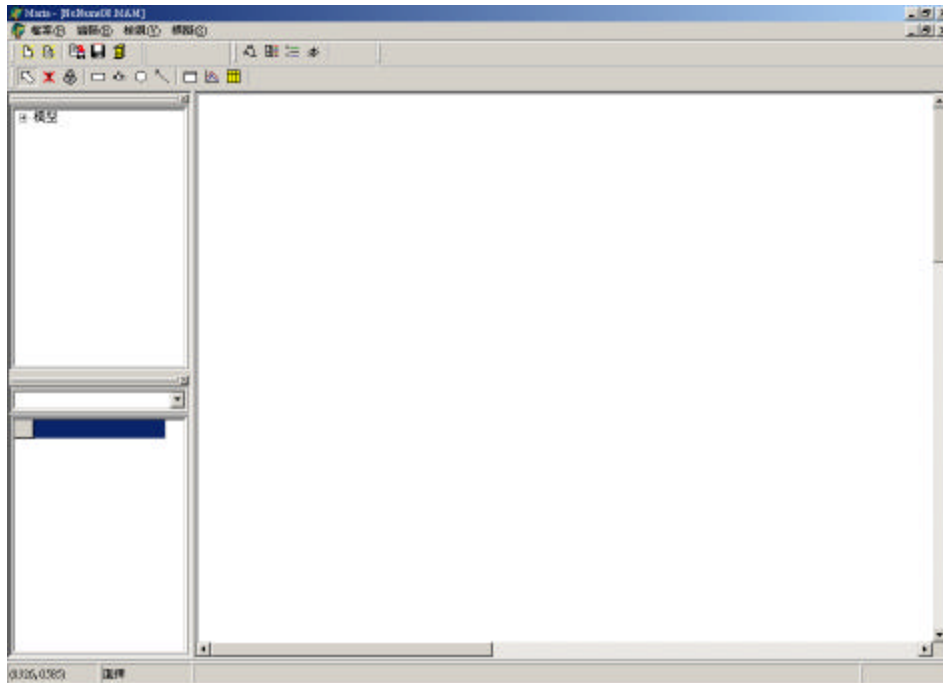


Figure 3.2 Main appearance of the Maria

Whole the system of Maria is by four are partially the composing:

- **Drawing board of the model :** The each piece and its pass of the cause and effect that show the model of the dynamics of the system connects. User can from tool dollar in the row piece the dish wins election to choose a piece, delay any more to put to the drawing board to establish the model. Provide in the model in Maria at the present time one kind of piece:

- **Level Variable :** Describe the static quantity in system.



figure 3.3 Level Variable

- **Rate Variable :** Describe the dynamics quantity in system.



figure 3.4 Rate Variable

- **Assist Variable :** Indicate in model although not affect to accumulate directly the quantity increases or decrease, can affect the quantity of the rate or other variable changes the quantity.



figure 3.5 Assist Variable

- **Data flow :** Indicate each variable in model the fluxion of the

information.



figure 3.6 Data flow

- **Data Source** : Define the model of the dynamics of the system connect of source of the data of the exterior with to write in/ read way, Is the window way that model of the dynamics of the system and exterior data source communicate.



figure 3.7 Data Source

- **Statistical chart** : Providing the value of each element that imitate model's lead designs the function of the statistical chart.



figure 3.8 Statistical chart

- **Statistical Table** : Providing the value of each element that imitate model's lead designs statistics the function of the form.



figure 3.9 Statistical Table

And establish the model of the dynamics of the system in Maria, is

from the dollar of the row of the tool piece the dish wins election to take a piece, then drag along it puts to the version of the diagram of the model combine. As the figure 4.9 show:

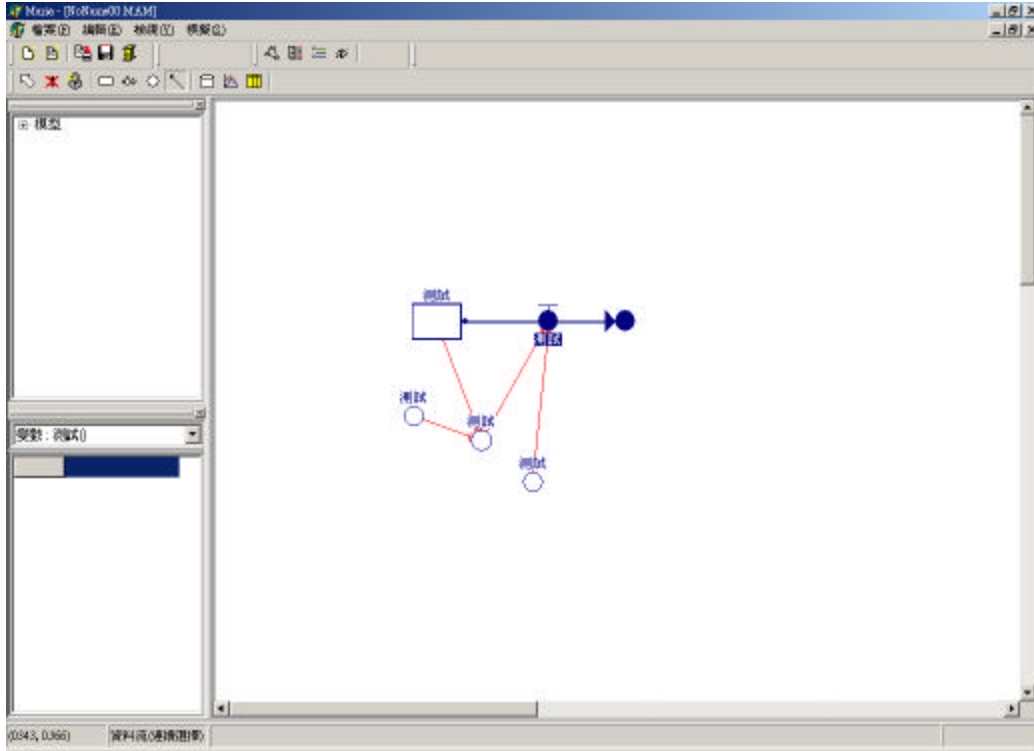


figure 4.9 Establish the model on the version of the diagram of the model

- **Model manager** : Show current model in the editor with the diagram of the form of the tree and it include a piece.

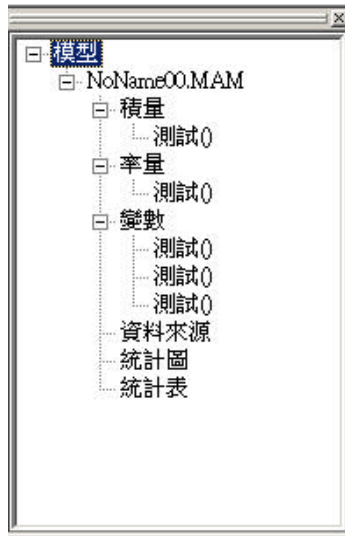


figure 4.10 Model manager

- **Attribute Manager** : The article that manifestation choose at the present time to the attribute.

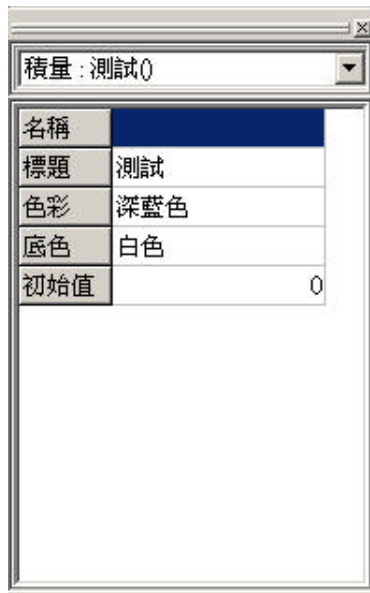


figure 4.11 Attribute Manager

- **Formula Manager** : Show the formula of the element of the system.

3.4 The dynamics of the system combine with the exterior data source

In Maria, the link of the model and source of the data of the exterior is solid to make, main be divided into two parts:

- **Data Source element :**

The Maria is different from the tradition system dynamics imitates the tool of, consisting in adding namely first "Data Source", In this, it is main to is a definition:

- The source of the data of the exterior that model of the dynamics of the system link.
- Read the frequency and way of the hour of the data.
- While writing in the data of frequency and way.

- **Traditional system dynamics dollar the modification of the piece:**

In the structure of the model of the dynamics of the system in Maria, accumulate the quantity, amount of rate and variable of the assistance to all compare the traditional system the dynamics dollar the piece had another two attribute :

- **Read the data :** Set up to be the model of the dynamics of the system to read from the source of the data of the exterior data, want to be through that data source dollar piece in of specify the column reads data, and set up for the value of the dollar's piece.
- **Write the data :** Set up when the model of the dynamics of the system wants to write in the data to source of the data of the exterior, current dollar the piece is worth to want the source of the data and column that write in.

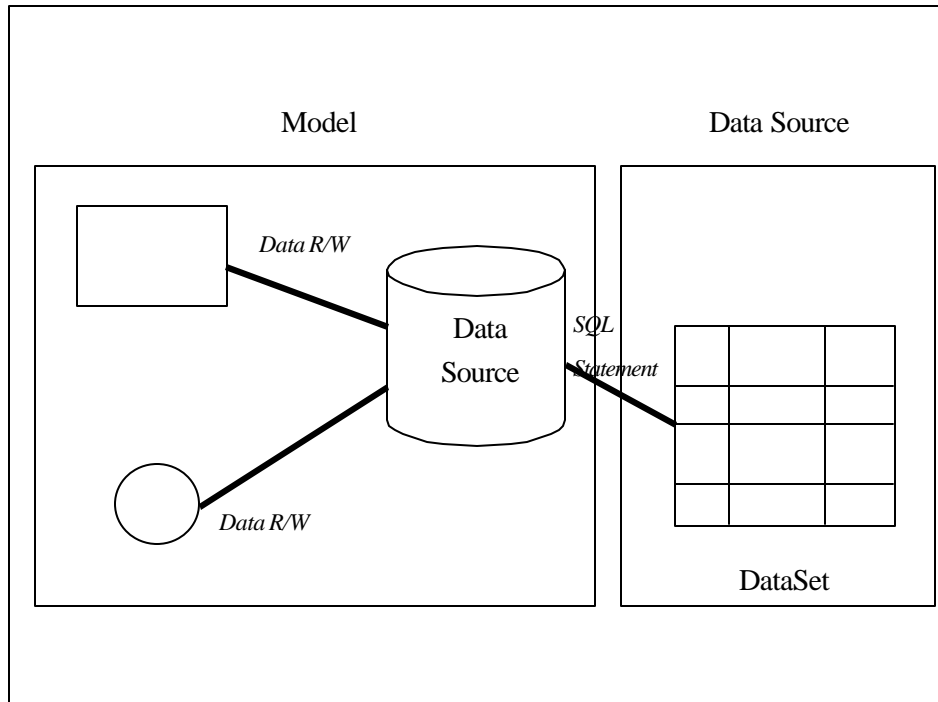


figure 4.12 Maria is in the structure of the model, the link of the model and source of the data

3.5 Model identification

3.5.1 Enactment of the model of the foundation :

In this stanza, this research with the university's student gets stripe the model for example, the link of solid model of the dynamics for making the system and source of the data of the exterior.

Assumption have a new- established university at the present time, establish early school to only have 100 big a new-born, manage the authorities the project to recruit every year 300 freshman, and each academic year be over hour:

- The freshman reach 60% can rise to the sophomore.
- The sophomore reach 70% can rise to the junior.
- The junior reach 80% can rise to the senior.

- The senior reach 90% can graduate smoothly.

Want to be with that university of the analysis of the dynamics of the system to solicit students after few year, the number of the student of each grade assigns. First, we first in the version of the diagram of the model in Maria, establish the model of that university :

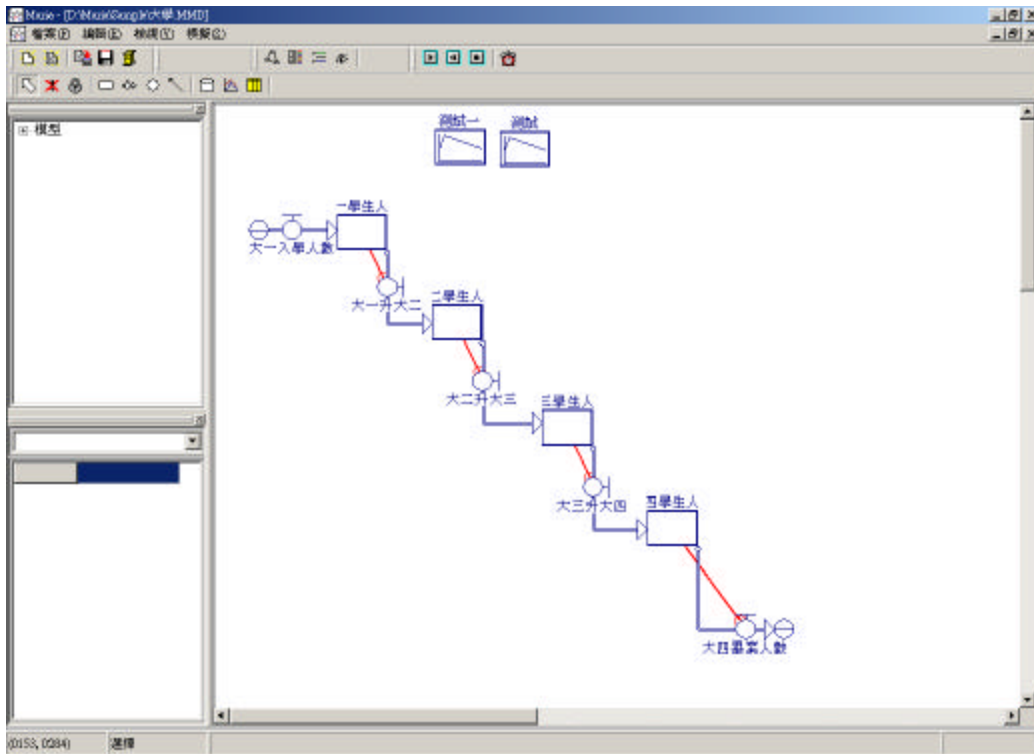


figure 4.13 The model of university study is design with MARIA

That model in the dollar of the containment the piece has:

- **Label Variable :**
 - **UA :** The freshman total (Unit : Person)
 - **UB :** The sophomor total (Unit : Person)
 - **UC :** The junior total (Unit : Person)
 - **UD :** The Senior total (Unit : Person)
- **Rate Variable :**

- **NEW** : The freshman who enter school when academic year start
(Unit : Person / Year).
- **AB** : The total of the academic year to start is freshman on rising to
sophomor of student(Unit : Person / Year).
- **BC** : The total of the academic year to start is sophomor on rising
to the junior of student(Unit : Person / Year).
- **CD** : The total of the academic year to start is junior on rising to
the senior of student(Unit : Person / Year).
- **GDU** : The total of The student who graduate when academic year
start(Unit : Person / Year)

And the calculate type of the luck in the model indicates with the format
of iThink, then for:

- $UA(t) = UA(t - dt) + (NEW - AB) * dt$

INIT UA = 100

INFLOWS:

NEW = 300

OUTFLOWS:

AB = UA*0.6

- $UB(t) = UB(t - dt) + (AB - BC) * dt$

INIT UB = 0

INFLOWS:

AB = UA*0.6

OUTFLOWS:

BC = UB*0.7

- $UC(t) = UC(t - dt) + (BC - CD) * dt$

INIT UC = 0

INFLOWS:

$$BC = UB * 0.7$$

OUTFLOWS:

$$CD = UC * 0.8$$

- $UD(t) = UD(t - dt) + (CD - GDU) * dt$

INIT UD = 0


INFLOWS:

$$CD = UC * 0.8$$

OUTFLOWS:

$$GDU = UD * 0.9$$

The model establishes after completing, we choose the Maria the form of the function of " imitate the "-" time the enactment", or press emulation

 button in the row of the tool. Will show to set up to imitate the dialog

box of the period on the appearance:



figure 4.14 Set up to imitate the period

In this example, we anticipate to imitate should the variety of the inside enrollment of 30 years of the university, so the period of the emulation settles to 1-30 periods, the unit of time is a " year", again because at current we do not plan to do different policy and outside environment under imitate result of comparison, so only need to be imitated once.

Set up imitate after period, we choose the Maria the form of the function of " imitate"- " carry out", The Maria will start carrying on the emulation namely.

Imitate after completing, we move the cursor of the mouse to statistical chart dollar piece, then press right key of the mouse, the appearance will show at appointed inside of the period of the emulation namely, should the variety of the number of the student of each grade of university:

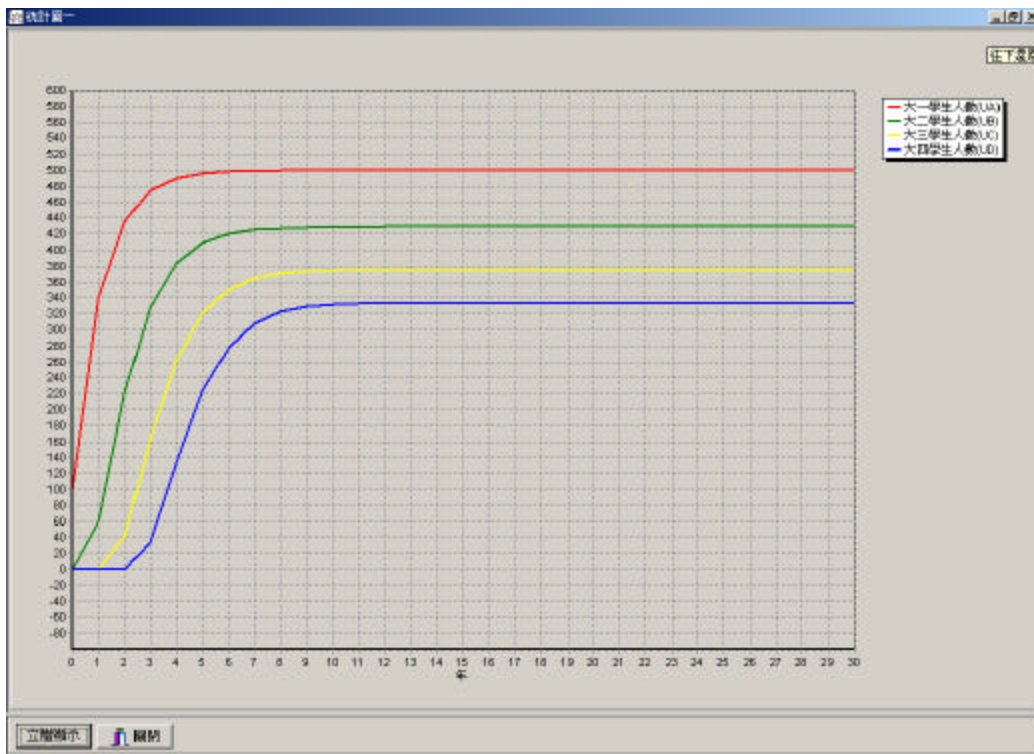


figure 4.15 Simulate result

Can find by above statistical chart, at start the eighth that solicit students to the ninth academic year, the number of each grade will maintain to fix, number with freshman at most, senior is least. And on another tool iThink of emulation, we also see the result of the homology:

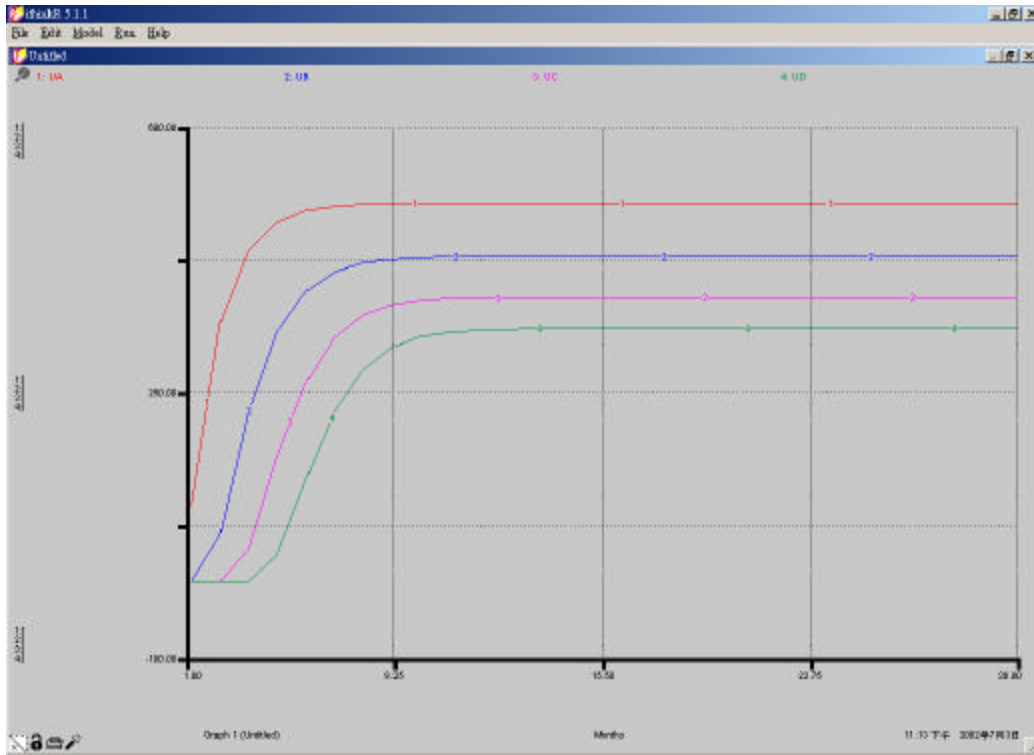


figure 4.16 The result of simulate with iThink

3.5.2 Analysis of the policy and scenario:

In last a stage, we already can through the function of the emulation of the Maria, carry on the estimate to the future, and in this stage, we will explain the model of the dynamics of the system how to link the application of the model of the data of the exterior.

Suppose the school manage the emulation in last a stage of the process of the authorities, have known the school the enrollment in 30 yearses of the future the variety, but, if we when the beginning of the school solicit students, big a the number of the freshman different, whether would to the number of each grade of school cause influence in the days to come?

Establish a new form “TestRead” of the data in with Maria carried on imitate,

us first can the database of Northwind in school:

ID	U1DEFAULT
1	300
2	500
3	1200

**Figure 3.17 Store the data of different scenario of the policy the form the
TestRead**

There is two columns in TestRead form of the data: {There is two columns in TestRead data form:} The ID stores the code of the policy, and the U1DEFAULT then stores When the beginning of the school solicit students, big a the number of the freshman.

Join an article of the source of data in set up form of the data after, us return to Maria, previously ex- model, and set up its "Data Source" Attribute to link the database of Northwind of the school:

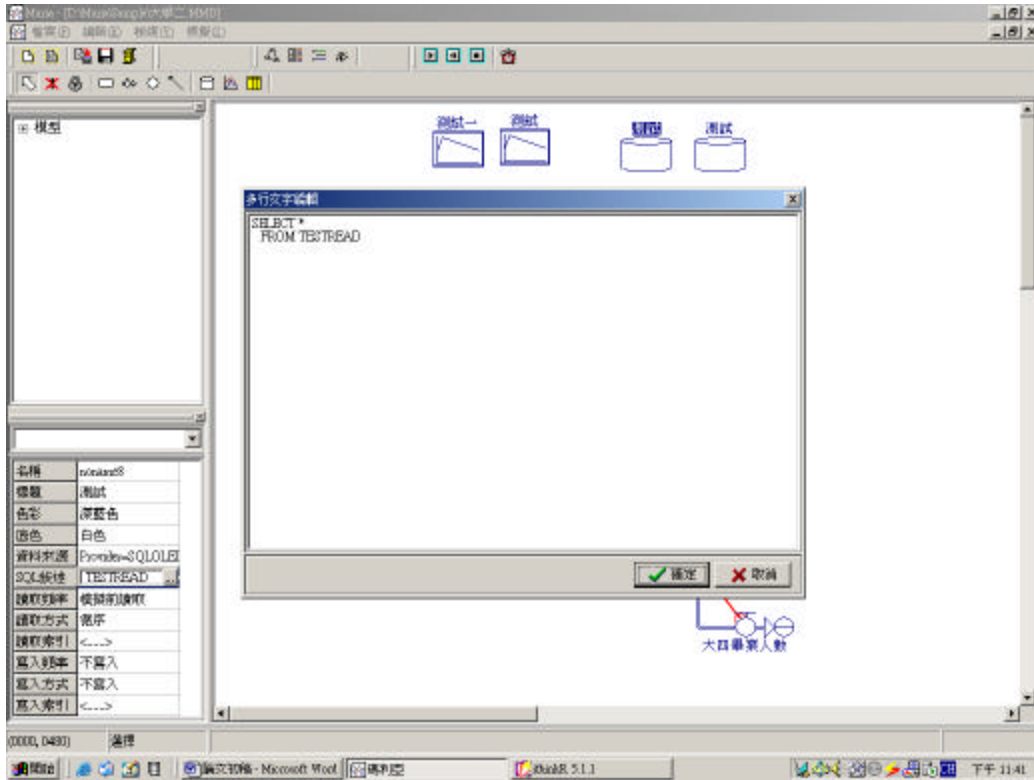


figure 3.19 Set SQL Statement

Immediately after, we data source dollar piece of" read frequency" establish for" before imitating read";" read way" belong to the sex establishes for" in proper order";Let data source is in the emulation of the every time front, meeting from the first beginning of the data form in order read data into model.

Then, we choose to accumulate to measure a piece UA(the freshman number), set up its" read the data" Attribute.

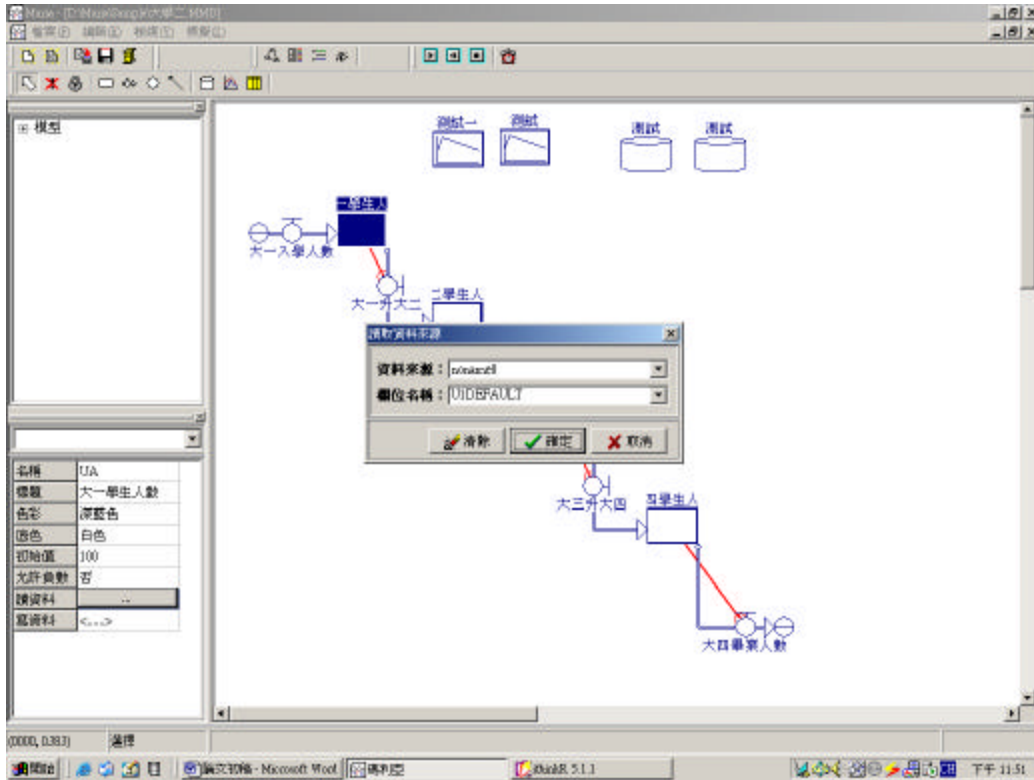
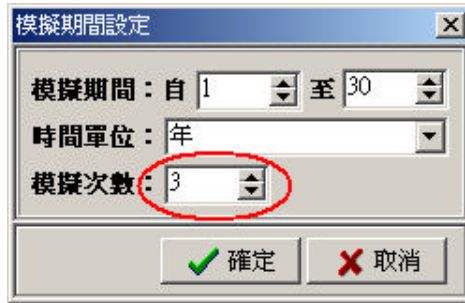


figure 3.20 Set up the data link of elements

Set up after completing, we choose the Maria the form of the function of "imitate"- " time set up", Will show to set up to imitate the dialog box of the period on the appearance. This time because we wants to imitate three kinds of different scenarios under of result of the emulation, so establish to three " emulation number of times", request the Maria the repetition the emulation three times, all imitates to Issue 30 from Issue 1 each time, the unit of time is a " year".



Connect down, like that of last time, we choose the Maria the form of the function of "imitate"- "carry out", Different from last time is, in imitate after open statistical chart, can saw result that the same piece of top manifestation of the diagram three times imitate, and emulation in every time, Maria would according to source of the data current record, solicit students the beginning big a the number of the freshman establishes for 300 and 500 and 1,200 people respectively:

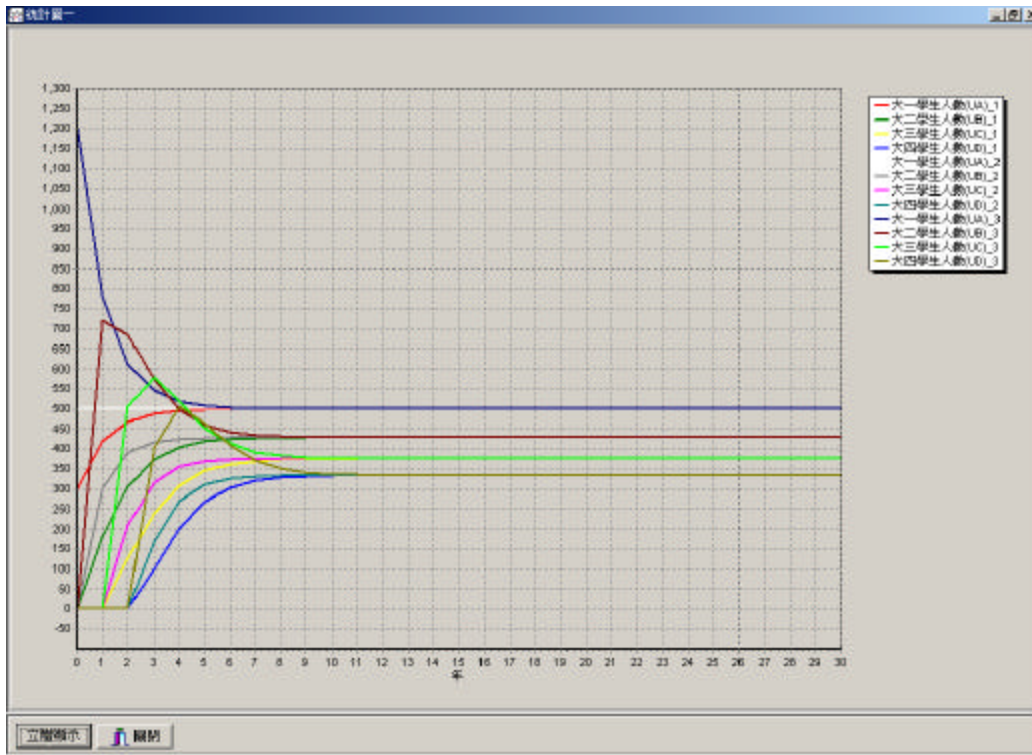


figure 3.21 The result of changing freshman total

By last diagram in can find, even while starting solicit students, big a the number of the freshman is different, but along with the changes of time, the number of the last grade all would be same.

4 Conclusion

4.1 The application of the actual situation of the information of the business enterprise

If the system that study this move the information of the business enterprise the management the aspect from the laboratory, that application realm again is how?

At current the information of the business enterprise manages the structure, having headed for the coordination from the traditional dispersion. The information of the business enterprise inner part were integrated in the information source of the business enterprise, and business enterprise in if trade the information system of the type of the management system(TPS) and management information system(MIS) or decision support system(DSS), are all from read or write in the data in the business enterprise data source. As the figure 4.1 show:

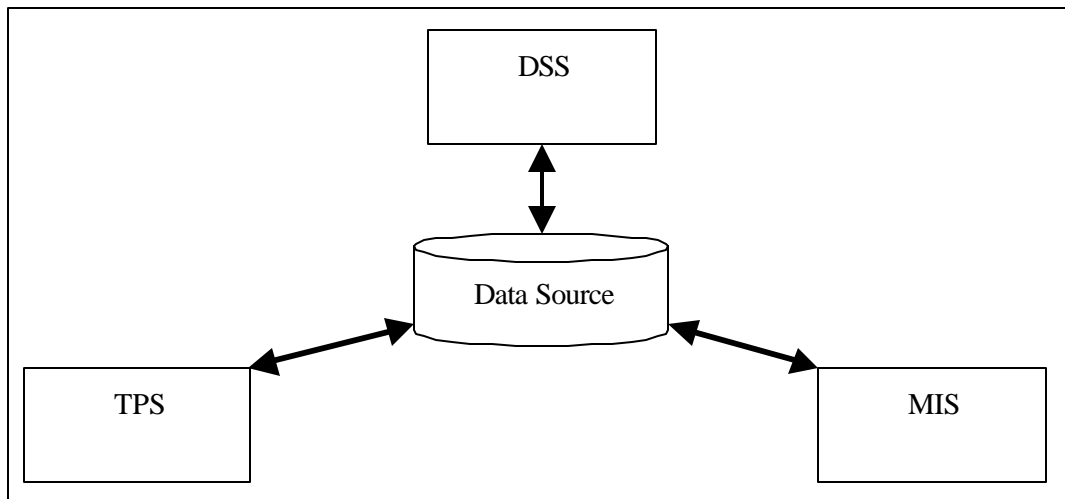
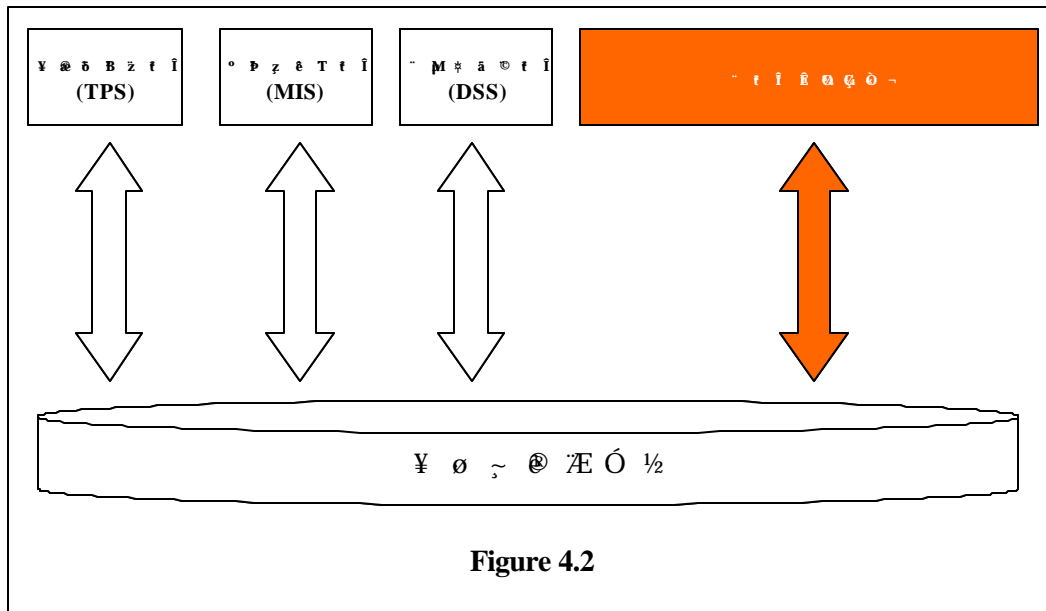


Figure 4.1 The structure of the system of the information of the business enterprise

If the structure of above diagram and speech, then traditional dynamics model of the system is after increasing to link the function of the source of the data of the

exterior, main and applied direction can be divided into the both side:

- Making use of the model of the dynamics of the system obtains the data of the business enterprise to take into the emulation, then save the result after imitating to return to data of the business enterprise, toing provide the business enterprise the other information the system the usage. As the figure 4.2 show:

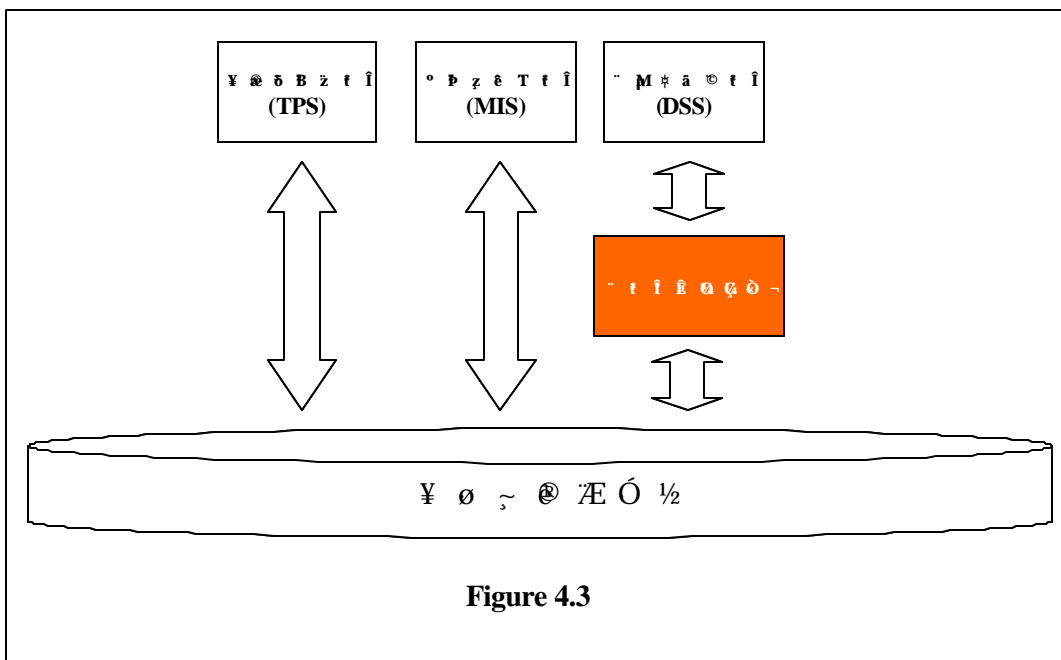


Is shown as diagram above, the business enterprise can be used as its analytical data to source of the data for model of the dynamics of the system to imitate, imitating the result writes again to return the source of the data of the business enterprise in, be used as the source of the information of the decision support system(DSS) and system(MIS) of the information of the management or analysis of the system of the information of the top executive or manifestation.

- Be used as the mode of the core of the decision support system(DSS) with the model of the dynamics of the system:

Making use of the mode carries on to imitate and predict, using in the

structure of the decision support system very important and analytical tool, the structure of the mode of the decision support system of the tradition most likely with the mode of mathematics and logic reasons logically the mode for lord, and model of the dynamics of the system is in provide and the tool that exterior data source link after, also can brought into the sub- system of the mode of the decision support system, being used as the decision support system the decision a wreath of the mechanism. As the figure 4.3 show:



5 Consult the cultural heritage

English

- Jay W. Forrester. 1961. *Industrial Dynamics*. MIT Press
- Augusto A. Legasto, Jr., Jay W. Forrester, James M. Lyneis. 1980. *System dynamics*. North-Holland Pub. Co. ; New York