A TEST ON META-SYNTHESIS SYSTEM APPROACH TO FORECASTING THE GDP GROWTH RATE IN CHINA

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ABSTRACT

Meta-synthesis method is proposed to tackle with complex, open and giant systems by Chinese scientists Qian, X.S. and his colleagues around the start of 1990s. It emphasizes the synthesis of collected information and knowledge of various kinds of experts, and connecting quantitative methods with qualitative knowledge. Later it is evolved into Hall of Workshop for Meta-Synthetic Engineering (HWMSE), which emphasizes to make use of breaking advances in information technologies. In 1999, Natural Science Foundation of China (NSFC) approved a 4-year major project engaging to implement a pilot prototype for HWMSE for macroeconomic decision making. We participate in this project. For the concerned problem in macroeconomics in this project, we have designed a flowchart for realizing the meta-synthesis system approach from qualitative to quantitative. The main ideas of this flowchart consists of three phases; synchronous meeting I; asynchronous analysis; synchronous meeting II. This January a test was taken to the forecasting of GDP (gross domestic product) growth rate of China in 2003. In this paper, the procedure of the test is given with relevant tools applied to each phase of the GDP growth forecasting. From this test, three systems of the main parts of HWMSE, expert system, knowledge system and machine system are clearly reflected where some experiences have been practically acquired about applying meta-synthesis approach and HWMSE.

Keywords: meta-synthesis approach, HWMSE, macro economics

INTRODUCTION

Macro-economic system is an open complex giant system. It is very difficult and even impractical to apply general reductionism methods. Professor Qian Xuesen (Tsien HsueShen) and his colleagues had proposed meta-synthesis approach (MSA) as a main approach in 1990 and a test bed - Hall for Workshop of MetaSynthetic Engineering (HWMSE) in 1992 to solve those open complex giant systems problems, such as

economic system, social system, environment system and military system etc. (Qian, Yu & Dai, 1990). The formulation of idea of HWMSE assimilates both theoretical and practical knowledge, such as seminars, meta-synthesis from qualitative to quantitative approach, C^3I system and war gaming in military sciences, information technology, artificial intelligence; virtual reality; systematology, and other new advanced technologies. It aims to exceed the traditional decision support systems (DSS), which mainly based on computers, to man-machine hybrid systems, where people play main role to give judgment for strategic planning and decision analysis. There are three systems in HWMSE, machine system, experts system and knowledge system, where machine system does not only limit to a traditional DSS but refers to a network system, such as the Internet. Experts system puts people as the principal role in HWMSE, and machine system helps people work. For strategic and critical problems, experts are selected based on those information such as background, age, knowledge and experiences stored in experts system. Knowledge system not only consist available knowledge stored by machine and experts systems, but also new knowledge produced with in the Hall. Actually both the experts system and machine system are carrier of knowledge in knowledge system. Then the Hall not only has abilities in collecting, storing, transferring, analyzing and synthesizing information and knowledge, but also abilities for creating new knowledge. A generic framework of HWMSE where are activities taken is shown as in Figure 1. Those activities and relations also belong to research in epistemology.

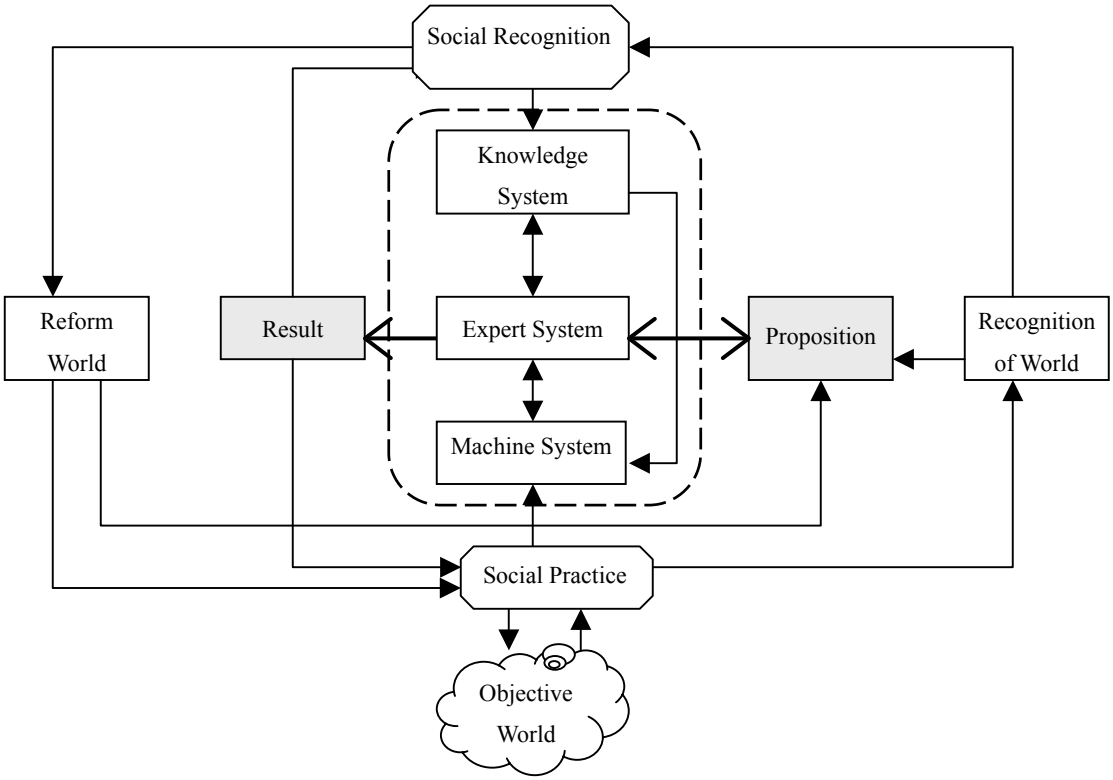


Figure 1. Generic Framework of Hall for WorkShop of Meta-Synthetic Engineering

Since MSA and HWMSE were proposed, Chinese system researchers and practitioners have tried to apply both in some economic, ecological, military and industrial system problems. In 1999, National Natural Science Foundation of China (NSFC) approved a major project for the implementation of a pilot prototype for HWMSE for macroeconomic decision making (Wu & Wei, 2001; Gu & Tang, 2002; Tang & Gu, 2002). We belong to Group 3 on methods research. Since the start of the project, a series of tests had been carried out to partly exhibit how to apply MSA and HWMSE for the GDP growth forecasting in China, such as a test in system reconstruction analysis (Shu, 2001), a test for expert discussion held for mid-term check of the major project by NSFC in August of 2001, and sub project test about distributed discussion rooms in December of 2001. In 2001 December's test, a commercial software for group work PathMaker II were also in trial use by Group 3 people in Beijing. Most of those tests focused on only one part of the HWMSE, not the whole system. This January a test was taken to the forecasting of GDP growth of China in 2003. In this paper, the procedure of the test is given with relevant tools applied to each phase of the GDP growth forecasting. From this test, three systems of HWMSE as shown in Figure 1 are clearly reflected where some experiences have been practically acquired about applying meta-synthesis approach and HWMSE.

First we address the flowchart of MSA. Then we give the whole working process of the test. Finally some comments and further work will be discussed.

THE FLOWCHART OF METASYNTHESIS APPROACH (MSA)

There are three stages in applying MSA, 1) qualitative meta-synthesis; 2) from quantitative to quantitative; 3) quantitative meta-synthesis (Yu & Tu, 2002). A rough flowchart of applying MSA based on three stages is designed as from synchronous stage I (Meeting I) to asynchronous Stage (Analysis), then to synchronous stage II (meeting II) (as shown in Figure 2).

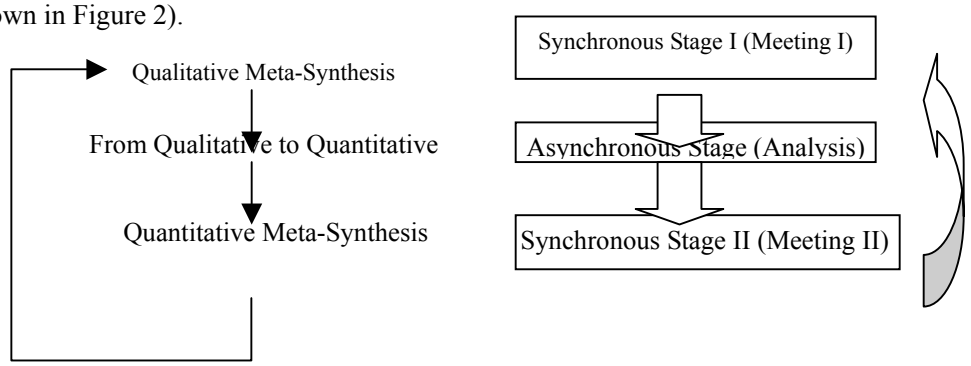


Figure 2. Rough Flowchart of MSA Working Process

During the Synchronous Stage I, usually group divergent thinking is applied for a group of expert for the concerned issues, such as GDP growth forecast. A variety of methods and tools may be applied to help experts with different knowledge backgrounds and enable the expert discussion to be more effective and efficient. Such as Delphi method, brainstorming tools, groupware, computer supported cooperative work (CSCW), etc. It is expected to reach some results based on group argumentation in this stage; however, those results are still qualitative hypothesis which should be under verification and validation.

During the Asynchronous Stage, analysis will be given to those hypotheses proposed in the Synchronous Stage I. Usually various models will be applied for analysis. In our project, different models have been built to describe macro economic system from different perspectives or based on different modeling principles. Such as econometric model, time series models, multi-agent simulation model, evolutionary economic model, neural network model, Bayesian network, system reconstruction model, etc. Model integration mechanism is applied to integrate various models for a comprehensive scenario about macro economic system operation. Experts or analysts may run those models based on those hypotheses or their own viewpoints about GDP growth and acquire quantitative analytical results separately. Usually there are no time pressure or tight limit to analysis in the analysis stage compared with synchronous discussion stage. Then analysis may be undertaken on distributed sites. On this stage, quantitative analysis is done from qualitative hypothesis.

During the Synchronous Stage II, not only experts with different knowledge, but managers from different organizations related to the economic decision making and some high responsible decision makers may also be invited for group argumentation and group decision making. This meeting is not only for free discussion, but also for some decision-making. Then convergent thinking will be applied to reach some compromise or consensus. Usually various methods or models for decision analysis will be applied, such as analytical hierarchy process (AHP), nominal group technique (NGT), multiple criteria decision making (MCDM), etc. Also there are other methods, for example, system reconstruction method and feasible desirable method. The former can be applied to quantitative analysis on the one hand, while to use data, information and knowledge for meta-synthetic reconstructive analysis on the other hand. There are a lot of tools or platforms to support group work in this stage, such as Expert Choice (based on AHP), PathMaker and various group support systems. For more details about consensus building, please refer to Gu (2001) for some basic concept, theory, method and tools. Considering those methods, tools, experts, data, information, etc. are resources in HWMSE, a possible meeting framework utilizing HWMSE resources for macro economy problem is as shown in Figure 3.

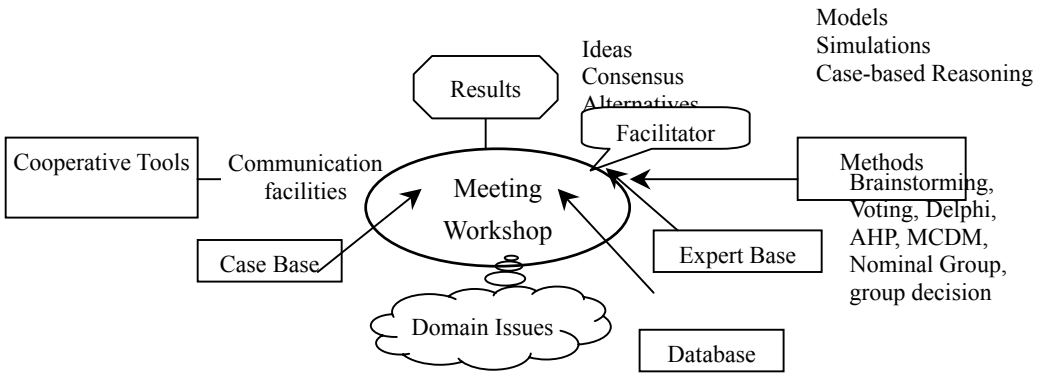
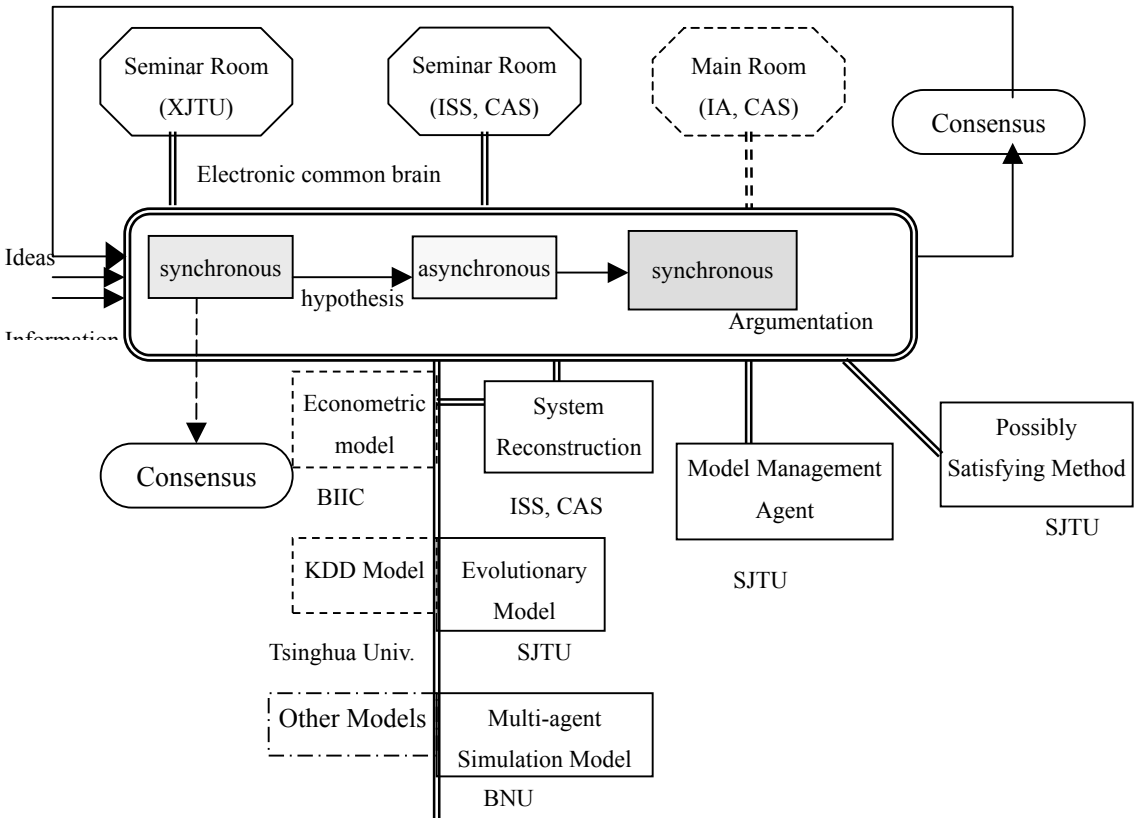


Figure 3. A Meeting Framework Utilizing HWMSE

According to the above-mentioned ideas and design, some results had been achieved in Group 3 within the NSFC major project. And much work also has been done from other groups. Figure 4 is an extensive flowchart of MSA working process, which points out all process, functions and tasks for the major NSFC project. Next we present our test on GDP growth forecast based on Figure 2.

TEST ON MSA TO THE FORECAST OF GDP GROWTH IN CHINA IN 2003

This test was taken in the School of Knowledge Science, Japan Advanced Institute of Science and Technology (JAIST) in January of 2003. The aim of test is to go through the working process as shown in Figure 2 and acquire some direct experiences about MSA and HWMSE and for further improvement about our current research work in the NSFC major project. Since most of our computerized research work is in China, we apply some available tools to this test. PathMaker by SkyMark Corporation was chosen as a cooperative support tool for our synchronous meeting. We also made full use of those advanced facilities in JAIST, such as the specific collaboration room. For a satisfying result of test, adequate preparations were taken ahead.



Note:

Double line or rectangle: web-enabled resources in HWMSE;

arrow line: information flow;

dashed line: non-Group 3's work

BIIC: Beijing Institute of Information and Control; BNU: Beijing Normal University; CAS: Chinese Academy of Sciences; IA: Institute of Automation; ISS: Institute of Systems Science; SJTU: Shanghai Jiaotong University

Figure 4. Extensive Flowchart of MSA Working Process

Preparation of the Test

The preparation mainly includes two parts, one is acquaintance of PathMaker and those facilities in collaboration room whose aims to ascertain the easy use of PathMaker and switch between different facilities. Another is a preparation meeting for all members.

Tool Preparation and Specific Flowchart about the Test

As a main tool in our test, Pathmaker provides meeting discussion about some projects. Here the project is to forecast China's GDP growth trend in 2003. Each project follows a pathway, which is the roadmap of a project. In PathMaker, users make project plan, list access to different tools, arrange meeting agenda, etc. by the Project Pathway. In our test, Figure 2 serves a basis to the depiction of the pathway. A more specific working process is as shown in Figure 5 for pathway depiction.

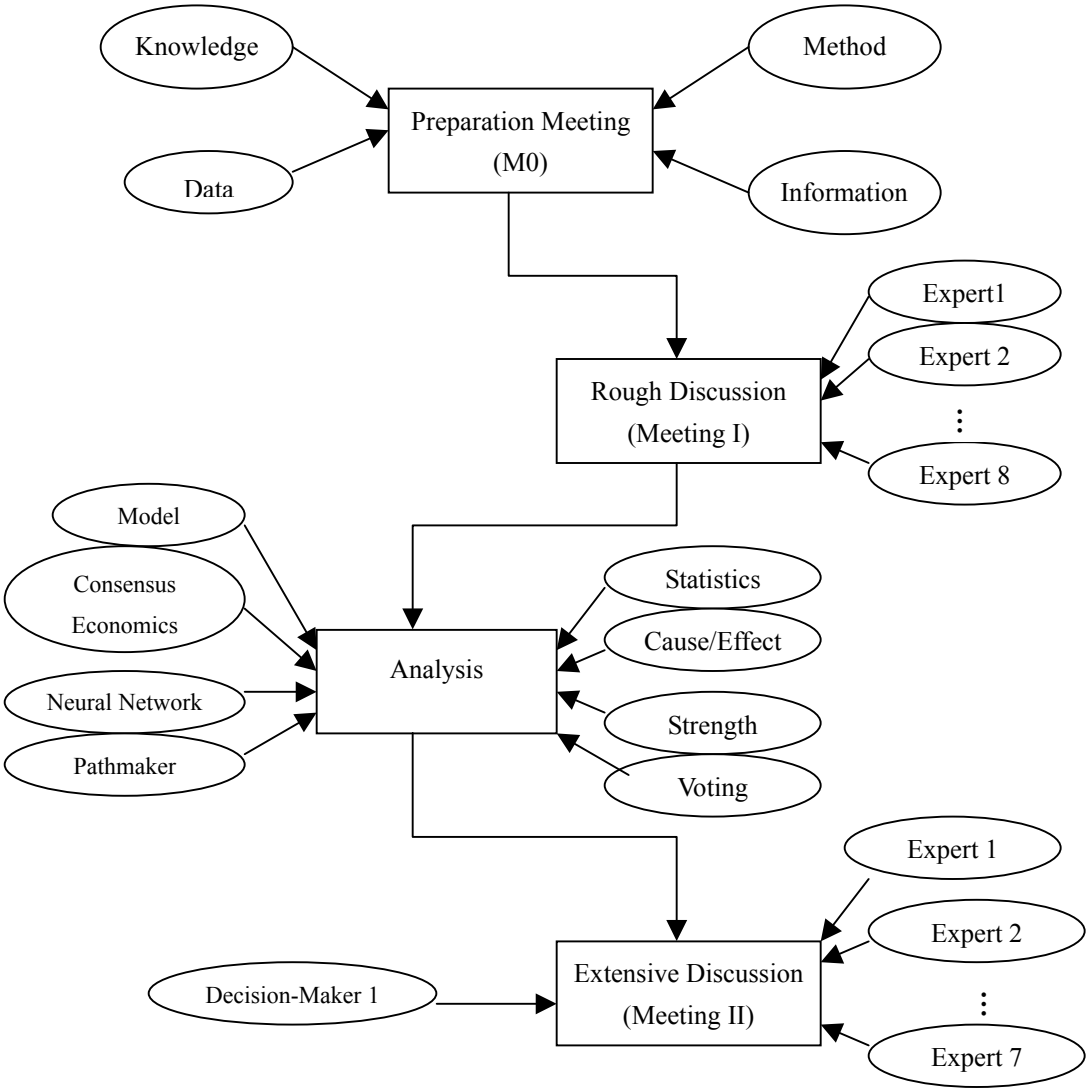


Figure 5. Specific MSA Flowchart in GDP Growth Forecast

From the procedure as shown in Figure 5, participants explored PathMaker and plan to try those tools available in PathMaker, such as brainstorming and affinity diagramming, cause and effect analysis, flowcharting, force field analysis and consensus builder (voting). There are other four parts along with a Project Pathway, which are:

- *Project Information*: All the information about the forecasting the GDP growth in China in 2003.
- *Team Member*: The information of all participants of test. Each member will be registered, including name, password, limitation, and responsibility, and an ID is given. In our Test, one professor, one visiting scholar and 6 JAIST Ph.D or master students are involved.

- *Action Items*: Includes ID, description, person responsibility, deadline and status. The professor serves as chairman or decision maker during the test, visiting scholar serves as the representative of knowledge system on macro economics. Other students form different schools of forecasting GDP growth.
- *Discussion History*: Every team member can design and trigger an on-line discussion, either in a intranet or in internet. In our test, all members are concentrated in the main discussion for the main topics at each meeting stage.

Preparation Meeting of Test

To facilitate the formal discussion, several preparation meetings were taken to introduce the knowledge and information related to the main topic of project - forecasting the GDP growth in China in 2003. In the meeting, all preparation work has been tested; the aim and procedure of test are declared clearly and role of each participant is defined, such as chairman, facilitator and experts. The main work include:

- Background introduction, including meta-synthesis approach, HWMSE, MSA trend, the major project supported by NSFC, overall design of the test.
- Introduction of methods of GDP growth calculation and relative factor analysis, primary statistic index, principal macroeconomics models in China and several different schools in forecasting GDP growth rate.
- Introduction of Consensus Economics, a UK-based organization who surveys over 130 prominent Asia Pacific financial and economic forecasters for their estimates of a range of variables including future growth, inflation, foreign trade and exchange rates in every month.
- Introduction of the main collaborative software PathMaker and its components and their functions (pathway, information, team member, action items and discussion history).
- Debug of operations of all tools and facilities in the Collaboration Room which will be used in the test. Those facilities include: 2 desktops and 6 laptops, 2 projectors; 1 printer; and convenient access to WWW in the Collaboration Room (20 available port to Internet).
- Contents and organization of different systems (knowledge system, expert system and machine system) for the test in comparison of three systems in HWMSE.

For concentration of discussion, opinions about GDP growth trends in 2003 is divided into three levels:

- High growth trend- 2003 year's GDP rise rate higher than 8.1%;
- Smooth growth trend- 2003 year's GDP rise rate hold the line 7.9-8.1%;
- Low growth trend- 2003 year's GDP rise rate lower than 7.9%.

And then all participants are also divided into three schools which support different GDP growth trends. And representative of knowledge system provide specific macro economics materials for different schools to enable those participants be familiar with

their role during the testing process.

Formal Test Procedure and Principal Analysis

The whole test procedure is based on Figure 5, and mainly underwent three phases: rough discussion, analysis and extensive discussion.

Synchronous Discussion about GDP growth –Meeting I
Firstly, China's GDP growth in 2003 is roughly discussed by PathMaker in the first meeting of our test (M1) with the following steps:

1) Establishing Meeting Agenda
The meeting agenda tool in PathMaker provides advance notice of topics, structure for discussion, and a place to record decisions, ideas, and action items. The agenda for MI is as shown in Figure 6.

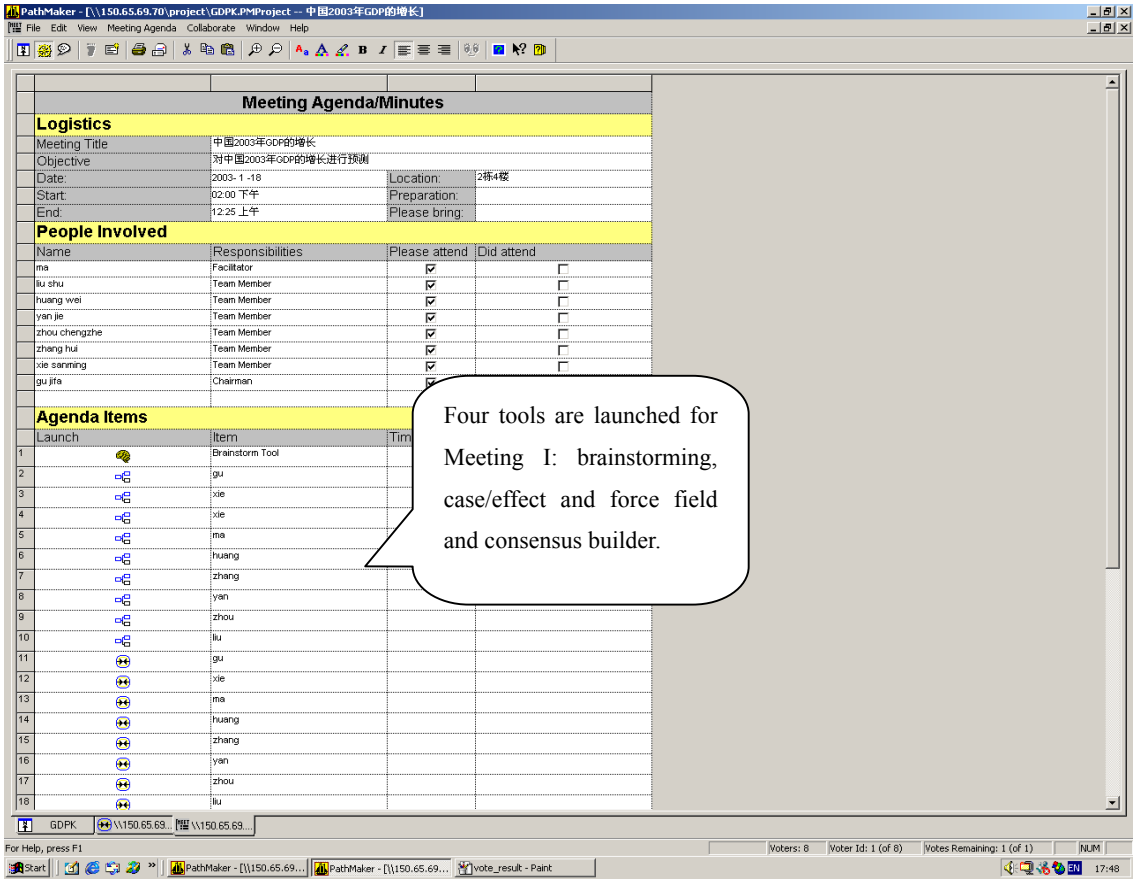


Figure 6. Agenda of Synchronous Meeting I

After constructing the meeting agenda, the meeting goes on according to the flowchart.

2) Idea Generation

The first agenda item launched is brainstorm tool, which is for creative ideas about given topics. Brainstorming is a kind of open thinking method. The more the opinions there are, the better performance it has; then criticism and suppression will be avoided for more complementary and ameliorative opinions. Therefore brainstorming can sufficiently exert participants' positivity. Brainstorming tool of Pathmaker combines brainstorming and affinity diagramming into one tool, allowing the rapid recording and sorting of ideas. Figure 7 is the record of the brainstorming session for idea generation and classification. Experts present their opinions freely about China's GDP growth trend in 2003 anonymously and their utterances are recorded in the left column of the window as shown in Figure 7. The right column of the window shows three categories of all utterances by experts, high, smooth and low forecast about China's GDP growth in 2003 according to the original design in our experiment.

Figure 7. Brainstorming and Affinity List for Idea Generation and Sorting during Meeting I

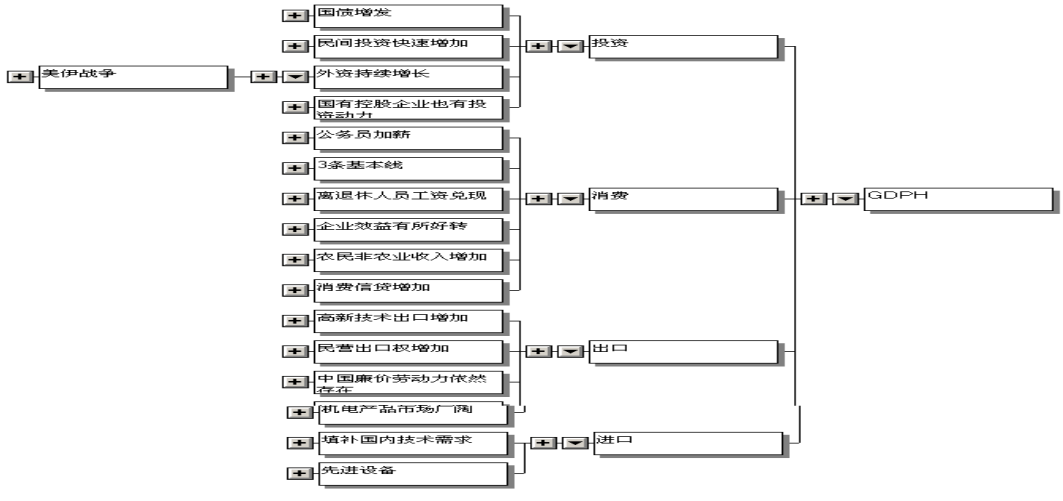


Figure 8. Cause/Effect Analytic Tree in Meeting I

There are also cause/effect trees for smooth growth and low growth trend analysis. Cause/Effect analysis discovers those factors which influence GDP growth, while the strength of those factors' influences in GDP growth can also be exhibited.

3) Forces Review about GDP growth

After acquiring rich opinions about GDP growth, some other tools are applied for discussion processing.

4) Cause and Effect Analysis

Cause and Effect Tool in PathMaker is to arrange ideas in a tree structure, by which to discover the reasons for a certain result. Figure 8 is a cause/effect tree about the high GDP growth forecast. The facilitator creates the tree based on contributions from representative of expert system about factors for GDP growth.

Force Field Tool in PathMaker can be used to analyse and display the driving forces and restraining forces of a transformation. Here we review those forces about high GDP growth in China in 2003. Figure 9 shows such an analysis. There are four columns, from the left to right, the first column denotes the driving forces, the second denotes how strong the driving forces are, the third denotes how strong the restraining forces are and the fourth denotes the restraining forces. For such a review, participants of the discussion can understand and then think further about their initial ideas about GDP growth forecast.

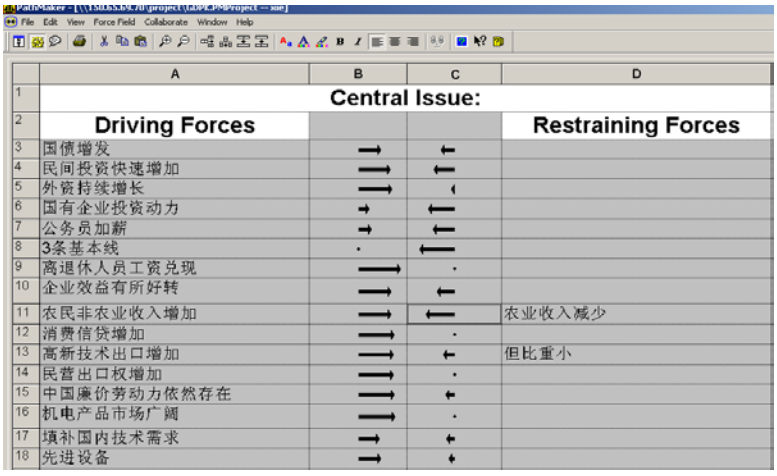


Figure 9. Forces Review in Meeting I

5) Consensus Building

According to the MSA working process, it is expected to reach a qualitative meta-synthesis which is for further analysis. Here we apply PathMaker's Consensus

Builder to evaluate and quantify the discussion results. There are three methods users can use to build consensus with this tool, rating vote, multivote and group multivote. In this test, multivote is applied. Figure 10 & 11 shows the voting process.

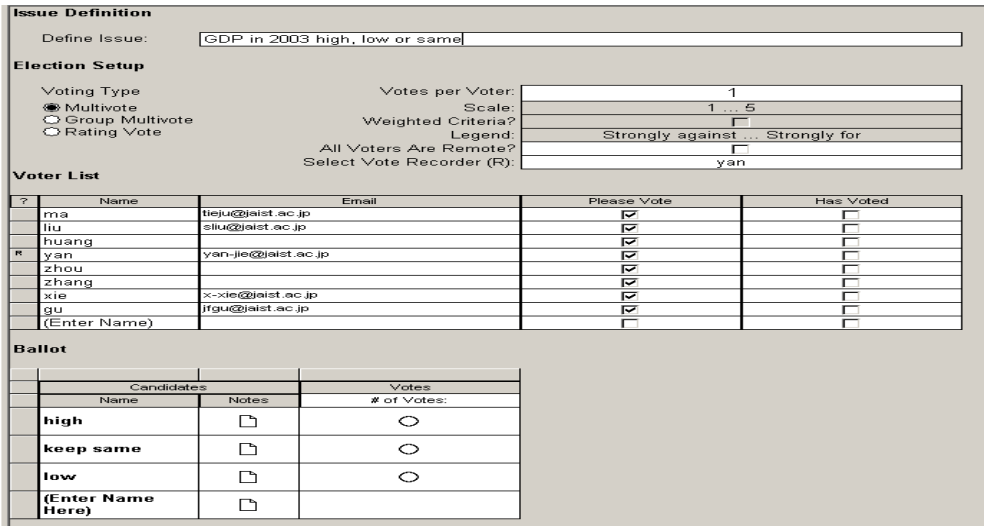


Figure 10. Voting for GDP Growth Forecast

An important concept in building consensus is consensus threshold, which is a relative value from 0-100. When the value is small, it means the users need strict consensus. When the value is big, the users don't need strict consensus. We voted on the three GDP growth trends, high growth, smooth growth and low growth. Every expert votes once. Figure 11 shows the result of voting. We can see middle class, low class and high class get 4, 3 and 1 supporter, respectively.

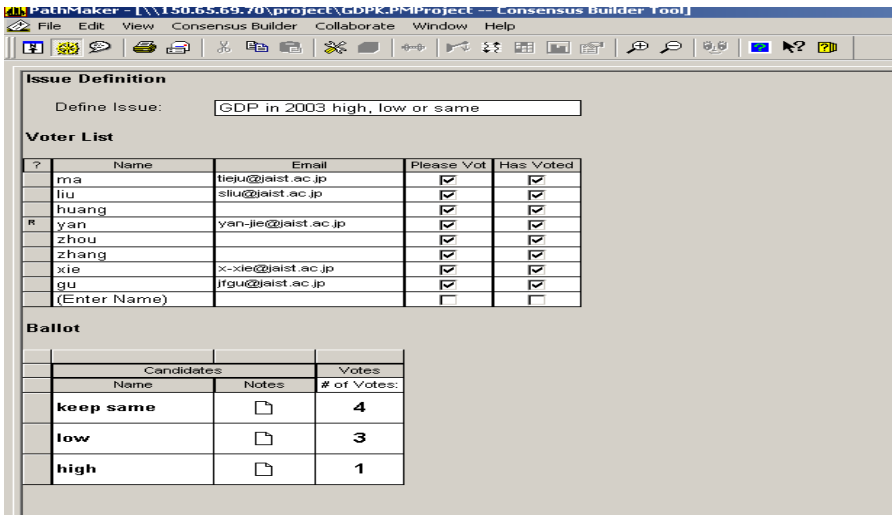


Figure 11. Voting Results for GDP Growth Forecast

As the qualitative meta-synthesis is finished, endeavours will be engaged on quantitative analysis - from qualitative to quantitative before Meeting II for quantitative meta-synthesis. According to our original flowchart we would do some quantitative analysis by a series of calculations based on different models. However, this time we couldn't access enough models to forecast GDP growth rate in advance. So this time, we skip this step and directly move to the discussion-meeting II. It is supposed that each participant apply one model for quantitative analysis based on discussions held in Meeting I.

Synchronous Discussion about GDP growth –Meeting II

In Meeting II, participants are no longer only experts in Meeting I. Decision makers are also invited. In our test, the chairman of MI serves as a decision maker in MII. After analysis stage every participant of Meeting II has a prediction about the growth rate of China's GDP in 2003. Then we synthesize their opinions based on weighted sum method. If given with same weight, the average of predictions given by all participants is 7.31%. If decision makers and general experts were given different weights ranging from 1 to 10, the weighted average of the predictions is 7.83%. In China, prediction result is always under discussion with senior or top decision makers again and again; usually top-level decision makers have heavy weight on the final decision. If we increase the weight of decision maker four times, the final prediction result of GDP growth rate goes up to 7.99%.

Comments on the Test

The whole test lasts several days (January 14-January 21, 2003). Actually the preparation meeting took the longest time at a total of 9 hour among all meetings in the test. Meeting I took 3 hour and Meeting II last 2 hour on separate days. There are many difficulties confronted, such as

1) Not enough data of GDP, so it is difficult to apply neural network model；
2) PathMaker is for group work, then of weak ability on complex computing; so the prediction result of GDP growth in this test is not so persuasive;
3) In the Force Field Tool of PathMaker, the analysis on the push and pull force is limited to be qualitative with strong subjectivity;

Also some bugs of Pathmaker were discovered. However, from the test, three systems of HWMSE are clearly reflected. Initially, difficulties about machine system were underestimated until much time was invested. The role of expert system is critical towards further processing of discussion. The whole testing process had been recorded for review. Those experiences practically acquired about applying MSA and HWMSE will be very helpful for further research in our NSFC major project.

CONCLUDING REMARKS

Since Professor Qian proposed the meta-synthesis approach in China, it became more and more popular, since the complexity of open complex giant system has been gaining more wide attention around the world. Recent developments in complex system modeling, decision support systems, artificial intelligence and relevant fields have been showing the inevitable trend to meta-synthesis (Gu & Tang, 2002). This test is just a partial effort in applying MSA and HWMSE to macroeconomic decision making.

As a matter of fact, Group 3 had developed some collaborative tools for meeting in HWMSE as shown in Figure 4, such as Electronic Common Brain (ECB) (Cheng & Zhang, 2001), Group Argumentation Environment (GAE) (Tang & Liu, 2002), which can both support Meeting I & II in our test. However, those tools still under further improvement and practical distributed applications. Technical integration is the first task in applying those tools. Further experiments will be taken to test those platforms developed by Group 3 people and explore the power of MSA and HWMSE.

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REFERENCES

Cheng, S.C. and Zhang P.Z. (2001). A Study of the Information Organization for the Design of Electronic Common Brain, Journal of Xi'an Jiaotong University (Social Sciences), 16(1): 42-47. (in Chinese)

Gu, J. F. (2001). "On Synthesizing Opinions – How Can We Reach Consensus", *Journal of Systems Engineering*, 16(5): 340-348. (in Chinese)

Gu, J.F and Tang, X.J. (2002). Some Trends in the Studies on Meta-Synthesis, in the Proceedings of the 46th Annual Meeting of the International Society for the Systems Sciences, Shanghai, August 2-5, No.195.

Gu, J.F., Wang, H. C. and Tang, X.J. eds. (2001). Special Issue on Meta-Synthesis and Complex System, *Journal of Systems Engineering*, 16(5).

Hu, D. P. and Wang, H. C. (2001). "Building Forecasting Model System in Workshop for Hall of Meta-Synthetic Engineering to Support Macroeconomy Decision", *Journal of Systems Engineering*, 16(5): 335-339. (in Chinese)

Shu, G.F. 2001. Meta-synthetic system reconstruction and application in macro-economic researches, Journal of Systems Engineering, 16(5): 349-353. (in Chinese)

Tang, X.J., Gu, J.F. (2002). Systemic Thinking to Developing a Meta-Synthetic System for Complex Issues, in the Proceedings of the 46th Annual Meeting of the International Society for the Systems Sciences, Shanghai, August 2-5, No. 126.

Tang, X.J., Liu, Y. J. (2002). A Prototype Environment for Group Argumentation, in the Proceedings of the Third International Symposium on *Knowledge and Systems Sciences* (KSS'2002), JAIST Press, Shanghai, August 7-8, 252-256.

Wu, Y. T. and Wei, L. eds. (2001). Introductions to Major Projects Sponsored by National Natural Sciences Foundation (1996-2000), Science Press, Beijing, 191-193. (in Chinese)

Qian X. S., Yu, J.Y. and Dai R.W. (1993). "A New Discipline of Science – The Study of Open Complex Giant System and its Methodology", *Chinese Journal of Systems Engineering and Electronics*, 4(2): 2-12.

Yu, J.Y., Tu, Y.J.(2002). Meta-Synthesis – Study of Case, Systems Engineering – Theory and Practice, 22(5): 1-7. (in Chinese)