Main TOC

SYSTEMIC THINKING TO DEVELOPING A META-SYNTHETIC SYSTEM SUPPORTED COMPLEX ISSUES*

Xijin Tang
Institute of Systems Science, Academy of Mathematics and Systems Sciences
Chinese Academy of Sciences Beijing
100080 P.R.CHINA
Email: xjtang@staff.iss.ac.cn

Jifa Gu
School of Knowledge Science, Japan Advanced Institute of Science and Technology
Tatsunokuchi, Ishikawa 923-1292 Japan

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. Around 50 researchers from 14 research institutes or universities are involved. They are divided into 5 groups or subprojects for better management by NSFC: Group 1. HWMSE platform; Group 2. Macroeconomic modeling; Group 3. Meta-synthesis method and macroeconomic method research; Group 4. Knowledge discovery and cognitive process analysis of macroeconomic decision making. There is another group in charge of whole system design, other 4 groups' work, and communications between NSFC and the project, as referred as Group 0 in this paper.

Besides concentrating on respective research tasks, each member institution also engages in their own interested issues based on their own past research achievements and understanding toward HWMSE. Therefore, bottom-up or emergent research brought out similar methods or tools for communications, collaborations or consensus building under the title of HWMSE. How to integrate all those research achievements reasonably is a big issue. Till now there are no decisive final solutions to this problem. We present our thinking to this issue in this paper. Not only limiting to the technological views toward what a HWMSE would like for our project sponsor, we take a systemic view to this issue

* Supported by Natural Sciences Foundation of China (Grant No. 79990580).

by applying *Wu-li Shi-li Ren-li* system approach. And also give our undergoing practice in our subproject (Group 3).

Keywords: Meta-synthesis, system thinking, *Wu-li Shi-li Ren-li* system approach

INTRODUCTION

The tide of system rethinking emerged with difficulties confronted in system practice on complex systems since 1970s. Researchers and system practitioners rethought over those analytical methods and explored effective methodologies towards complex problem solving (Tomlinson and Kiss, 1984). It is said analytic thinking was quite inappropriate to unstructured messy problems, rather than synthetic thinking. Gradually attentions were paid to eastern system thoughts. Pressman (1992), who synthesized the system inquiry and eastern mode of inquiry, mentioned the name of eastern system methodology. On the other hand, eastern researchers never stop in comparing thinking modes between eastern and western in their system research. They try to explore approaches which are easier accepted and practiced by oriental people under their oriental contexts. Both Chinese and Japanese scientists made their achievements at this field. Around 1990s, Japanese researchers forward *Shinayakana* system approach which emphasizes human support and interactive work during system modelling (Sawaragi, Naito and Nakamori, 1990). Later, they proposed *i*-System, which is a methodology including 5 subsystems (intelligence, imagination, involvement, integration and intervention) for developing knowledge creating system (Nakamori, 2000). Almost in the same period, Chinese scientists Qian, X.S. and his colleagues proposed meta-synthesis method to tackle with complex, open and giant systems (Qian, Yu and Dai, 1993). The method emphasizes the synthesis of collected information and knowledge of various kinds of experts, and connecting quantitative methods with qualitative knowledge. It was then successfully applied to socio-economic system engineering practice – a synthetic study of financial subsidy, price and wage. Later the method 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 HWMSE prototype for macroeconomic decision making under a budget of 5 million *yuan*, the largest investment for individual project by NSFC. Around 50 researchers from 12 nationwide research institutes or universities are involved. Those people are separated into 5 groups or subprojects: Group 1. HWMSE platform; Group 2. macroeconomic modeling; Group 3. meta-synthesis method and macroeconomic method research; Group 4. knowledge discovery, data-mining and cognitive process analysis of macroeconomic decision making; Group 0: overall system design, master coordination of those 4 groups' work and communications between NSFC and this project.

After 2-year research and development, lots of achievements had been made according to the original working plan submitted to NSFC. Several models for macro economy had

been developed and tested. Methods for synthesizing experts opinions, such as Delphi, analytical hierarchy process (AHP), etc. are also programmed into modules. At a mid-term summary meeting in the end of 2001, it was found that at least 4 meta-synthetic halls had been developed. Factually, the construction of Hall is the principal task for Group 1. Due to respective research focus, other groups also develop some simple halls to demonstrate process of from qualitative to quantitative, such as method group (Group 3) and KDD group (Group 4), and most of those halls support brainstorming, Delphi, and AHP. Group 0 people did not set up standard for system integration from the start of project implementation. Then finally they face the problem directly: how to integrate all ready work into a whole for the sponsor. Different views have been existing toward this problem since the start of the project. That is why no detailed overall design of HWMSE proposed from the start. And there are still no definite solutions after the mid-term summary meeting. As a member of Group 0 and also principal coordinator for Group 3, we propose our ideas for this issue.

First we analyze project implementation by our oriental *Wu-li Shi-li Ren-li* system approach, then present ideas about what a HWMSE would like for our project sponsor, followed by our undergoing practice in our subproject (Group 3).

PROJECT ORGANIZATION AND IMPLEMENTATION

The project is mainly for Professor Qian's theory on meta-synthetic engineering. As the meta-synthesis method was proposed, there were some projects to implement his ideas both in civil and military areas. However, there were no practical products which can really demonstrate the essence of the theory in China. Lack of support from both technology and further relevant theoretical research is among those reasons. Breaking advances in information technologies in recent years, especially networking and distributed computing technologies, provide advanced support to past bottleneck problems. Many imaginations have been turned into reality. On the other hand, lots of achievements with similar ideas to meta-synthesis method had been reached abroad, some of them are commercial products. It is time to take endeavours again. This time, NSFC called for proposals for HWMSE.

Initially, several organizations submit their applications for the project independently. After several round of evaluations, some units united, some invited others to enter. Rivals became partners to increase their application success. Finally all possible units are organized under a 3-level hierarchical framework as shown in Figure 1; then NSFC approved the project. The whole project is consisted of 4 subprojects or groups, as stated above. There is a heading unit at each group to facilitate communications and mediations between member units and Group 0. Initially, Group 1 takes main responsibilities for Group 0. One year later, each leading unit from each group was asked to contribute one young principal investigator, who, together with principal investigators from Group 1, formed a new master coordinating group.

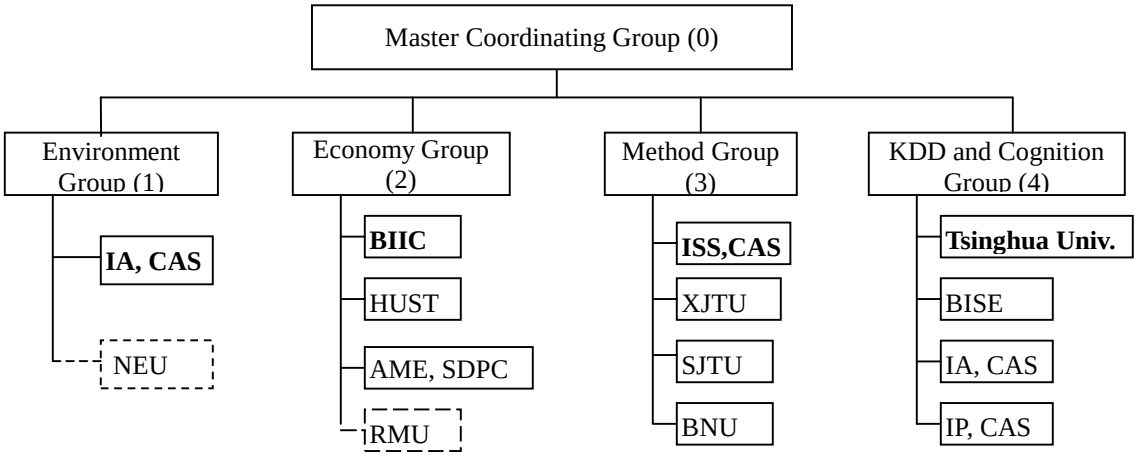

Figure 1. The Organizational Framework of the HWMSE Project

Where AME: Academy of Macro Economy; BIIC: Beijing Institute of Information and Control; BISE: Beijing Institute of Systems Engineering; BNU: Beijing Normal University; CAS: Chinese Academy of Sciences; HUST: Huazhong University of Science and Technology; IA: Institute of Automation; IP: Institute of Psychology; ISS: Institute of Systems Science; NEU: Northeastern University; RMU: RenMin University; SDPC: State Development and Planning Commission; SJTU: Shanghai Jiaotong University; XJTU: Xi'an Jiaotong University.

Figure 1's organization is factually a compromise among those involved units authorized by NSFC; therefore some hidden conflicts between group members are existed from the start. For example, BISE people had already developed a similar prototype of HWMSE. Initially they ran for HWMSE platform implementation. NSFC did not approve that application and still consider their past achievements, and assigned them to Group 4. Obviously BISE people are not satisfied with their position within the whole project. Some units quit at once, some other units joined even with no fund. Since it is a great honour to undertake a NSFC major project for those researchers in their organizations.

Since applying the project, the leading investigators of the projects proposed two questions for Group 3 people. 1) How to integrate experts opinions especially when those opinions are so different and conflicted during debates? Referred as *opinion synthesis issue*; 2) How to integrate current operable models and to construct new models for unknown problems? Referred as *model integration issue*. From the start, Group 1 people waited for new and better methods from Group 3. They also waited for macro economy models from Group 2. However, other groups waited for Group 0 & 1 to forward a top-down framework under which to take purposeful actions. Endeavours went into a dilemma for project implementation. With no unified framework, people begin to work with their own understanding toward HWMSE, and its support for macro economy decision making. Then after 2-year research, at least 4 meta-synthetic halls had been

constructed separately. Some other computer based discussion tools were also developed. Then Group 0 is facing a great issue, how to integrate all those accessible achievements into a satisfying HWMSE prototype for NSFC.

Here a CATWOE analysis is applied to this issue for a more comprehensive and further view of the project implementation. The mnemonic word CATWOE, proposed by Checkland (1981), denotes six elements (*customers*, *actors*, *transformation*, *Weltanschauung*, *owners*, and *environment* constraints), which should be considered to understand the observed system and build the concept model. In this project,

- ***C****ustomers* - Victims and beneficiaries of what the system does. NSFC is a big customer. Usually it is a time-consuming process to set up and approve a major project. NSFC expects effective performance of project implementation and first-rate results to enhance their own fame. Other possible customers are governmental institutions for macro economy policy making. That is why AME is invited to join the project.
- ***A****ctors* - Those who carry out the system activities. All participants are actors. They are organized into a hierarchical framework, which however cannot limit their research activities. Bottom-up or emergent research is taken and some communities with common grounds in meta-synthesis are formed beyond the top-down project organization due to different disciplines and objectives.
- ***T****ransformation* - The purposeful activity which transforms an input into an output. Obviously, input is NSFC fund and project participants, and output is a HWMSE prototype. Moreover, the output is a product which embodies knowledge and wisdom of involved people. Thus, knowledge conversion and creation include many micro transformations during the project implementation, such as from an idea into a computerized application, from an individual model into an accessible resource in the HWMSE for experts, from a theoretical method into a practical model about economic growth forecasting, etc.
- ***W****eltanschauung* - The world view which makes it meaningful to consider the system. First, the intention of NSFC funding is to develop a computer-based decision support product based on our own meta-synthetic ideas and theory. Thus, the final product owns knowledge property. Such kind of endeavours seems more necessary with tremendous advances in information technologies and global focus in complex system research in recent years. And to make full use of all accessible research resources in China leads to Figure 1's diagram by NSFC. How to better utilize those resources is task of Group 0. Researchers expected to engaged into this project not only to get necessary research funds, but also wish to achieve more results in complex problem solving and relevant fields. Such kind of objectives can bring rival applicants to

partners; while differences in viewpoints and benefits conflicts still lead to competitions and information blockage between participating units.

- ***O****wners* - Those who can stop the activity. Seemingly NSFC is the only owner. Actually all participants are owners to some extent, especially those leading investigators and leading units within each group. Since funds are first allotted to them by NSFC, then they assign funds to the member units affiliated to their group. They can stop fund unsuitable or unnecessary organizations. For example, initially NEU was a member in Group 1 according to the NSFC project plan (Wu and Wei, 2001). However they did not get fund and then quitted. On the other hand, RMU was not among participating units. Since their research in complex adaptive system and communications with Santa Fe Institute, and also their desire to join, they finally became a formal member in Group 2.

- ***E****nvironmental* constraints - The things in its environment which this system takes as given. NSFC is eagerly to see a prototype instead of theoretical papers with simple demonstrations by most NSFC projects. However, sponsor's intention to include nationwide best research units relevant to the project focus also leads to disharmony, unbalance and ineffective communications between project groups. Different knowledge background, different understandings about Professor Qian's theory on meta-synthesis method and HWMSE, different attitudes towards tasks for each group and towards relations between groups, and different research foci affect project implementing. Limited fund is also a big factor. So there are different technological solutions toward overall system design and system integration. Emergent activities also brought many solutions towards both opinion synthesis and model integration issues.

From the start, people had done much research with their own specific focus relevant to above referred 2 issues. As time goes on, the bigger issue for Group 0 people is how to transform all achievements by all project actors into an effective HWMSE demonstration for project owners and customers with very limited budget in the last 2 year. Here we refer it as *integration issue* in this paper. It not only concerns system integration, but concerns to integrate all resources including participants' knowledge, wisdom, etc. into a final demonstrative HWMSE prototype.

Pressures from other group members became more heavier than before. What are the *right* things worth efforts toward this issue? CATWOE analysis shows it is a complex problem from the start. And human factors play unavoidable and dominating role in searching a feasible resolution of the issue with so different worldviews from actors and customers, and changing environment constraints. Next we apply *Wu-li Shi-li Ren-li* system approach to this issue.

WU-LI SHI-LI REN-LI SYSTEM APPROACH TO THE PROJECT

Wu-li Shi-li Ren-li system approach is an oriental system approach whose core ideas had been under long practice before it was finally formally proposed by Gu and Zhu (1995). There are many papers about the approach itself, its applications (Gu and Tang, 2002) and comparisons with others system thinking (Brugha, 1999; Linstone and Zhu, 2000). In short, *Wu-li* explains the mechanism of what is concerned, *Shi-li* points out the framework of managerial tasks of making the best use of everything, and *Ren-li* is to make the best possible of human beings and to manage in exploring available potentials for a satisfying or reasonable result of whole activities (Gu and Tang, 1995). Here we try to see what kinds of *li*s relevant to our study in the project.

What is the *right* thing worth endeavors?

This refers to *Wu-li* aspect of the project and the concerned issue. Here it denotes to effective technological solutions of the integration issue.

Group 1's HWMSE platform is a web-based framework for distributed work. Users (experts) can register and log on to access to the resources (macro-economy models and opinions synthesis methods) during their discussion and debates on macro economy issues.. Actually, the workshop hall is similar to any chat rooms seen in the Internet except the hall has quantitative analytical resources and opinion synthesis methods support a convergent decision process. Delphi and AHP are principal methods to synthesize expert opinions. Component-based approach is applied to integrate macro-economy models and opinion synthesis methods into Group 1's platform. Each individual model or method is encapsulated into a component. For mid-term NSFC evaluation, only a few models or methods, mainly from each leading unit at Group 2-4 in Beijing, were considered for integration due to time and location limitations. The integration was a time-consuming process for both developers of those individual models and interfacing engineers in Group 1. Component-based integration also brings more burdens to those interfacing engineers. For example, opinion synthesis method is usually based on the process of a meeting. Different kind of meetings may need different processing. As methods developers only submit a method component, while computerized work on meeting process fit for that method transferred to interfacing people. There are many successive problems, e.g. how the meeting facilitator formulates the procedures for his organized meeting and his selected synthesis method? It is necessary to provide meeting templates instead of only synthesis methods for users. But then the interfacing for templates integration seems impossible in practice, as there are different programmed structures about a meeting.

Since owners of methods and models only concentrated in transformed those individual and independent applications into components for HWMSE, Group 1 people use a chat room directly connected to synthesis method and macro economy models to overcome this shortcoming. Group 0 people wrote a comprehensive script about economic growth

forecasting and to construct a scenario in the demo where those integrated those models and methods could be applied to on-line expert debate for mid-term NSFC expert evaluations.

There are many problems toward such style of solution towards integration issue. 1) Time consuming. It took at least 1 month to integrate one economy model into the platform and make it operable. If interfacing work for some other models was not successful, those models were not exhibited for expert evaluations. Such omissions affect the evaluations for those models' developers and their affiliated group. Obviously, integration of more models from other units will be very hard and expensive, especially considering the communications and co-operations between Group 1 and other group members which are not in the same city. It is also labour consuming. Coding and debugging for interfacing work demand much labour. 2) Centralized control of resources. The platform supports distributed users who can access to centralized resources that are integrated into the main server. If the server stops working, resources could not be used. Other groups who had their own halls had two ways for integration. One is only to contribute their methods as components, as recommended for mid-term NSFC evaluations by Group 1 people. The other is not included in the platform. The first way demands tight and continuous communications and collaborations among interfacing people, which are as a matter of course not practical for all group members. The second cannot be acceptable and will also affect actors to gain appropriate evaluation from project owners who usually care the final achievements instead of implementation process.

So is it the right thing to follow framework with centralized control of resources? Even though it was an efficient way to integrate limited resources successfully within short period for mid-term NSFC evaluation, it may not be efficient when to integrate more resources. Moreover, such kind of implementations lacks effectiveness especially for those competitive partners. Group 3 people have explored much in this issue (Gu, Wang and Tang, 2001). A prototype of agent-based integrative design had proposed for distributed management of models (Hu and Wang, 2001). The ideas need further reviews with those factors analysed in CATWOE analysis.

Component-based and agent-oriented techniques are hotly discussed in software engineering field. Component-based design has been said to make a revolution in software engineering with object-oriented perspective, especially increasing the speed of the development and the capabilities of software systems on integrating previously-existing software components. While agent-oriented perspective represents an exciting new means of analysing, designing and building complex software systems. It is expected to significantly improve current practice in software engineering and to extend the range of applications that can feasibly be tackled. Actually component-based is relevant more with implementing techniques while agent-based with the design philosophy.

For an efficient implementation of technological solution to the integration issue, a feasible systemic design is the first necessity. Multi-institution, multi-discipline and multi-objective are big drives to discard centralized framework and apply distributed framework in order to integrate all resources and all achievements. Then next issue is how to fulfil such a task? How to achieve a systemic design?

How to fulfill the *right* tasks?

This refers to *Shi-li* aspect in this project. Here it denotes to issues in efficient implementation of the technological solutions.

During the first 2-year research, the method group proposed feasible prototype for model integration issue using agent technology to support for macro economy decision making and explored expert opinion synthesis issue extensively (Gu, 2001; Tang, 2001a). It could be said that method group provide feasible solutions and also provide demos for Group 1. However, those ideas were not accepted or understood by other people, especially Group 0 before mid-term evaluations. It is necessary to rethink the integration modes so as to disseminate those feasible ideas effectively. Here 4 modes for integration issue are considered.

1. *Top-down and centralized mode*

The premise for such mode is a centralized top-down design. Implementations have to follow the design strictly for successful integration of all modules. The coordination between modules is centrally controlled. A simple example is applications based on mainframe computer system. Nowadays mainframe is out of date, as it is difficult to fit for environment changes. However top-down designs always exist. Such mode is still feasible for small or specific integration system.

2. *Top-down and distributed mode*

The resources for integration will be under a unified framework, while coordination between resources is not fully centrally controlled. But the whole activities are under unified framework for specific purposes. Compared with the first mode, the control of resources goes down for this mode. Our project accords with this case. Now we are exploring a better top-down framework to integrate all accessible distributed resources (computer applications) into a HWMSE for NSFC final evaluation.

3. *Bottom-up and centralized mode*

The resources are emerged or produced with bottom-up activities, such as research results by one interest community. There is no tight control of members in one community. The members communicate by common interest. And then may be united for cooperation. They may finally go into collaborations for specific missions while all accessible resources owned by community members will be placed into a purposeful framework. Still take our project for example. When applying the project, some units united in order

to win the project from their rivals. At that time, the resources for application are centralized managed temporarily.

4. Bottom-up and distributed mode

The best example for this mode is Internet, which is growing with more and more resources accessible globally.

The accessible resources in our project are actually achieved by bottom-up research. Even with no such project, people still engage in explore their interested topics with other research funds. Such a project may drive them explore specific problems. For example, the main task for Group 2 is macro economy modelling. HUST people applied case-based reasoning approach to financial crises warning. Moreover, they also propose their HWMSE prototype as a by-product, since they have strong research in decision analysis method. However, Group 1 had no plans to integrate the 'extra' opinion synthesis methods, since it is not under their top-down framework used for NSFC mid-term evaluation and they are reluctant to assign labour to do 'extra' interfacing work for HUST method. By our views, such an omission is a kind of waste of resources (HUST methods).

Here, we study the expected framework from utilization views. The aggregation of all resources is for complex problem solving. Comprehensive and further discussions of the unknown problem is one step to identify problem and search some structures of the issue for further analytical work. Four ready HWMSE platforms can obviously provide effective support, especially for distributed discussions. While the other 3 HWMSE platforms are not mirrors of Group1's, as most web sites do in the sake of quick access and reliability. They have respective specific considerations in synthesis of expert opinions other than Group 1's. Since past practical experiences bring those people advantages in specific problems. For example, when discussing how investments will pull the economic growth in western area, HWMSE in Xi'an (Group 3) can organize local experts and send a synthesis report to HWMSE in IA (Group 1). By such a way, it is unnecessary to really store all methods by XJTU people into main server by Group 1, while XJTU's work is practically included into the final product.

Considering the resources' integration from utilization perspective instead only from technology perspective can also release labours from many interfacing tasks. Appropriate supporting technology is needed. Agent-oriented technology supports such kind of view transfer. However, such a change in implementing technology is not good for Group 1 people. How to deal with those issue in view transfer?

Shall we accept all ideas and satisfy all actors?

This refers to *Ren-li* aspect in this project. Here it denotes to human and organizational issues in effective implementation of the systemic design.

Different understandings towards Qian's theory of HWMSE, different research interests and foci, and different objectives bring different or even conflicted actions during project implementation. For respective benefits, every group tries to take the project's advantage to expand or strengthen their influence in the relevant communities. Above CATWOE analysis has explained those conflicts due to project organizational framework and ideas of resources integration.

If for centralized integration, Group 0 should give overall design from the start. The set-up of Group 0 borrows successful project management practices from China aerospace industry. However, there are still essential differences between a basic academic research project and a space flight project. The latter is actually a hard systems engineering project. An overall system design and concrete indicators will be given from the start. And Overall Design Group has full authorities of all affairs in the project. If facing some problems, Overall Design Group proposes queries to the second level working group, who will trace down to the bottom group for a definite answer. Such a hierarchical framework guarantees an efficient operation of the whole project for definite goal, i.e. a successful space flight. Out project is not as hard as space flight program. The influences of Group 0 in this project are obviously not so authoritative, and some lower group members also continually question the performance of Group 0. On the other hand, even as almost all member units declare to support the centralized integration design, Group 1 people cannot afford to integrate so many opinion synthesis methods because they need to modify their current discussion room.

The mid-term evaluations also had shown the advantages and disadvantages of centralized resources integration to all project members. Centralized control of models may give the evaluators such an impression those models are developed by Group 1 people, which cannot be acceptable by original developers. Moreover, centralized control is not convenient for models' maintenance by original owners. On the other side, decentralized management of resources is convenient for users to access and for original explorers' further improvements.

Conflicts among some member units led to few possibilities of collaborations between them. A centralized control will only satisfy the controller. A distributed management welcome participation of all members. Actually, centralized mode does not work well in practice. It is impossible to satisfy all actors even from the start. The openness and relative easiness in aggregation of distributed resources also provide friend interface to resources makes. A community with similar views emerged beyond the original project organizing structure. The community members come from different units at different groups in the project. It is a practical support for distributed integration of all accessible resources. Here we regard it as community intelligence to overcome administrative power in messy problem solving.

Next we present our thinking to system integration issue using distributed mode.

FRAMEWORK FOR HWMSE IN THE PROJECT

Figure 2 displays our proposed framework for HWMSE in this project. Such a framework adopts ideas from DecisionNet (Bhargava, Krishnan and Muller, 1997). Tang (2001b) proposed three approaches (top-down, bottom-up and systemic approaches) for model integration and listed DecisionNet as a typical example for bottom-up approach. DecisionNet, a collection of decision analytical tools, aims to improve the usability, interoperability and reusability of decision technologies by exploiting these strengths of Web technologies. HWMSE is for a process from qualitative to quantitative which includes both analysis and synthesis technologies.

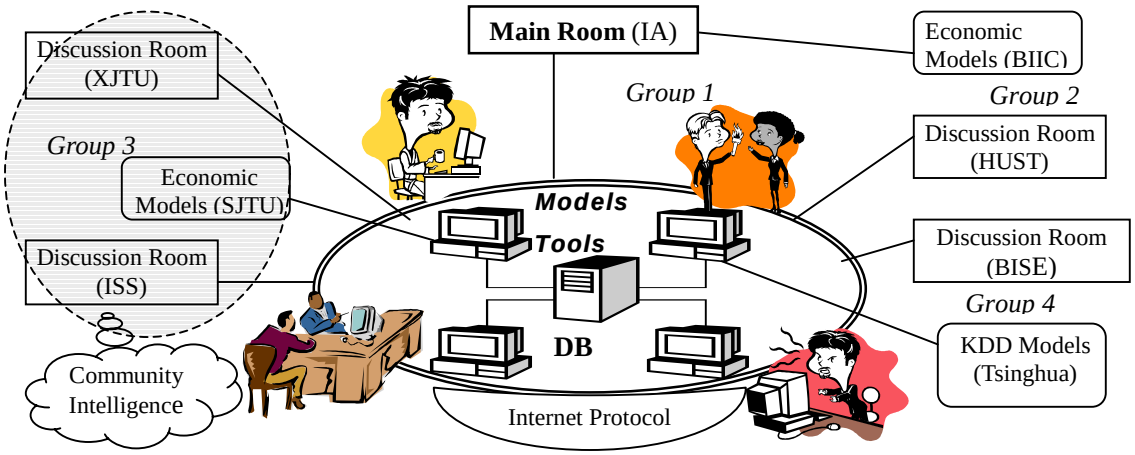

Figure 2. A Framework for HWMSE

According to current achievements from all members of the project, there will be at least 5 discussion spaces to the end of project. Just like most convention centres in reality, we construct a big web-based convention centre (Hall) specific for various workshops. Group 1's platform is the main hall or main room of the 'building'. Other platforms are general rooms for workshop. Macro economy models can be stored in servers where run those platforms or independent servers. As opinions synthesis tools support different meeting styles and each discussion room has special tools, administrators of each discussion room will recommend appropriate workshop for meeting organizers. Sometimes, organizers select one room while meeting template is not available, there are

two solutions based on current situations. One to move to available rooms; another is to remote use of tools or templates in other rooms or other independent servers. Ideally, users do not know where those resources exist, only organizers set up a virtual room with necessary resources for problem discussion.

Figure 2's framework is applied to the integration of their exploring results in Group 3 people. A possible meeting process utilizing HWMSE resources for macro economy problem is shown in Figure 3.

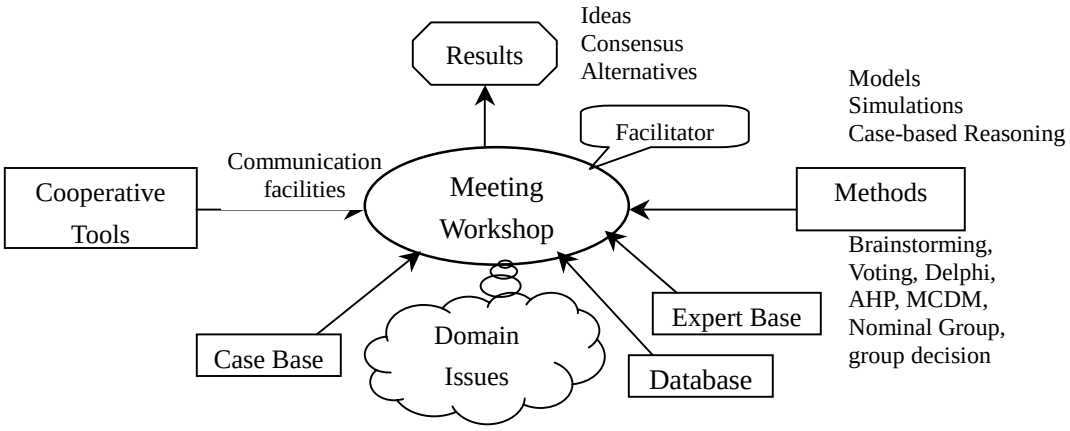

Figure 3. A Meeting Process Utilizing HWMSE
MCDM: multiple criteria decision making

To deal with unknown problems, expert meetings will be organized. Expert base will provide basic background for meeting organizers, which usually serve as facilitators during the meeting. All participants make full use of resources such as communications facilities, cooperative tools, models and methods to support relevant activities during the argumentation process, such as review all topics, propose own arguments, call accessible models to analyse interested arguments, etc. If for a convergent decision process, voting, Delphi, AHP, etc. may be used to achieve some consensus toward concerned issues. If for divergent thinking process, brainstorming template is applied. We can use brainstorming to aggregate as much as possible ideas toward concerned problems. In Group 1's platform, the participants' conversations are only displayed as texts like most chat rooms in the Internet. There are no analytical methods to process all acquired information. ISS people develop a template for brainstorming meeting and implement a visual analysis tool to display both participants' conversations and keywords within a 2-dimenstion space. Such visualization aims to help participants review past conversations, initiate their creative associations and find common grounds about the concerned issue. Visualized analysis for argumentation process is useful to get creative ideas toward some structure of unknown or complex problems during a divergent thinking process. Figure 4 shows a visualized analysis of all participants' conversations during a discussion about factors which may affect economic growth. Such a discussion is important to confirm parameters for some economic models. By visualized summary of all conversations, it is easier to find hot topics among participants. However, those conversations or keywords scattered sparsely might also be among contributing factors but are not noticed by the majority.

Figure 4. Visualized Analysis of a Discussion

REMARKS

In this paper, we analyse a major NSFC project by *Wu-li Shi-li Ren-li* system approach. The project is to develop a demonstrative prototype of hall of workshop for meta-synthetic engineering support for complex problem solving. More than 10 academic units involved into the project. Even there exists a structural framework towards organizing those units, the genuine research activities are almost bottom-up happened in each individual unit based on their own understanding toward complex problem solving. Few serious top-down designs were not given from the start of the project also contributes to such a phenomenon. Seemingly all endeavours are under unstructured and inefficient organizing. The emergence of a variety of solutions towards various aspects of macro economy problems, expert opinion synthesis and model integration seems to result in a messy situation for system integration.

After WSR analysis, we present our thinking towards how to integrate those versatile achievements effectively into a demonstrable HWMSE prototype for project sponsor (NSFC). Instead of concentrating technological solution toward integration issue (complex problem in this project), we pay attention to how to use the expected final product for complex problem solving. Four modes about resources integration issue are given based on under what kind of organizing style those resources appear and how to manage those resources for utilization. Then we recommend a framework for final

integration of all academic achievements from all group members. Actually, debates still exist in the undergoing project toward this complex problem.

REFERENCES

Bhargava, H. K., R. Krishnan and R. Muller (1997). "Decision Support on Demand: Emerging Electronic Markets for Decision Technologies", *Decision Support Systems*, 19(3): 193-214.

Brugha, C. M. (1999) A Cybernetic Model of Thinking Progresses for Use in Oriental/Occidental Mutual Understanding, presented at the special cluster *Methodology for Analyzing Complex Societal Problems*, presented at the 15th Triennial Conference of International Federation of Operational Research Societies (IFORS99), August 16-20, Beijing, China.

Checkland, P. (1981). *Systems Thinking, Systems Practice*, John Wiley & Sons, Chichester.

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. (1995). "W-S-R System Approach to a Water Resources Management Decision Support System", in *Systems Methodology: Possibilities for Cross-Cultural Learning and Integration* (proceedings of the First UK-China-Japan Workshop held in Beijing, China, G. Midgley and J. Wiley eds.), The University of Hull, United Kingdom, 41-48.

Gu, J.F and Tang, X.J. (2002). "An Oriental *Wu-li Shi-li Ren-li* System Approach to OR Practices in CHINA**",** presented at the16th Triennial Conference of International Federation of Operational Research Societies (IFORS99), July 8-12, Edinburgh, UK.

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).

Gu, J.F and Zhu, Z.C. (1995) "The *Wu-li Shi-li Ren-li* Approach: an Oriental Systems Methodology", in *Systems Methodology I: Possibilities for Cross-Cultural Learning and Integration* (G. Midgley and J. Wiley eds.), The University of Hull, United Kingdom, 29-38.

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)

Linstone, H. A. and Zhu, Z. (2000). "Towards Synergy in Multiperspective Management: an American-Chinese Case", *Human Systems Management*, 19(1): 25-37.

Nakamori, Y. (2000). "Knowledge Management System toward Sustainable Society", in proceedings of International Symposium on *Knowledge and Systems Sciences:*

Challenges to Complexity (E. Shimemura et al. eds. KSS'2000), Japan Advanced Institute of Science and Technology, Ishikawa, Japan, 57-64.

Tang, X. J. (2001a). *Toward Consensus Understanding and a Distributed Computerized Approach*, Research Report, Japan Advanced Institute of Science and Technology, Ishikawa, Japan.

Tang, X. J. (2001b). "Model Integration", proceedings of International Symposium on *Knowledge and Systems Sciences: Challenges to Complexity* (KSS'2001), Japan Advanced Institute of Science and Technology, Ishikawa, Japan, 285-296.

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.

Sawaragi, Y. M. Naito and Y. Nakamori (1990). *Shinayakana* Systems Approach in Environmental Management, Proceedings of 11th World Congress on Automatic Control: Automatic Control in the Service of Mankind, Pergamon Press, Tallinn, USSR, Vol.V, 511-516..

Tomlinson R and Kiss I, eds (1984). *Rethinking the Process of Operational Research and System Analysis*, Pergamon.