Proceedings of the 2009 IEEE International Conference on Systems, Man, and Cybernetics
San Antonio, TX, USA - October 2009

Meta-synthetic Seminar Hall for Power Supply and Demand Research

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***Abstract*—The complexity and uncertainty of prediction on power supply and demand are analyzed in this paper, and studies the meta-synthesis method of man-computer integration from qualitative analysis to quantitative analysis. The meta-synthetic seminar hall system for power supply and demand research is designed and implemented. The system integrates power economy information, knowledge and experience of experts, computer simulation, and computing capacity. The mode of meta-synthesis from qualitative analysis to quantitative analysis is adopted to construct the intelligent system, which can support research, meeting and decision-making related to power supply and demand. And, the system can support experts to synthetically analyze and evaluate the important data depended by power supply and demand, e.g. policy environment and external condition, and the analytical results. More scientific, reasonable and quantitative scheme for decision-making can be obtained by this system.**

***Keywords*—Meta-synthesis, decision support, power supply and demand**

I. INTRODUCTION

The electric power demand and supply research is a typical complex problem, it is not only involving the production, supply, operation and other factors in electric power system, but also related to many fields, such as macro-economy, macro-policy, producing and transportation of energy, weather etc., each factor is complicated and volatile, and introduce many uncertainties to electric power demand and supply research. The economic system is very sophisticated, the economy growth is affected by many policies which are mostly uncertain. According to the economic situations, it is difficult to anticipate what policies will be taken and how many efforts will be put in, these policies and measures will affect the power supply and demand by influencing the economic activities. The climate and hydrology affect not only the hydropower generation capability, but also the peak load, but the climate changes are very complex too. Although the short-term climate forecast can be relatively accurate, the uncertainty of long-term climate forecast is greatly increased. The emergencies such as the blizzards, the hurricanes, the floods, the earthquakes can influence the power supply and demand greatly, but the forecast of these emergencies is still a worldwide difficult problem. It is difficult to solve the semi-structured or unstructured problems such as economy, policy and to quantify some quantitative problems through traditional models, all these problems should be solved through more scientific and effective methods. Qian Xuesen and other Chinese scientists put forward the meta-synthesis theory[1,2], which emphasizes solving complex system problems through integrating experts, computers, information and knowledge. In order to solve some main problems of electric power demand and supply, based on the meta-synthesis theory, using the techniques of internet, database and data warehouse, computer simulation, multimedia, collaborative work etc., this paper builds a hall for workshop of meta-synthesis of electric power demand and supply research.

In this paper, the basic theory of meta-synthesis and hall for workshop will be introduced in section II, structure of the hall for workshop of meta-synthesis of electric power demand and supply research will be studied in section III, a case study will be shown in section IV, finally, the conclusion will be given in section V.

II. META-SYNTHETIC ENGINEERING

Meta-synthetic Engineering is a methodology to solve complex system problems, which was put forward by Chinese scientist Qian Xuesen in 1989. The method emphasizes to exert the advantages of integrated system to solve problems by integrating export group, data, all kinds of information and computer simulation, integrating all kinds of theory and the human experience and knowledge. In 1992, the scientists further proposed to establish the Hall for Work Shop of Meta-synthetic Engineering (HWSME), which is an application form of the methodology. The essence of HWSME is to establish an intelligent man-computer cooperated system by integrating expert group, statistical data, information resources and computer techniques.

From qualitative analysis to quantitative analysis, meta-synthesis and discussion are the key subjects of HWSME. From qualitative analysis to quantitative analysis means transforming qualitative variables to quantitative variables by combining experts' qualitative knowledge with quantitative results of many models. The structured problems can be solved through quantitative models, the unstructured problems can be solved through qualitative analysis, the semi-structured problems can be solved through the method combining qualitative analysis to quantitative models. Meta-synthesis means integrating all kinds of resources including experts' knowledge, models, database and so on. Discussion means the group collaborative work between the researchers, they can use the qualitative and quantitative models, database and other tools, discussion can achieve effective man-computer cooperation.

978-1-4244-2794-9/09/$25.00 ©2009 IEEE

There are many researches on meta-synthetic engineering and hall for workshop of meta-synthetic engineering at home and abroad, the related theories and techniques have been into practice in macro-economy decision, military strategy decision and other fields.

Compared to the decision support system (DSS) or organizational decision support system (ODSS), the experienced experts are the important part of the HWSME, which is a man-computer cooperated system. On the other hand, the interaction between experts system and the models is especially emphasized in the decision course, in HWSME the experts are not only the decision makers, but also the providers of knowledge and skills.

There are many domestic applications of HWSME, Dai Ruwei, an academician of Chinese Academy of Sciences, developed an HWSME to support the macroeconomic synthesizing, and analyzed the situations and policies of china in 2003. Si Guangya and Hu Xiaofeng[3], researchers of National University of Defense Technology, developed an HWSME for strategic decision. The other applications can be referred in [4-7].

The abroad researches mainly focused on earth sciences, environment sciences, medicine, space sciences, engineering design, economy, society administration, etc. such as the complex science, proposed by Santa Fe Institute, and many studies in ecological system, economic system, human brain system. Japanese experts proposed the Shinayakana systematic methods to deal with the environmental complex systems, it is emphasized that the combination of mathematical models and human intuitive judgments, especially the man-computer dialog. The human capability can be perfectly utilized to adaptively cope with the sophisticated problems.

III. THE CONSTRUCTURE OF POWER HWSME

A. The Construction Goal of Power HWSME

The Meta-synthetic Seminar Hall for Power Supply and Demand Research (Power HWSME) is built to research the external or internal factors and the complex relations which are arising in the power supply-demand analysis, forecast, early-waning, to research the sophisticated problems, to which the techniques of multi-fields, multi-view, qualitative-quantitative combination are needed. The main goal of the Power HWSME is to support the combination of qualitative and quantitative problems in the specific fields, at the same time, the other functions such as the flexible group discussion platform, information resource environment, problem decomposing tool, opinion synthesize tool must be provided too.

According to the practical researches of the current analysis or forecast of the power supply and demand, the following topics are necessary to be discussed or studied in the Power HWSME:

- The effects of macro policies, such as financial policies, loan policies, monetary policies, investment policies, industry policies;
- The growth of macro-economy, such as GDP, three industries, important sectors;
- The comprehensive analysis and evaluation of the power supply and demand balance, the power supply and demand early-warning;
- The climate analysis of main regions and runoff forecast of main river basins;
- The motivations analysis of the investment, consumption, export and import;
- The analysis of the amount or structure of macroeconomic, the relations between economy and power demand.

B. The Architecture of the Power HWSME

The Power HWSME is consisted of the expert system, the computer system and the power information or knowledge system.

The expert system is grouped by the experts in power energy, the experts in macroeconomic, and experts or researchers in other related fields. The role of the expert system is reflected on the application of the expert's experience, idea, intuition, which is difficult for computers to simulate.

The computer system is consisted of technical support system, network communication equipments, servers, storages system, clients, and other software or hardware, it will provide mass storage capacity and high performance calculating capability.

The power information or knowledge system is consisted of power data, information and knowledge, which include the info or knowledge in the other related fields, the info or knowledge of analyzing and synthesizing, the models and methods based upon the above info or knowledge.

Three parts are integrated to a whole system, which is a unified, man-computer cooperation platform to support the research of power supply and demand, to support the decision making.

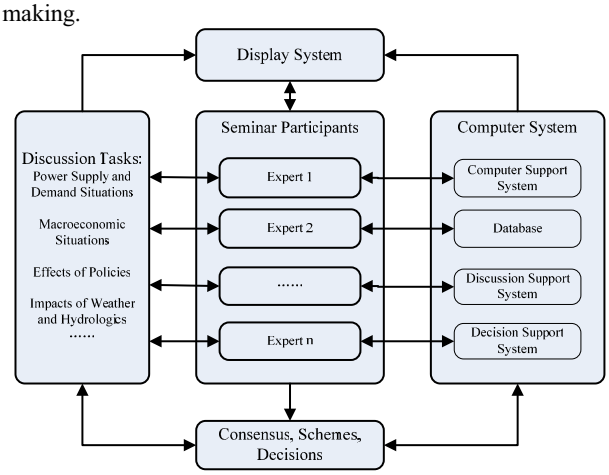

Fig.1 The Architecture of the Power HWSME

C. Functions of the Power HWSME

The main function of the Power HWSME is meta-synthetic seminar, the other functions are net meeting, data analysis, seminar support, decision support, system management.

1) The net meeting

The net meeting function can provide experts the most fundamental communicating environment and tools. On the

special seminar client or PC, using the keyboard, mouse, microphone, input board, voting machine, camera, the information input, opinions exchanging, material sharing can be realized. This system supports not only the simultaneously and locally centralized discussion, but also the distributed discussion on the intranet or internet. The detail functions include:

- The information input – audio input, video input, text input;
- The information communicating – free discussion, group discussion, deeply discussion;
- The information displaying – meeting groups, meeting agenda, expert's speech and meeting status;
- The information sharing – data sharing, file transferring, electronic whiteboard, desktop sharing;
- The remote control and adjusting – providing remote assistance point to point, helping remote user to set the devices or HWSME system.

2) The data analyzing

This function supports the visually online query, analyze, display the power or economic data in the database, display the analyzed or forecasted results, it can be used to manually input data, import related external data, furthermore, to analyze and display these data. It is easy and flexible to call the existing models such as time series analysis models, regressive models, grey models and so on, the Power HWSME can integrally call the models programmed with Matlab or GAMS languages, and return the call results.

3) The discussion supporting

The power HWSME provide many technical tools to support the divergence and convergence discuss, including the problem analyzing tools, opinion analyzing tools, discussion recording tools. The problem decomposing tools are used to hierarchically decompose the specific problems level by level, and decompose a complex problem to the multi-grade sub-problems.

The opinion analyzing tools are used to online or offline analyze the expert's opinions and ideas, there are two main parts: the question surveying and the speech evaluating. The question surveying is a tool to flexibly and easily design or edit questionnaires, to automatically deliver and collect the questionnaires based on the instant message mechanism, to automatically analyze and count the questionnaires, and to intuitively display the analyzing result of the questionnaires. The speech evaluating tool is mainly used to analyze the opinions and suggestions which are proposed by experts during a seminar, and visually show the analyzing result with opinion structure charts and opinion relation charts.

The discussion recording tools can be used by the meeting secretary to entirely record the seminar.

4) The decision supporting

The decision supporting tool can be used to synthesize the expert's opinions, to achieve a consensus or an optimal scheme about the specific topics after a full discussion. There are three opinion synthesizing models: the grouped analytic hierarchy process (AHP), the expert investigating method (Dephi), and the fuzzy consensus method. These models are suitable for many kinds of convergence discussion issues, which will be synthetically discussed.

5) The system management

This module is mainly used to set or manage the discussion topics, meeting agenda, seminar template, related resources and expert info. The function of seminar topics management is to plan and create the discussion topics. The function of seminar agenda management is to set the detailed course of every sub-seminar. The seminar template management is used to store seminar agenda template, synthesized evaluating template, questionnaire template. The function of resource management is to link the discussing model to the specific data, models, document and so on. The expert management is used to maintain the expert information database.

D. The seminar agenda

There are two themes among the discussion: the first one is solving the problem, the main duty of which is to form the organization and agenda of the seminar, by way of choosing different seminar patterns and problem analysis techniques for the sub-tasks at different levels, and based on the task decomposing and task flow. The other theme is the knowledge circle, by way of choosing the knowledge, applying the knowledge and the information feedback, the circulation between the experts and the HWSME will be accomplished, the job of HWSME supporting the experts will be implemented too.

IV. THE CASE STUDY

The worldwide financial crisis which was triggered by American sub-prime lending crisis deeply affected china macroeconomic and power industry. The main effect is that the export processing enterprises continuously stop or reduce their production, then the import rapidly declined, the electricity consumption significantly declined too. In order to cope with the financial crisis, the Chinese government issued many policies and actions to stimulate the economy, such as additional 40 billion Yuan investment, raising the export tax rebate rate, subsidizing appliances to the countryside, and so on. These above factors make the present power supply and demand research more complicated, it is impossible or difficult for relatively isolated experts to determine the macroeconomic situations, the power supply and demand situations, because the expert's knowledge and experience are not sufficient to cope with the sophisticated meta-synthetic system, so we invited 6 experts, who are professional in administration, economist, industries administration, energy producing, power supply and other fields, worked in the Power HWSME to study the macroeconomic situations of China. The seminar procedure is:

1) Firstly, the meeting secretary will make the seminar ready, such as the contents, agenda, topics, messages of the seminar;
2) The experts will deeply discuss the hot topics and difficult topics after they freely discuss the macroeconomic situations of 2009;
3) Using the analytic hierarchy process (AHP) and nominal

According to the proportions of three industries, the China GDP of 2009 will growth 8%, and the electricity consumption will increase about 4.7%.

Fig. 2 The Macro-economy of China in 2009

4) To create the related seminar reports, analysis and forecasted results.

V. CONCLUSIONS

By analyzing the complexities and uncertainties of power supply and demand research, the necessity of introducing the meta-synthesize technique is obvious. The ideas and techniques of meta-synthesize or HWSME played a key role in the building of Power HWSME.

Guided by the meta-synthesize theories, and focused on the requirement of the important policies, external conditions and decision supporting which are all related to the power supply and demand, the HWSME for power supply and demand (Power HWSME) was developed with the information techniques and decision supporting techniques. In the Power HWSME, some experts have studied China macroeconomic of 2009, many macroeconomic indicators are analyzed and forecasted, the forecasted GDP growth rate should be 8%, and the electricity consumption will increased 4.7%.

The Power HWSME should be gradually improved to respond many complicated problems in the practical researches, according to the different types of seminars, it is necessary to gradually strengthen the opinion analyzing templates and seminar agenda templates, and increase their usability and intuitive. The theoretical foundation of Power HWSME is the meta-synthesize which is verified an effective theory to study the macroeconomic and power supply and demand.

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