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Japan Advanced Institute of Science and Technology

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Metasynthesis and Knowledge Creation

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ABSTRACT

The metasynthesis system approach (MSA) proposed by Qian et al has closely related to the knowledge creation. When we run a major project related to the realizing the MSA supported by National Natural Science foundation from 1999 to 2004, we found the knowledge creation process has been materalized also in this project. We have used the Wuli-Shili-Renli system approach to explain the Renli aspect for creation and used the complex network, especially social network analysis to describe the creation process in this major project quantitatively.

Keywords: Metasynthesis System approach, Knowledge creation, Wuli-Shili Renli, complex network

1. INTRODUCTION

During our staying in the school of knowledge science, Japan Advanced Institute of Science and Technology (JAIST) we had learnt a lot from our Japanese colleagues in the fields of knowledge science, we found that in this school there are four directions for knowledge science:

1) Knowledge Management;
2) Knowledge Engineering;
3) Knowledge creation;
4) Knowledge System science.

At the same time we had joined a major project titled in "Metasynthetic systems with combination between man and machine for decision support of macroeconomics" (1999-2004) supported by National Natural Science foundation of China (NSFC). Since this project involved four subprojects and 14 universities and research institutes. The entire research process covered more than four years and published 385 articles and more than 300 activities had organized. The number of keywords from 21 in 1999 rose to 298 in 2004, which shows the growth of new ideas and terminologies or the growth of knowledge creation. We found that the EO-SECI model may describe our research process well. In this paper we not only wish point out the relation between MSA and Knowledge creation, but also try to use the social network analysis to analyze this knowledge creation process quantitatively

2. KNOWLEDGE CREATION

For the knowledge creation we may divide it into some aspects:

(1) *Theory and concept for Knowledge creation,* Nonaka's *SECI model*(S-Socialization, E-Externalization, C-Combination, I-Internalization) for the knowledge conversion and the concept of *Ba* as the environment for creation [1], Nakamori's ***i**-system* (***i***ntervention, ***i***magination, ***i***nvolvement, ***i***ntelligence and ***i***ntegration) methodology for knowledge creation [2]; Kunifuji and Sugiyama's knowledge creation support system [3]; are important research directions for knowledge creation, especially in JAIST

(2) *Knowledge creation techniques,* such as Brainstorming, Morphological analysis, Synectics in West; KJ method, ZK method, NM method in Japan;

(3) *Knowledge creation support system*, such as Idea Fisher, Inspirations, Colab, Clear Board, TRIZ in West; AA1, SC1, AIDE, Wadaman, Keyword Associator, KJ Editor, D-ABDUCTOR, GUNGEN, GRAPE, GrIPS, FISM, Meme Media, PMD etc. in Japan; GAE, Electronic Common Brain etc. in China;

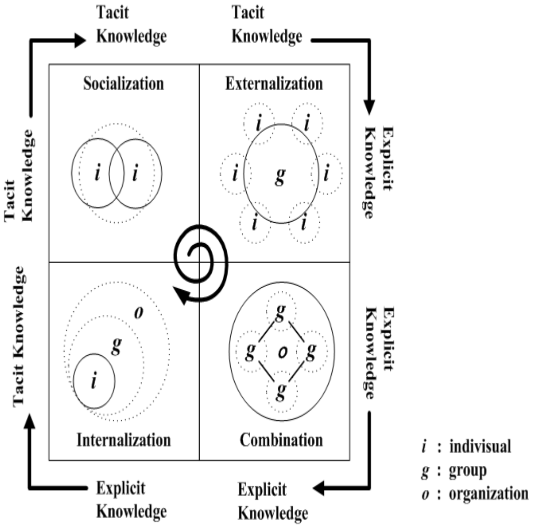

Figure 1. Knowledge Creation as the Self-Transcending Process

Source : Nonaka and Konno (1998) , p.43

(4) *Creative thinking*,

such as Intuition, association, logical and emergent thinking;

(5) *Creative education.*

Both in China and Japan we pay much attention to the creative education. In the 21^{st}-Century COE program "Technology creation based on knowledge science" run by JAIST they propose to educate two kinds of graduated students: Knowledge creator and Knowledge coordinator.

Here we wish pay much attention to the SECI model and its variants (see Figure 1) [4, 5] and the new EO-SECI model, here the E stands for Epistemology and O stands for Ontology (see Figure 2) [6]. We described the EO-SECI model for our major project. In the first column of Figure 2 we mention some individuals just in the ISS (Institute of Systems Science). In the third column we mention four research groups in the subproject 3, ISS, SJTU (Shanghai Jiaotong University), XJTU (Xian Jiaotong University) and BNU (Beijing Normal University). In fourth column we list only some of organizations in all subprojects: IA (Institute of Automation), BIIC (Beijing Institute of Information and Control), HUST (Huazhong University of Science and Technology), Macroeconomics Academy, Renmin University of China, ISS, SJTU, XJTU, BNU, BISE (Beijing Institute of Systems Engineering), Tsinghua University, Institute of Psychology et al.

3.METASYNTHESIS SYSTEM APPROACH

Metasynthesis System Approach is a Chinese system approach for solving problems related to the open, complex giant systems. MSA stands for combining the data, information, model, expert experience and wisdom [7]. Later Qian proposed the Hall for the Workshop of Metasynthetic Engineering (HWMSE), which is important tool for realizing the MSA. Qian also names the HWMSE as Integrating the large wisdom, or Large wisdom integration. Qian pays much attention to the theory of thinking, he give the name as Noetic science, in western many researchers also proposed the simliar name as cognitive science. Qian stands for utilization of the advanced computer and information techniques and the combination between the computer and human, but with emphasizing the human, since the human has the creation ability and more wise idea for problems solving. For realizing the MSA to solve complex problems we design a flowchart: from synchronous (meeting I) to asynchronous (analysis), then synchronous (meeting II) [8]. In the meeting I we will invite experts who are familiar with the topics which we wish discuss and solve. We will provide enough information , such as information from web and other publications, data base and case base for their deep thinking. In this stage (synchronous) many experts originally have their different knowledge, especialy the tacit knowledge, through the meeting discussion they will converse the tacit to tacit knowledge (***tt***), but finally we wish them concentrate to propose some assumptions or scenarios (explicit knowledge) for further analysis (***te,*** from tacit to explicit). In the second stage (asynchronous) we will mainly operate a series of models, especially use model integration to help the experts to verify their assumption or run calculation on modeles under different scenarios, from the model analysis we may got some quantitative conclusions (***te***, from tacit to explicit), even more we may use the integration of models to combine different analysis ***(ee***, from explicit to explicit). Finally we will again convene the meeting (meeting II) , but we will invite not only the experts with some special knowledge, but also the leaders and managers, who care for more the final results, final use and implementation of these results. They will validate the results from the models, especially they will discuss the validation and useness of the results (***ee***, from explicit to explicit). Finally if they find all these results are really useful, they will make decision to take measure or decide to produce some new products, certainly they wish keep the results secret in that time, thus from explicit to tacit (***et***)(see Figure 3)

. If the problem is not solved, we will iterate this process again and again until getting some solution, or consensus.

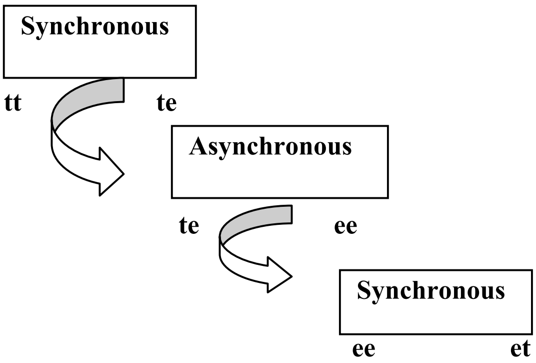

Figure 3 the flowchart for MSA

4. MSA AND KNOWLEDGE CREATION

During the implementing the mentioned NSFC major project we found some insights related to the knowledge creation and MSA:

1 1) when we started this project we knew some known knowledge, which will be useful for our project. We

knew some hopeful results, which NSFC had assigned to us as the aims and objectives for the project in the start of project. But we don't know how can we realize them concretely, by the way if we know everything in the start this is not a research project. From the view of SECI model we find that at first ***S*** step we have some tacit knowledge (our belief and experience for running similar project) and explicit knowledge, which existed already within some of members of project. For getting the success of this project we had run a lot of meetings within our members and through several assessment meetings we had to change the aims and objectives and enlarge our members whose knowledge NSFC assumed to be useful for this project. In ***E*** step we run a lot of academic exchanges through the meeting, peer-to-peer, person-to person for getting the explicit knowledge, and run a lot of seminars to introduce the explicit knowledge within us. Then the more time was spent for doing research by individual researchers or subprojects. Here as a matter of fact some new creations had emerged, only they did it separately. In ***C*** step we just wish combine all our knowledge (explicit and tacit) together to check the verification of research results and organize the possible linkage between different research groups. In ***I*** step we just put emphasis on the validity-how can we use it in some practice. We had run a series of tests on some selected topics related to macroeconomic system. And we collect all papers, software etc. for finalizing all researches and submitting final research reports to NSFC, then waiting for formal appraisal by a special assessment committee. As the full project we have to open our main results to the members of assessment committee, especially theoretical results which were published in journals and coneferences, but the software were not opened to the publicity, only as demo showed to the members of assessment committee or other people but the programs are secret as tasit knowledge.

2)In running MSA we pay much attention to the problems how can we synthesize the opinion from different experts, Dr. Tang and her students had developed the Group Argumentation Environment, which might be one of the important tools for knowledge creation [9.10]. We also pay attention to the quantitative description about the consensus within the experts [11]

3) The second aspect we pay much attention is to introduce a system of modeling paradigms (modeling by knowing mechanism, modeling by analogy, modeling by knowing rule, modeling by learning, modeling by data, modeling by evolutionary scenario) and modeling integration [12]. Modeling is a good method to help us to understand the reality, to change some thing to check the correctness of our new idea Even more some modeling paradigm may help us to find some new idea, like Multi-agent simulation may help us to find some emergence, or new idea, new creation, and the modeling by evolutionary scenario may help us to find the chaos which usually we couldn't find it by simple thinking and analysis.

4) During the time for waiting the formal appraisal our group found that the complex network, especially social network might be useful for analyzing the whole project, the knowledge creation process. We construct four type networks(coauthorship; activity; integrated with coauthorship and activity ; keywords) and their evolution from 1999 to 2004. We may find the process for emerging the new creation and the co-operation process between our members, as one example for keyword network we have listed in Figure 4 [13].

5) Chinese scholars of Creativity studies pay much attention on the Matter(物 Wu) and People(人Ren), or "create matter" and "educate people", so the Wuli, Shili ,Renli system approach also had been used in our study. In this project we use the ***Wuli*** as different knowledge which assume they will be useful during the project, they are systems science, systems engineering, knowledge science, economics, distributed computation, decision science, complex science, cognitive science, artificial intelleigence etc..Then the ***Shili*** is the different functions and tasks we wish fullfil, such as macroeconomic information and data base, macroeconomic case base, macroeconomic modeling and model integration, the platform for HWMSE, electronic common brain, group argumentaion environment, study on the behaviors for macroeconomic systems. Finally we pay much attention on the ***Renli***, we divide renli aspects as four levels:

5.1) *Inter-technica*l: here we mention integrative designing; distributed discussing; distributed modeling;

5.2) *Inter-personal* :in the aspect of human feeling here we emphasize *emotion* ;collaboration/ co-operation/ conflict, then in the aspect to acquaintance of interdisciplinary knowledge we emphasize the *knowing* : we had organized a serious of seminars, workshops and interdisciplinary discussions between the groups.

5.3*)Inter-organizational:* we consider two aspects: *relationship* between individuals, groups and organizations, one between members of project and the sponsor; *benefits* related to the budget allocation within the members of project and to the project with the sponsor;

5.4)*Inter-situational* : here we wish mention the *Ba,* which not only provides the place for meetings, but also requires the mental environment for discussion and exchange knowledge, as a matter of fact the HWMSE itself is a good *Ba* for creating knowledge and also the WWW or we may call them as cyberspace which using the internet people may exchange their ideas and knowledge much more freely and fast. Finaly we find the culture is very important for peoples to exchange inter-organizationally and internationally[14,15]

5. Conclusion

Through four or five years for running the major project we find the knowledge creation process is a very complex process, we not only must to keep the law for creation of new discipline and science, the *Wuli* and *Shili* aspects, but also pay much attention to the *Renli* aspect, using the social network analysis we may find the role of the leadership in a large project. The good leaders must be the key person for creating knowledge, but also the key person for co-operation and collaboration.

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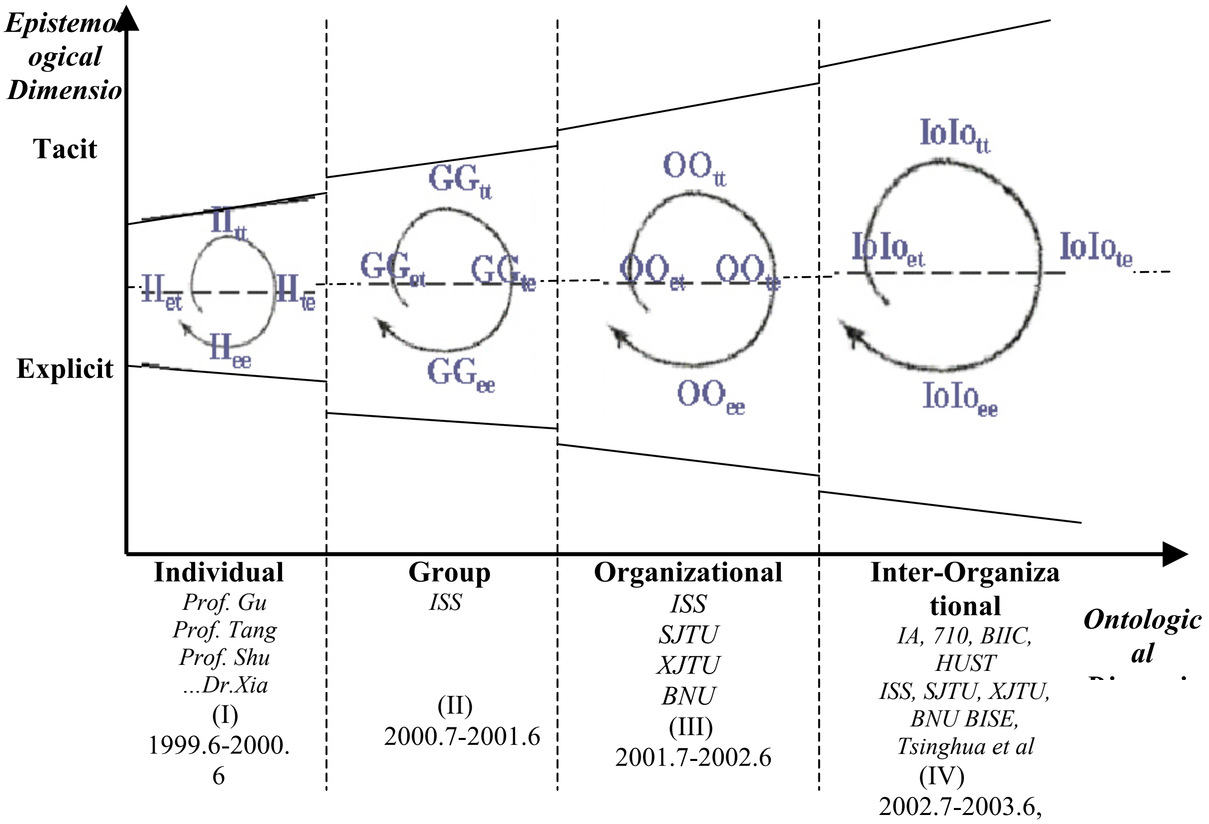
Figure 2 EO-SECI model for major project by NSFC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Individual
Prof. Gu
Prof. Tang
Prof. Shu
...Dr.Xia
(I)
1999.6-2000.6
Group
ISS
(II)
2000.7-2001.6
Organizational
ISS
SJTU
XJTU
BNU
(III)
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Inter-Organizational
IA, 710, BIIC, HUST
ISS, SJTU, XJTU, BNU BISE, Tsinghua et al
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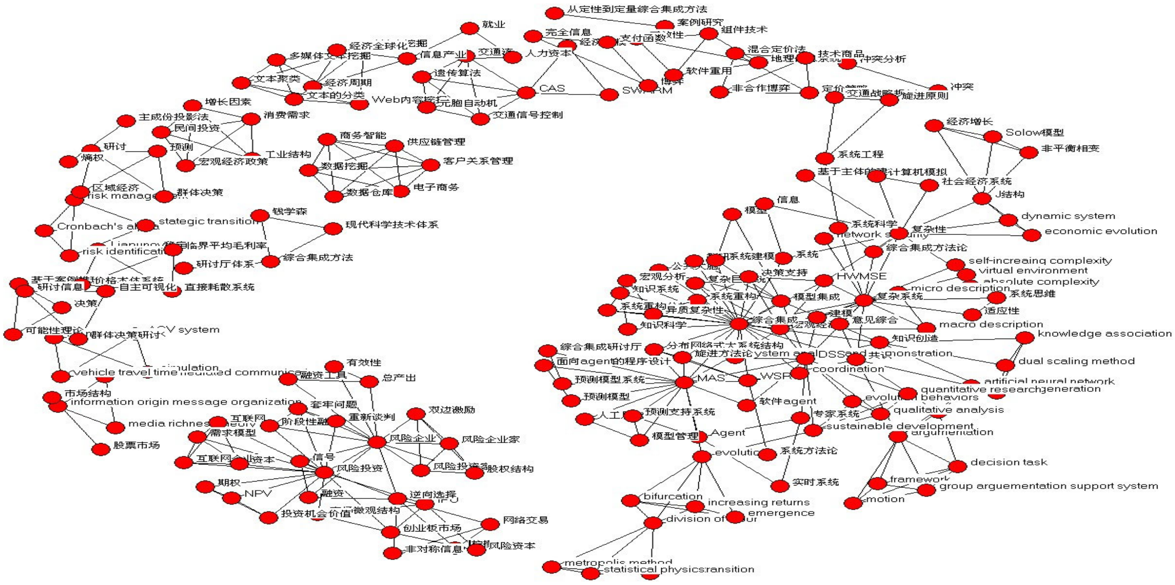
Figure 4. Keyword network for major project



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文本聚类
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stategic transition
钱学森
现代科学技术体系
risk identification
Lyapunov
综合集成方法
研讨厅体系
直接耗散系统
研讨信息
自主可视化
决策
可能性理论
群体决策研讨
ACV system
vehicle travel time
mediated communication
simulation
市场结构
information origin message organization
media richness theory
股票市场
有效性
融资工具
总产出
套牢问题
阶段性融资
重新谈判
双边激励
互联网
需求模型
风险企业
风险企业家
互联网企业
资本
信号
风险投资
股权结构
期权
NPV
融资
逆向选择
IPO
投资机会价值
微观结构
网络交易
创业板市场
非对称信息
风险资本
经济增长
Solow模型
非平衡相变
系统工程
基于主体的计算机模拟
社会经济系统
J结构
dynamic system
economic evolution
模型
信息
系统科学
network security
复杂性
综合集成方法论
self-increaing complexity
virtual environment
absolute complexity
micro description
系统思维
适应性
macro description
knowledge association
dual scaling method
artificial neural network
知识系统
宏观分析
复杂巨系统
系统重构
异质复杂性
知识科学
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决策支持
HWMSE
模型集成
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建模
意见综合
知识创造
综合集成研讨厅
分布网络式大系统结构
面向agent的程序设计
MAS
WSR
IDSS
coordination
预测模型系统
预测模型
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预测支持系统
模型管理
软件agent
专家系统
Agent
evolution
系统方法论
实时系统
evolution behaviors
quantitative research
qualitative analysis
sustainable development
arguementation
decision task
framework
group arguementation support system
motion
bifurcation
increasing returns
emergence
division of labour
metropolis method
statistical physics
transition