

Study on Computer Aided Innovation Tools Supporting in Distributed Innovation Process

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Abstract: Computer Aided Innovation (CAI), as an ended and nonlinear problem-solving tool, has been carried out gradually in process of enterprise distributed innovation, in order to promoting innovation capacity of organizations and maintaining competitive advantage. Basing on TRIZ theory, this paper analyzes categories and function mechanism of integrated CAI system, brings forward practical values of CAI supporting in distributed innovation, which will change the way that conventional collaborative innovation has done and promote the advanced application of Computer Aided Innovation tools in distributed Innovation, especially for conceptual design process and product specific process.

Keywords: Computer Aided Innovation (CAI); TRIZ theory; Distributed innovation; Conceptual design

1 Introduction

Nowadays, with the development of knowledge economy, the pace of transformation of information technology on Chinese manufacturing industries are gradually accelerated, especially from the 21st century, it is manifest achievements that software application creates, such as CAD, CAM, CAE [1]. On the other hand, more and more large enterprises which actively explore distributed innovation, employing the ERP (Enterprise resource planning) and PDM (Product Data Management), SCM (Supply Chain Management) to share the knowledge and realize efficiency and lower costs through integration system [2]. However, benefits are far from expected growth, with the so-called results of “digital prototype or sample”, “reduction of the number of prototype testing”, and “improvement of accuracy” [3], enterprises innovative capacity is still insufficient [4]. In fact, distributed innovation not only refers to the invention or new products, but also means a complex multi-dimensional platform of conflicting solution which is on the basis of computer network. Process of cross-regional distributed innovation renewed for its typical characteristic of synergistic, multi-task and uncertainty. To realize efficiency, the key question remains how to accomplish this complex process from ideation to market diffusion successfully [5]. In other words, the existing product of CAx and other engineering software are difficult to support conceptual design without reservation in the process of creative product development. It is significant for enterprises to develop and apply innovative tools to support effective innovation system and keep sustainable competitiveness.

2 Connotation of Computer Aided Innovation

2.1 Trajectory and definition of computer aided innovation

Computer Aided Innovation (CAI) emerged from the initial process of innovation and presents a new software tools, which supported by the use of Altschuller's TRIZ method [6]. Principles and problem-solving model of TRIZ Theory are shown in Figure 1. Causal analysis and resource analysis of initial problem are needed and the problem should be defined firstly; secondly, using technical contradictions, physical contradictions or object-fields analysis to create functional model of problems. In this step, functional diagram of technology system components, with harmful interactions laying out, should be given; thirdly, in terms of algorithm for conflict matrix, separation principle, and knowledge database, including 40 principles of innovation, 76 kinds of standard solutions, solutions generated. It means that using known principles and methods to improve partial technical system and relative parameters. The exploitation of Computer Aided Innovation software is also built on foundation of computer technology, such as knowledge discovery, data mining, database technology, artificial intelligence, image processing technology [7]. CAI coordinates with the relevant process of new product development via systemic theory, and integrates with modern design methodologies, specifically computer-aided technology, such as ICT systems, series of CAx products. Compared with CAx engineering application tools, It is a different platform which not just simply focus on new product development, architecture, design or technical behaviors, but also stresses the logic thinking.

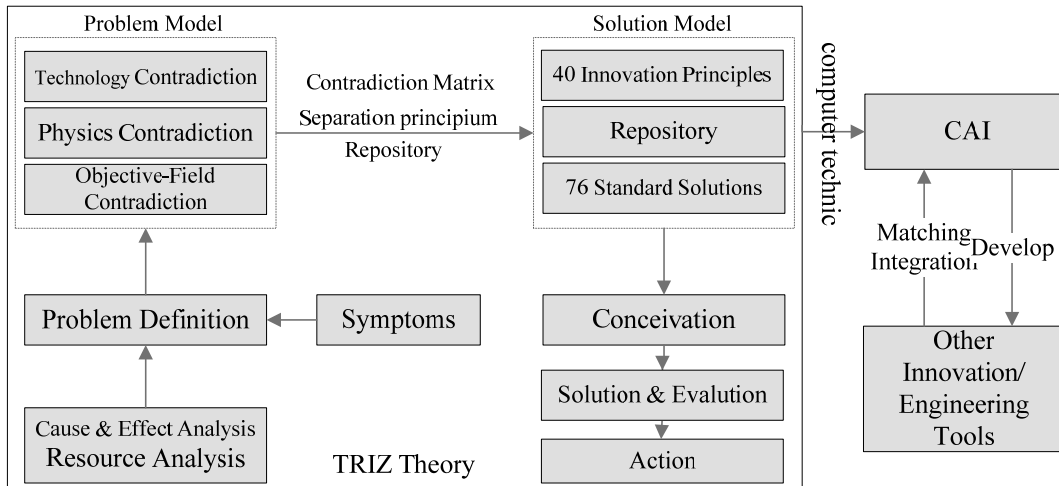


Figure 1 TRIZ Theory Support for Integrated CAI System

2.2 Classification of computer aided innovation

There is no clear definition for CAI currently, but Stefan Hüsigg (2007) investigated 150 CAI products which have been put in use, and divided them into three categories according to the function principle of CAI [8]. In terms of software architecture, CAI can be divided into three modules, including problem analysis module, innovative solutions generation module, and knowledge support module [9]. This paper argues that in process of distributed innovation, CAI can be classified into four categories in accordance with management functions, named strategic management (knowledge management), product conceptual design management, product specific design management, and patent management, as shown in Figure 2. Typical application of CAI tools is product conceptual design and product specific design, CAI provides advanced innovation theory and approaches to implement a comprehensive analysis of issues for users, help to construct an effective innovative design and optimize the research and development processes.

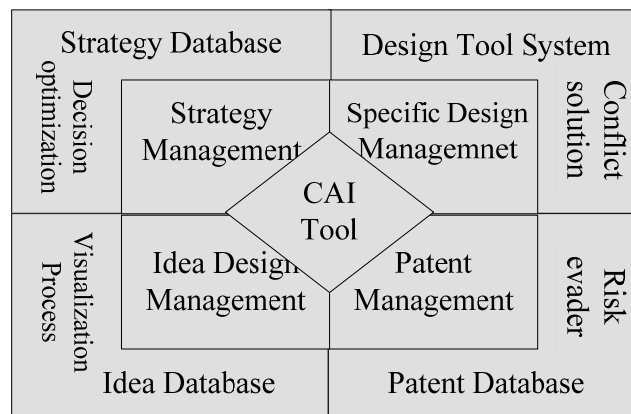


Figure 2 Categories and Function of CAI Tool

3 CAI Supporting in Distributed Innovation

3.1 Distributed innovation process

Distributed innovation emerges because of globalization in information networks, and represents theoretical and practical development of technological innovation. As sixth-generation innovation model, distributed innovation have been experienced a long-time evolvment, started from simple linear technology-push model, linear market-driven model, interactive technology and marketing model, and then developed to integrated innovation process model, integration network model. Now this paper gives us representative views about the process of distributed innovation as follows.

Cooper (1990) proposed five stages-gate model of technological innovation, including preliminary assessment [10], product determination, detailed design of new products, testing and commercial. The

aim of this model is to shorten product life cycle, and help enterprises adjust technical direction. However this model lack of dealing process of innovative ideas, and behavior process of looking for innovative ideas is one of the most important processes of distributed innovation. Professor Karl T. Ulrich and Steven D. Eppinger (2005) divided innovation process into seven stages, including mission statement, concept development, system design, detail design, testing and optimization, trial operation, and product launches. Professor Koen (2001) brings forth three stages model which is called fuzzy front end phase (FFE), a new concept development stage (NPD) and commercialization stage. Liu Guoxin (2009) brings forward five stages model in distributed innovation process, including fuzzy front design, product determination phase, development phase, testing and commercialization [11].

3.2 CAI supporting in conception and product design

Although there are obvious divergence in number of stages in distributed innovation process according to above perspectives of scholars, two essential processes in the distributed innovation can be proposed, the first one is front ideation design, and the second one is product specific design process. Front ideation design, similar with Fuzzy Front End stage [12], which refers to a proceeding that begins with initial thinking, idea assessment, and end with preparation phase for complete development of product. The influx of knowledge in front ideation design stage determines the success of innovation. But on the one hand, this stage is the most irrational phase, have large freedom, fewer constraints, and blur design. On the other hand, knowledge in fuzzy front is widely distributed, and affects knowledge absorption capacity and innovation network capacity. Therefore, fuzzy front or conception design is one of important elements in distributed innovation process. The role of CAI tools to support distributed innovation is shown in Figure 3.

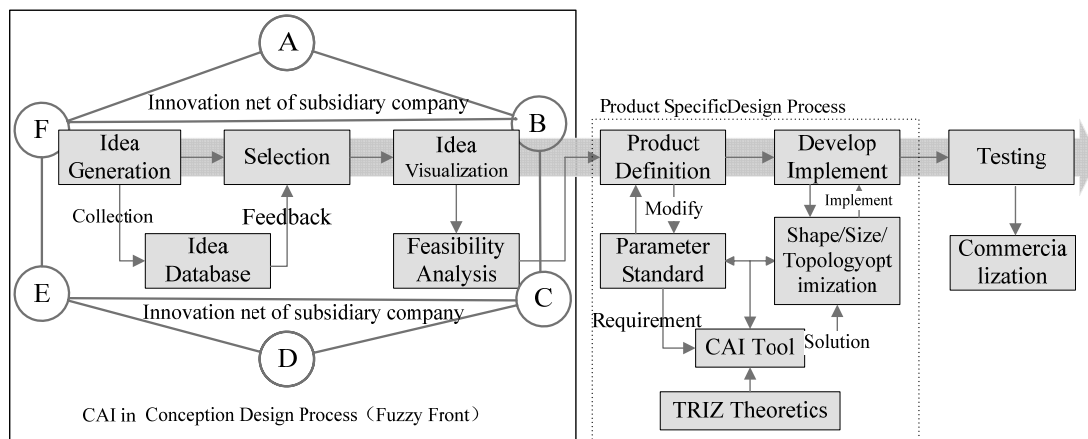


Figure 3 CAI Supporting Distributed Innovation Process

Conception database is shared by various subsidiary distributed innovation networks which built on the foundation of interior enterprise computer system. When Idea generated, the system implements instructions of collection, storage, and data analysis, then selects conception, and clusters the idea, it means idea classification. The final expert system provides a platform for idea valuation, and visualizes the whole development pipe through optimal combination of ideas for different stages of innovation with corresponding portfolio. This is how the CAI tool supports concept design process of distributed innovation.

The product specific design is another critical process [13]. Design standards have been established in accordance with environmental constraints and requirements in specific product design process, whereas confliction generated, accompanying with improvement of data parameters. Performance improving of segmental system would result in degradation of other partial parameters, and such conflictions can not be resolved in engineering design tools, or optimization tools, because those tools, such as CAX, can only realize monomial task. Exactly, they can not defined geometric models to support conceptual design behavior in innovation process, or can not automatically weigh the importance of different conflict elements and promote multi-objective management [14], but this could be resolved by CAI tools, and CAI use algorithms to define the conflict, propose solutions in logical instructions.

4 Conclusions

TRIZ-based Computer Aided Innovation (CAI) system has been gradually integrated with other design software, and there are still some challenges in application of CAI system. For one thing, CAI users need to be proficient in TRIZ theory; for another, obstacles of technology and conception sheltered the integration process of CAI system, design software and other existing effective product design proceedings. At present, it is not satisfactory for achievements of some experiments about integration test in TRIZ principles and CAD. Thus, it is no doubt that this research has significant theoretical and practical values, which focus on CAI system supporting the conceptual design process and product specific process in Chinese enterprise distributed innovation.

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