Hindawi
Scientific Programming
Volume 2022, Article ID 3605987, 8 pages
https://doi.org/10.1155/2022/3605987

Research Article

Design Method of Product Concept Model Based on CAD Technology

Xiangbin Meng

School of Art and Design, Changzhou Institute of Technology, Jiangsu, Changzhou 213000, China

Correspondence should be addressed to Xiangbin Meng; mengxb@cit.edu.cn

Received 5 May 2022; Revised 28 May 2022; Accepted 8 June 2022; Published 24 June 2022

Academic Editor: Lianhui Li

With the comprehensive development of information technology, the continuous optimization of products can make enterprises stand in the market. Various industries are involved in the upsurge of computer-enabling products; computer-aided (CAD) technology has also been rapid development. CAD technology is composed of problem analysis, innovative method, problem transformation and problem-solving invention principle, standard solution, and so on. In this paper, the theoretical system, basic scheme, and solving algorithm of CAD technology are described in detail. Meanwhile, the content of value evaluation and root cause analysis is analyzed and solved to further illustrate the application process of CAD technology optimization products and gradually form a more perfect application method of CAD innovation technology so that its solution process is more scientific, operable, and universal.

1. Introduction

With the increasing development of the market economy and technology, all companies around the world are competing in the market, and the new products that are developed and successfully brought to market each year are the key to all companies' success in the competition [1, 2]. New products are the result of continuous technological innovation. An important part of product innovation is the creation of new concepts with marketability and realization possibilities that arise during the product concept design phase, a process that requires the support of knowledge. There are many problems that need to be solved in each stage of product innovation. Some of them can be solved according to experience, but they cannot solve difficult problems or invention problems, which form obstacles to product or process innovation. Inventing problem-solving theory can help corporate developers solve difficult problems, thereby removing obstacles [3–6]. The popularization and application in Chinese enterprises are of great significance to improve the independent innovation ability and market competitiveness. Since 2000, the former Soviet Union invention expert Akishule and a group of researchers, after years of efforts, put forward and create theory of the solution of inventive problems. The theory is proposed based on the analysis of a large number of high-level patents in the world. The core of the theory is to answer the problems of the process of invention problem-solving and support tools. Designers or problem solvers can solve current problems efficiently and conveniently on the basis of previous knowledge and experience in different fields of innovation. Achishuler argues that only patents are original, while the rest take advantage of existing ideas or concepts, plus novel methods. He firmly believed that the basic principles of solving invention problems existed objectively and could be organized into a complete theoretical system, which could be used to improve the success rate of invention, shorten the invention cycle, and make the solution of invention problems predictable [7–11]. After more than half a century of development and rapid explosive popularization and application in the past ten years, it has become an effective tool in the field of engineering technology to creatively solve the problems of product design and manufacturing process and has helped many well-known companies to achieve significant economic and social benefits [12].

The technology in the early stage of computer-aided innovation is only the application platform of electronic invention problem-solving theory. Due to the limited application scope of the early theory, it has high requirements on the user's knowledge level, thus greatly hindering the spread and promotion of technology [13]. Modern technology integrates innovation theory, innovation technology, and technology, and theory is no longer just a tool for experts to innovate, which greatly reduces the use of technology and promotes the spread and application of theory. With the rapid development of science and technology in recent decades, technology has become an important basic technology in the development of new industrial products. At present, computer-aided technology software is a powerful tool for designers to break the thinking pattern and broaden the ideas in the conceptual design stage of products in different fields and put forward effective design schemes with high quality [14–17]. Throughout the characteristics of these types of software, rich innovation knowledge base as important support, with the advantages of large storage, fast speed, stability, and reliability of the computer, reduces accidental factors and one-sidedness in the design process, so technology is more effective than conventional solutions in solving existing problems and innovation problems of products [18–22]. It should be emphasized that software relies on an innovation knowledge database and innovation problem-solving process to provide feasible ideas for design innovation, and the complete final scheme needs designers to refine and expand these ideas concretely. The development trend of software is to gradually integrate different innovation principles and thinking methods into software to strengthen its ability to assist designers in innovative ideas. Compared with the traditional innovation methods such as trial and error method and brainstorming method, it has distinct characteristics and advantages [23, 24]. It successfully reveals the inherent laws and principles of creation and invention and is committed to clarifying and emphasizing the contradictions existing in the system, rather than avoiding them. Its goal is to completely solve the contradictions and obtain the final ideal solution, rather than compromise. It studies the whole process of product design and development on the basis of the law of technological development and evolution so that innovative design is no longer a random behavior [25–27]. Computer-aided innovation systematically analysis problems can help the designers quickly find out the nature of the problem or contradiction, accurately position problem of direction, and break the conventional mode of thinking, in a different way of looking at problems and analysis, according to the law of evolution in technology to predict the future development trend and accelerate the process of the social innovation and high-quality products [28]-.

After years of development, it has become a knowledge-based, human-oriented systematic method for solving invention problems. Technology is a new and high technology integrating theory, ontology, modern design methodology, semantic processing technology, and computer software technology, providing natural language query technology based on semantic processing technology. Analyze the problem situation systematically, find the essence of the problem, and define the problem and conflict accurately to provide more reasonable solutions to innovative technical problems and technical contradictions. It can predict the future development trend based on the law of technological system evolution, which opens the way for making decisions and developing innovative products, and can effectively save the innovation results for future use.

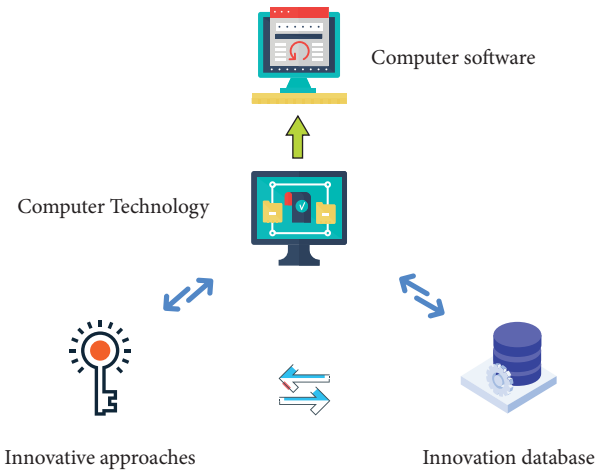

Figure 1: Computer-aided technology components.

2. Computer-Aided Technology

Computer-aided technology integrates modern design methods, invention and creation methods, knowledge of various engineering disciplines, and computer software technology and integrates scientific knowledge of multiple fields. Its system composition is shown in Figure 1. Technology provides technical support to designers at the stages of requirements analysis, concept design, solution design, and solution evaluation of new product development, assisting designers in broadening their thinking, guiding them to apply knowledge from various disciplines in an integrated and effective manner, gaining ground-breaking innovative thinking, and providing a constant stream of creative solutions for product design.

Analyzing the characteristics of innovative product design and the functional modules of the commonly used software mentioned in the previous section, the main functional modules of the current better software include project navigation, problem-solving tools such as innovation principles, technology forecasting, patent searching, solution evaluation, and knowledge management to help designers correctly analyze problems in technical systems, predict possible problems in the design phase, and explore the direction of innovative product development. Reasonable assessment of conceptual design options will reduce the probability of errors at this stage.

As can be seen in Figure 2, the designer can effectively use the built-in software in the field of multidisciplinary knowledge and the wisdom of predecessors, follow the rules of innovation, try to find the problems existing in the technical system, find innovative solutions to build their

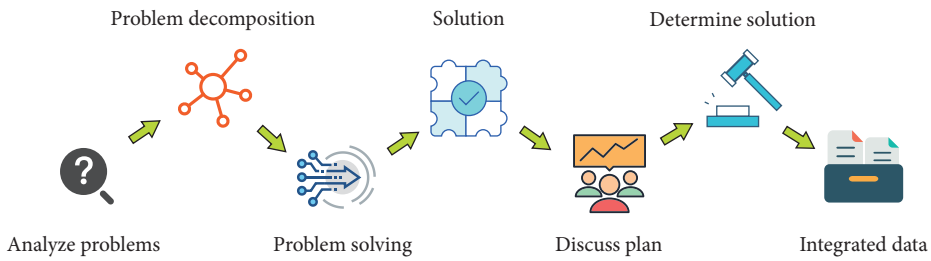

Figure 2: The logic of computer innovation technology.

own core technology and knowledge base, and help enterprises to effectively avoid the existing patent competition, into independent intellectual property rights.

2.1. Computer-Aided Innovative Design Platform. Pro/Innovator is a new generation of computer-aided innovative design tools combining TRIZ, ontology, modern design methodology, natural language processing technology, and computer software technology. With its powerful comprehensive analysis tools and innovative solution library created from the world's outstanding patents, technicians in different engineering fields can break the stereotype and broaden their thinking when facing each technical problem, analyze the problem with a new perspective and thinking, and quickly obtain operational and efficient solutions. Pro/Innovator problem-solving steps are divided into four stages: problem analysis, problem-solving, solution generation, and knowledge management.

2.1.1. Analyze Problems. The problem analysis stage consists of three modules: project navigation module, system analysis module, and problem decomposition module. Innovative design processes include project description, navigation module supporting project initiation, initial conditions and switching of each module, problem solution evaluation process, patent generation and project report generation. The system analysis module includes two parts: building component model and analyzing component value. Building component model mainly includes the interrelationship between functional analysis, role definition, flow analysis, and so on to help technical personnel from the perspective of system fully understand the problem system and its causation of the items constituting the system and subsystem effectively reveal the internal and external problems existing in the system and the weak link, so that the follow-up can be more accurate to describe the contradiction problem. The general improvement direction of the system model is further determined, which can also provide some reference for the subsequent system function evolution. After the completion of the system function analysis, the value analysis of each component of the system, first, determine the functional contribution value, problem, and cost allocation of each component. Then automatically calculate the ideal degree of each component of the system index, comprehensive analysis of each component of the initial problem of the degree of impact, and its contribution to the main function of the system value, and in order to locate the weak link in the system, clear system improvement direction. Component value analysis is based on the theory of value analysis in value engineering. The main idea of value analysis is to make certain product or certain operation have appropriate value at the lowest cost by analyzing the function and cost of the selected research object, that is, to realize the necessary function it has and improve the value of the object.

The problem decomposition module is a tool for the decomposition of surface problems, supporting the decomposition of initial problems and problems generated from the system analysis module. When describing the initial problem of a system, the root cause of the problem is often not found because the initial problem is not clearly and fully expressed at the beginning. Therefore, in order to dig out deeper causes, it is necessary to carry out a layer-by-layer analysis of the initial problem and its subproblems. The working principle of the problem analysis module is to use the triaxial analysis method to redefine the initial problems along the three axes of causality axis, operation axis, and subhypersystem axis and transform each subproblem into a triaxial diagram for analysis so that the root cause of the initial problems gradually emerges. In the process of problem decomposition, the causality of the problem is graphically expressed. In this process, other available resources in the system may be mined to analyze the actual causes of the existing resources.

The main working principle of problem decomposition module is based on the theory of root cause analysis and nine-screen method. The nine-screen method is one of the methods of system thinking, which can help people comprehensively and systematically analyze problems from multiple dimensions, such as structure, time, and causality, and find new ideas and solutions according to existing resources. Root cause analysis, also known as root cause analysis, is a process of analyzing problems in depth and finding out the mechanism or cause of failure. It is a simple and practical analysis tool for finding problems and locating causes. It helps to understand and explore the detailed causes behind the problems so that appropriate improvement and preventive measures can be taken. The root cause is determined and problem is fixed step by step. Root cause analysis is a systematic process of dealing with problems, including identifying and analyzing the causes of problems, finding solutions, and developing preventive measures.

2.1.2. Solve Problems. The tools in the problem-solving stage include the solution module, innovation principle module, and patent inquiry module. These three modules have their own knowledge base support, and appropriate modules can be selected according to the types of problems obtained in the previous step.

The solution module has a rich knowledge base of technical solutions, covering most engineering fields of manufacturing industry. The content of technical solutions is structured, refined, and supplemented by vivid, accurate, and professional animation demonstration and contains predefined solutions based on application examples of patent and innovation principles, as well as a library of technical solutions based on past experience of individuals or enterprises. It has a query tool based on ontology relationship, including functional query, structured query, and keyword query, and supports further expansion of query-related patents.

In the application of innovation principle module, the contradiction matrix is the basis of the tool, which supports the whole process of contradiction analysis and solution in the process of innovation problem-solving. It contains three ways to define contradictions: contradiction parameters, contradiction matrix, and contradiction definition wizard. After contradiction definition, the module will automatically give corresponding innovation principles to solve contradiction problems. Each innovation principle contains detailed subprinciples and is accompanied by animation demonstration to help users understand the connotation of innovation principles. The innovative thinking or breakthrough ideas obtained can be used as a reference to solve similar contradictory problems.

The patent query module contains multiple international patent databases and supports access to patent databases in China, the United States, Japan, and Europe. Patent query mode is an automatic extension function based on ontology relationship and function query. The module also has the ability to preview patent content through a web browser.

2.1.3. Form a Solution. In the process of solving contradictory problems, predefined solutions, alternatives, or analogical alternatives are generated based on some illuminating ideas. In order to obtain the best solution, these preliminary solutions need to be evaluated, and the final solution best suited to the initial problem can be selected based on the comprehensive evaluation results. The program evaluation module includes subjective evaluation and objective evaluation. Subjective evaluation includes a single expert program and a multiexpert program. The module provides an evaluation model and can also customize the evaluation model to set the weight of each expert according to the experience, background, or other factors of each expert. Objective evaluation refers to the evaluation based on the citation index of parametric patents. The evaluation results will be displayed in percentage format or bar chart format, and the predefined schemes or alternative schemes participating in the evaluation will also be ranked according to the comprehensive evaluation value.

2.1.4. Data Management. To improve the utilization rate and acquisition efficiency of knowledge, knowledge can be accumulated and shared by sorting out, summarizing, or adding knowledge to the user's knowledge base, and knowledge exchange and mutual learning between relevant personnel can be promoted. Knowledge management tools include project report generation, patent generation module, and knowledge sharing module. Software also has components, which can manage existing knowledge, obtain solutions to problems, and add them to the knowledge effect database of individuals or enterprises, so as to form a reference for similar problems that may occur in the future.

2.2. Value Analysis. Value analysis is a kind of thinking method and management technology to improve the value of the object of analysis. It is a thinking method and management technology to improve the value of the object of study by systematically analyzing the function and cost of the object of study through the cooperation of various related fields and constantly innovating. From the point of view of the purpose of carrying out value engineering activities, value engineering is through the analysis of the function and cost of the object of analysis, with the lowest life cycle cost of the object to reliably realize the necessary functions of the object of analysis, in order to obtain the best social and economic benefits. For products, it is necessary to improve their functions and reduce their life cycle costs through various means.

The main idea of value analysis is to make a product or an operation have appropriate value at the lowest cost by analyzing the function and cost of the selected research object, that is, to realize or create the necessary function it has and improve the value of the object. Value is the ratio of function and cost, which is inversely proportional to cost and directly proportional to function. That is, the higher the function, the lower the cost and the greater the value. Thus, the principle of value analysis is to improve product value to improve economic benefits by comparing product functions and costs.

In terms of the control scope of the product cost, value analysis considers product life cycle cost. Value analysis is to seek the lowest life cycle cost and to achieve the necessary function of the product as the goal and is committed to the study of the mutual interest between function and cost to overcome the one-sided consideration of a single aspect of blind practice. Value analysis is centered on function analysis. It is difficult to define product function accurately because there are many influencing factors, it is not easy to quantify abstract indicators, and people's evaluation methods of product function are different. Therefore, the analysis of product function can be considered the core of value analysis. Value analysis is an organized activity. Because the value analysis process runs through the whole life cycle of the product and involves a wide range of areas, it needs the cooperation of all units, departments, and professionals involved in the production of the product to accurately measure the cost of the product, function evaluation, and achieve the purpose of improving the efficiency of the unit cost of the product. Value analysis can reduce

product cost to the greatest extent. It can combine technology and economic problems organically and overcome the disjointed phenomenon of economy and technology in product design and manufacturing. Value analysis is a creative activity based on information. Value analysis is based on product cost, functional index, market demand, and other related information data, looking for the best solution for product innovation. In terms of the time spent on a product analysis, value analysis is carried out before product design and manufacture. Therefore, information is the basis of value analysis, and product innovation is the ultimate goal of value analysis.

2.2.1. Content of Value Analysis. The content of value engineering is the process of raising, analyzing, and solving problems according to the function and cost of products. The general working procedure of value engineering can be carried out in five stages: preparation stage, analysis stage, comprehensive stage, evaluation stage, and implementation stage. The specific working steps are shown in Figure 3.

The selection of value analysis object is the key step of value evaluation. The selection of objects mainly includes value coefficient analysis, cost proportion analysis, function evaluation coefficient analysis, and cost proportion analysis. The value coefficient is used to analyze the relationship between component function and cost, and the component whose cost does not adapt to function is taken as the key analysis object and the target of improvement. Value coefficient is determined by function coefficient and cost coefficient. Function importance coefficient refers to the proportion of part function to total product function, and cost coefficient refers to the proportion of part cost to total part cost.

$$\begin{aligned}\text{Value coefficient} &= \frac{\text{Function coefficient}}{\text{Cos coefficient}},\\ \text{Cost coefficient} &= \frac{\text{Cost of spare parts}}{\text{Total product cost}},\\ \text{Function coefficient} &= \frac{\text{Function of parts}}{\text{Product functions}}.\end{aligned} \tag{1}$$

The function coefficient of each component relative to the product is calculated according to the importance of the component in the whole component. A high value of the function coefficient indicates that the component has a great influence on the function of the component.

Cost-specific proportion analysis (ABC analysis method), a creation of Pareto, an Italian economist, is now widely used, especially in material cost analysis. It is a method that preferentially selects parts, processes, or other elements that account for a significant cost ratio as the object of value analysis.

Class A parts: the number of parts accounted for 10~20% of the total number of products, and the cost accounted for 70~80% of the total cost of products. Class C parts: the number of parts accounted for 70~80% of the total number of parts of the product, and the cost accounted for 10~20% of the total cost of products. Class B parts: the rest of the parts are called Class B, and the number of parts is proportional to the cost of the product. Using this classification method, we can find out the Class A parts which have the greatest impact on product cost as the main object of analysis and cost reduction. In practical application, the value coefficient analysis method is often combined with the ABC analysis method. Because A product often has many parts, it is relatively complicated to use the value coefficient analysis method for all parts. Generally, the ABC analysis method is adopted to select key parts, and then the value coefficient analysis method is applied to select specific objects based on the selected A or B categories.

Functional evaluation coefficient analysis method will queue up parts according to the size of functional requirements and preferentially select those with large functional coefficient as the value analysis object. And the cost proportion analysis method makes statistical analysis of various costs, and the largest one is the object of value analysis.

3. Root Cause Analysis

Root cause analysis is an analysis process of in-depth analysis of problems and finding out the mechanism or inducement of failure. It is a simple and practical analysis tool to find problems and locate causes, which can help to understand and dig out the detailed causes behind problems so as to take appropriate improvement and prevention measures. Root cause analysis is a systematic process to deal with problems, including identifying and analyzing the causes of problems, finding solutions, and developing preventive measures.

3.1. Root Cause Analysis Tool. The 5W2H method refers to the use of the five words "WHAT," "HOW," "WHY," "WHEN," "WHERE," "WHO," and "HOW MUCH" to ask questions in order to discover clues to solve problems, find ideas for inventions, and design ideas, so as to arrive at a comprehensive analysis of problems and ideas for solutions. The 5W2H method is shown in Figure 4.

In Figure 4, the process of asking and answering questions in the above seven areas provides some insight into the problematic events to be addressed and thus gets to the heart of the matter. The areas of the answers that are not at the desired level can then be improved in a more targeted way.

The system diagram lists the problems according to the order of occurrence and searches for all possible causes for each problem so as to get the root cause of the most likely problems. This is a way of describing an effect and all the possible causes that might affect it.

It can be seen from Figure 5 that the object of the tree diagram is a system, which is the relationship between a certain quality problem and its components. The graphic features are "layer-by-layer inclusive," just like a big tree. Therefore, a certain problem can be systematically decomposed into many components, and the logical and sequential relationship between them can be displayed. Through the description of the system, show the appearance of things to explore the most appropriate method to achieve the goal.

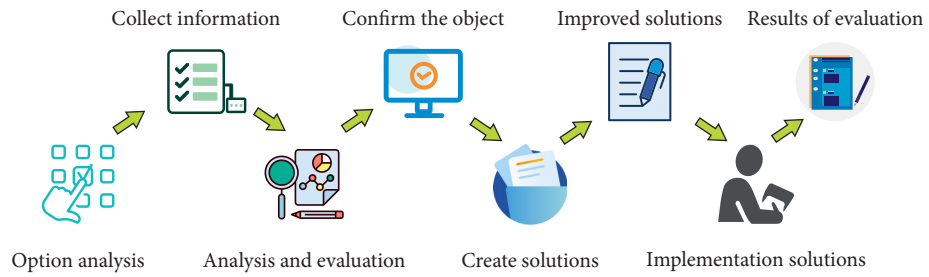

Figure 3: Process of value evaluation.

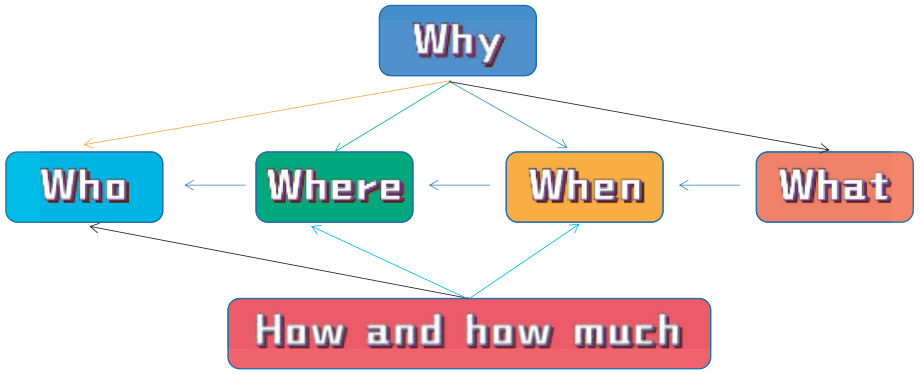

Figure 4: 5W2H method.

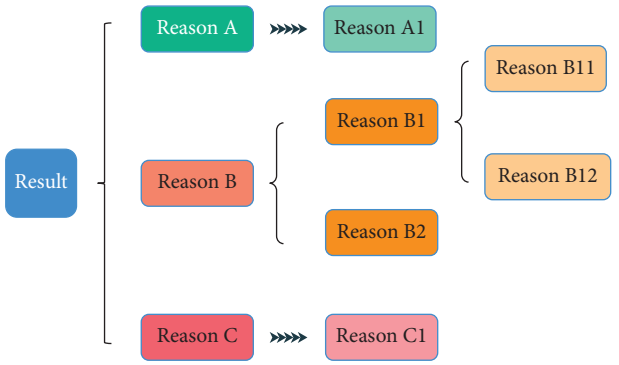

Figure 5: Structure of the system.

Figure 6: Root analysis process.

3.2. Application of Root Cause Analysis. The implementation of root cause analysis includes a series of logical processes, and its four key elements in solving problems are Define, Investigate, Verify, and Ensure. Based on the idea of Define, Investigate, Verify, and Ensure problem-solving tool, according to the characteristics of root cause analysis and the use of problem-oriented innovation strategy, the appropriate analysis method is selected and supported by a relevant knowledge base, and the prototype system structure is constructed, as shown in Figure 6.

The purpose of defining the problem phase is to set goals for improvement or solving the problem. Identify the conditions that are relevant to the problem and identify which factors may and may not be relevant to a particular problem. The purpose of the problem investigation stage is to find out the root and true cause of the problem. Through the analysis process, the basic situation of the problem is sorted out to lay a foundation for cause analysis and evaluation. It can be divided into two situations: when analyzing the problems of simplicity and inferiority, the "5 Why" analysis method can be given priority to gradually explore the root cause of the results through signs and find the root cause of the problem. In the analysis of complex problems, system diagram, and so on, in the design of manufacturing products, problems need to be analyzed from the machine, method, material, personnel, measurement, and environment in order to find the root cause of the problem. The

purpose of the problem identification and evaluation stage is to verify the validity of the root cause analysis. Analyze each cause with background information and data. The assessment identifies one or more most likely root causes. Verify and identify the cause of the problem through field tests or process descriptions that provide valid information to pinpoint the true cause. The stage of determining the best solution is to solve the root cause of the above three stages, use the invention of problem-solving-related tools and other methods to produce solutions, and then consider the feasibility of the solution from the perspective of time, cost, and resource utilization. Then the solutions are sorted out, the weight of each factor is set according to the existing common rules of the industry, the feasibility of the above schemes is evaluated by selecting appropriate evaluation criteria, and the best scheme is selected according to the comprehensive evaluation results. Finally, the effectiveness, reliability, and environmental adaptability of the scheme are verified by experiments.

In the problem decomposition module of Pro/Innovator, the subproblems of the initial problem were decomposed along the three axes of the causality axis, operation axis, and subhypersystem axis, and the subproblems were transformed into a three-axis diagram. The causal axis reflects the causal relationship between events that precede or follow the occurrence of the initial problem. This axis can be used to reveal the root cause and possible outcome of a problem, and the name of the causal axis node is Define Cause and Define Result. The action axis reflects the sequence of actions that represent all the actions experienced by the object in question. The hierarchy axis reflects how a subsystem or supersystem interacts with the technical system under consideration. The causality axis is the most commonly used and important decomposition axis for Pro/Innovator to solve problems. The layer-by-layer analysis of initial problems and subproblems along the causality axis by the problem decomposition module is actually the process of root analysis. Through the continuous decomposition of problems at the upper layer, the root causes of problems are gradually discovered. The graphical expression is similar to tree diagram or fishbone diagram. Pro/Innovator can automatically add analysis results to the project navigation and integrate them with subsequent problem-solving modules. When the problem decomposition module analysis does not reach ideal results, the solution process of root cause analysis can be used for deeper analysis.

The purpose of root cause analysis is to try to identify the contributing factors to a problem and analyze all the causes by repeatedly asking multiple whys and gradually digging deeper into the problem until the root cause is found. When exploring the root cause, try to evaluate each identified cause and try to give a solution, which will contribute to the overall improvement and improvement of the original problem. It should also be added that root cause analysis, as a general term, is not limited to the application process proposed in this chapter, but there are different structured approaches for solving specific problems.

4. Conclusion

CAD technology is an important auxiliary tool in the field of engineering. It benefits from the development of innovative methods and theories and the continuous integration with computer technology. The integration of technology innovation theory, value analysis, root analysis, and other theories makes the computer-aided innovation technology perfect day by day and consolidates its solid theoretical foundation. Computer-aided innovation technology supplements the limitations of traditional innovative design and technical improvement, and the integration of a variety of innovative methods can effectively help designers improve the efficiency of solving engineering design problems.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

Acknowledgments

The author acknowledges the Philosophical and Social Science Fund of Colleges and Universities in Jiangsu Province (no. 2016SJD760109) and the Education Reform Project of Changzhou Institute of Technology, Research and Practice of Digital Media Art Major Curriculum System and Content Based on Industry Standards (no. A3-3104-19-024).

References

[1] C. Wei, "Research on university laboratory management and maintenance framework based on computer aided technology," *Microprocessors and Microsystems*, vol. 6, Article ID 103617, 2020.

[2] Z. Wang, C.-H. Chen, X. Li, P. Zheng, and Li P. Khoo, "A context-aware concept evaluation approach based on user experiences for smart product-service systems design iteration," *Advanced Engineering Informatics*, vol. 50, Article ID 101394, 2021.

[3] G. Luo, Y. Guo, L. Wang, Na Li, and Y. Zou, "Application of computer simulation and high-precision visual matching technology in green city garden landscape design," *Environmental Technology & Innovation*, vol. 24, Article ID 101801, 2021.

[4] J. Luo, "Online design of green urban garden landscape based on machine learning and computer simulation technology," *Environmental Technology & Innovation*, vol. 24, Article ID 101819, 2021.

[5] Y. Zhou, M. Chen, Z. Tang, and Y. Zhao, "Simultaneous carbon storage in arable land and anthropogenic products (CSAAP): demonstrating an integrated concept towards well below 2°C, Resources," *Resources, Conservation and Recycling*, vol. 182, Article ID 106337, 2022.

[6] W. Chung, H. Lim, J. S. Lee et al., "Computer-aided identification and evaluation of technologies for sustainable carbon capture and utilization using a superstructure approach," *Journal of CO_2 Utilization*, vol. 61, Article ID 102032, 2022.

[7] E. Perez-Molina and C. Mejia, "Assessment of technology integration based on patent analysis — three archetypal case studies: computer generated animation, regenerative medicine and computer tomography," *World Patent Information*, vol. 66, Article ID 102058, 2021.

[8] Q. Liu, K. Wang, Y. Li, C. Chen, and W. Li, "A novel function-structure concept network construction and analysis method for a smart product design system," *Advanced Engineering Informatics*, vol. 51, Article ID 101502, 2022.

[9] C. Sasthav and G. Oladosu, "Environmental design of low-head run-of-river hydropower in the United States: a review of facility design models," *Renewable and Sustainable Energy Reviews*, vol. 160, Article ID 112312, 2022.

[10] B. H. W. Guo, Y. Zou, Y. Fang, M. Yang, P. X. W. Goh, and P. X. Zou, "Computer vision technologies for safety science and management in construction: a critical review and future research directions," *Safety Science*, vol. 135, Article ID 105130, 2021.

[11] S. Floryanzia, P. Ramesh, M. Mills et al., "Disintegration testing augmented by computer Vision technology," *International Journal of Pharmaceutics*, vol. 619, Article ID 121668, 2022.

[12] J. Yang, Y. Ma, M. Mao, P. Zhang, and H. Gao, "Application of regression model combined with computer technology in the construction of early warning model of sepsis infection in children," *Journal of Infection and Public Health*, vol. 13, no. 2, pp. 253–259, 2020.

[13] X. Zhu and S. Luo, "The influence of computer network technology on national income distribution under the background of social economy," *Computer Communications*, vol. 177, pp. 166–175, 2021.

[14] M. Ranjkesh Ghahnavieh, R. Kamgar, and H. Heidarzadeh, "A design-oriented model for FRP well-confined concrete cylinders under axial loading," *Structures*, vol. 38, pp. 1005–1017, 2022.

[15] Z. Ma, F. Xu, M. Wang, M. Zhang, and H. Zeng, "Design, fabrication, and dynamic testing of a large-scale outdoor aeroelastic model of a long-span cable-stayed bridge," *Engineering Structures*, vol. 256, Article ID 114012, 2022.

[16] D. Zhang, Xi Feng, C. Xu et al., "Rapid discrimination of Chinese dry-cured hams based on Tri-step infrared spectroscopy and computer vision technology," *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, vol. 228, Article ID 117842, 2020.

[17] G. Cao, Y. Sun, R. Tan, J. Zhang, and W. Liu, "A function-oriented biologically analogical approach for constructing the design concept of smart product in Industry 4.0," *Advanced Engineering Informatics*, vol. 49, Article ID 101352, 2021.

[18] L. R. Krol and T. O. Zander, "Chapter 2 - defining neuro-adaptive technology: the trouble with implicit human-computer interaction," in *Current Research in Neuroadaptive Technology*, s), S. H. Fairclough, and T. O. Zander, Eds., pp. 17–42, Academic Press, China, 2022.

[19] A. Raju Kulkarni, G. La Rocca, L. L. M. Veldhuis, and G. Eitelberg, "Sub-scale flight test model design: developments, challenges and opportunities," *Progress in Aerospace Sciences*, vol. 130, Article ID 100798, 2022.

[20] J. Chang, "Broadband technology opportunities program public computer center grants and residential broadband adoption," *Telecommunications Policy*, vol. 45, no. 8, Article ID 102147, 2021.

[21] K. P. Kusumo, K. Kuriyan, S. Vaidyaraman, S. García-Muñoz, N. Shah, and B. Chachuat, "Risk mitigation in model-based experiment design: a continuous-effort approach to optimal campaigns," *Computers & Chemical Engineering*, vol. 159, Article ID 107680, 2022.

[22] M. Scherz, E. Hoxha, H. Kreiner, A. Passer, and A. Vafadarnikjoo, "A hierarchical reference-based know-why model for design support of sustainable building envelopes," *Automation in Construction*, vol. 139, Article ID 104276, 2022.

[23] M. Kettler, H. Unterweger, and P. Zauchner, "Design model for the compressive strength of angle members including welded end-joints," *Thin-Walled Structures*, vol. 175, Article ID 109250, 2022.

[24] D. F. Andrade, J. P. Castro, J. A. Garcia, R. C. Machado, E. R. Pereira-Filho, and D. Amarasiriwardena, "Analytical and reclamation technologies for identification and recycling of precious materials from waste computer and mobile phones," *Chemosphere*, vol. 286, no. 2, Article ID 131739, 2022.

[25] K. Sharma and M. Giannakos, "Sensing technologies and child–computer interaction: opportunities, challenges and ethical considerations," *International Journal of Child-Computer Interaction*, vol. 30, Article ID 100331, 2021.

[26] S. S. Qarnain, S. Muthuvel, S. Bathrinath, and S. Saravanasankar, "Analyzing factors in emerging computer technologies favoring energy conservation of building sector," *Materials Today Proceedings*, vol. 45, no. 2, pp. 1290–1293, 2021.

[27] Jo-Yu Kuo, C.-H. Chen, S. Koyama, and D. Chang, "Investigating the relationship between users' eye movements and perceived product attributes in design concept evaluation," *Applied Ergonomics*, vol. 94, Article ID 103393, 2021.

[28] M. Meinel, T. T. Eismann, C. V. Baccarella, S. K. Fixson, and K. I. Voigt, "Does applying design thinking result in better new product concepts than a traditional innovation approach? An experimental comparison study," *European Management Journal*, vol. 38, no. 4, pp. 661–671, 2020.