Research on Environmental Feedback Mechanism Based on System Dynamics

Zhibin Wang
Teacher Education Department, Maanshan Teacher’s College, 243000, Maanshan, China

Abstract. Cultural science and technology integration and innovation has become a new way to promote the coordinated development of culture and science and technology. Based on the theory of fusion innovation and collaborative innovation, this paper applies the basic principles of system dynamics to construct the causality model of the interaction between cultural system and technology system, and uses Vensim PLE software to simulate the system and analyze the path of cultural technology fusion innovation and its influencing factors. The research results show that: culture and technology integration innovation system is composed of complex feedback mechanisms that interact with each other. Each feedback loop represents the realization path of cultural science and technology fusion innovation. In the implementation path, cooperation between industry, universities and research institutes, market demand forecasting accuracy, innovation there is a significant positive impact between the perfection of incentive mechanism, the perfection of cultural intermediary service system and the integration of cultural science and technology innovation.

1. Introduction
Convergence and innovation is a new trend of integrated development of technological innovation systems. Cultural and technological integration and innovation is a complex system of deep integration between cultural systems, technological systems and external environmental systems. It is to promote the development of cultural industries and enhance regional technological innovation capabilities and economics. An effective way of strength. In order to more accurately identify the realization path and feedback mechanism of cultural and technological integration innovation, this paper builds a dynamic model of cultural system and technology system based on the basic principles of system dynamics, and establishes feedback on cultural and technological integration innovation through system simulation. The mechanism of action is to further enrich and improve the theory of cultural science and technology integration and innovation, and to promote the improvement of cultural and technological integration and innovation efficiency to a certain extent.

2. Analysis of Causality between Culture and Technology Integration and Innovation
Based on the basic idea of system dynamics, we first need to determine the system boundary. As the factors affecting the integration of culture, science and technology are more complex and the factors affect each other, this paper combines the existing achievements and establishes a feedback mechanism for the integration of culture and technology innovation, which is proposed by the “cultural system—scientific and technological innovation system—external environment” The system's three subsystems
are coupled with their external environment to form a complex open system with multi-variable, multi-loop and dissipative feedback structures. According to the relevant influencing factors of cultural and technological integration and innovation, the system is divided into scientific and technological innovation system and cultural innovation system. The two systems are independent and interrelated, thus forming a feedback loop of reciprocating cycles. In addition, two subsystems It exists in the social and market environment, and is influenced by the national culture, science and technology policy, and cultural market consumption demand. Therefore, analyzing the feedback mechanism of cultural science and technology integration innovation and its important influencing variables must affect the normal operation of cultural science and technology integration and innovation. The external environmental factors are reviewed and combed.

This paper analyses the relevant influencing factors of variables such as cultural system, technological innovation system and external environmental system through SD method, and constructs a causal feedback loop (see Figure 1), where “S” stands for positive feedback and “O” stands for negative feedback; Establish a system dynamics framework containing variables and mathematical equations to carry out long-term dynamic quantitative simulation and simulation of the cultural technology fusion innovation feedback mechanism.

The ability of scientific and technological innovation has an important influence on the ability of cultural science and technology integration. The ability of scientific and technological innovation is an important driving force for the realization of cultural science and technology integration and innovation. The completion of cultural and artistic science and technology research projects represents the basic research and applied research results related to cultural science and technology; the innovation of science and technology refers to the initiative of scientific research personnel for scientific and technological innovation. And enthusiasm, subject to factors such as the perfection of incentive mechanism; and the cooperation of industry, university and research is an important means and method to improve the ability of innovation. The greater the cooperation, the more research results and cultural innovation talents obtained from the alliance of industry, universities and research institutes.

3. SD flow chart of cultural and technological integration and innovation
Based on the causality diagram above, this paper introduces state variables (levels), rate variables (rates), auxiliary variables (Auxiliary), and constants (Constant) to construct a system flow diagram of cultural science and technology fusion innovation (see Figure 1).

![Figure 1. Cultural Technology Fusion and Innovation SD Model](attachment:image.png)
The mathematical formulas of each variable are set according to the basic principles of the system dynamics equation and the actual meaning of each system variable. There are 4 state variables, 7 rate variables, 4 constants and 20 auxiliary variables in the system. At the same time, in order to ensure the accuracy of the simulation results, this paper puts forward the following assumptions: (1). According to the process of cultural system reform and the actual operation of cultural science and technology integration and innovation, this paper assumes that the initial time of simulation is 2005; (2). The ability of cultural science and technology integration is directly determined by the ability of science and technology transformation and cultural transformation. Under the same external conditions, the stronger the ability of science and technology transformation and cultural transformation, the stronger the fusion of culture and technology, and vice versa; (3). To simplify the model, this paper assumes that the number of graduates is determined by the number of students enrolled and the number of non-graduates, and the number of students enrolled depends mainly on the number of employees in cultural and educational institutions.

4. Parameter settings
In the process of setting up the model equations, the selection and determination of each parameter are based on the data obtained from the survey and analysis of the statistical yearbooks of the relevant years, mainly referring to the Statistical Yearbook of Chinese Cultural Relics (2006-2013). Specifically: (1). for the initial value of the state variables in the model, it mainly comes from the statistical yearbook and relevant empirical data. The initial value of the number of cultural and artistic scientific research projects and the number of graduates are from the Chinese Cultural Relics Statistical Yearbook 2006, 300 respectively. The initial value of cultural technology fusion ability and creative content enrichment is calculated based on relevant experience and statistics. The initial value of cultural technology fusion ability is 5, and the initial value of creative content enrichment is 2. (2). the four constants appearing in the model are obtained through the above statistical yearbook. The initial value of the cultural and artistic science and technology research and development institutions is 122, the number of middle and senior titles is 188, and the number of graduates in cultural and educational institutions is 13,952. The number of institutions is 186.

5. Main equation design ideas
L1 Creative Content Enrichment = INTEG (Cultural Innovation Capability - Obstacles in Cultural Innovation, 2).
R1 cultural innovation ability = cultural product form + cultural communication path + cultural expression; cultural innovation ability mainly consists of three levels: cultural product form, innovative cultural communication path and unique cultural expression.
A1 Cultural product form = 0.3* Technology conversion capability; the ability to transform technology can have a positive impact on the appearance and specific forms of cultural products. From the perspective of the effective patent composition in China, the proportion of design patents is about 35%, and the proportion of successful conversion is relatively low, so the relevant vacation is set at 30%.
L2 cultural technology integration ability = INTEG (cultural transformation ability + technology transformation ability, 5).
R2 cultural transformation ability = (innovative environment + cultural innovation mechanism + cultural innovation concept) * cultural intermediary market perfection;
Through the three dimensions of innovation environment, cultural innovation mechanism and cultural innovation concept, the reaction of culture to science and technology is realized, and the strength of reaction is affected by the perfection of cultural intermediary market. The higher the perfection of cultural intermediary market, the stronger the cultural transformation ability. The impact of technological innovation is also greater.
A2 cultural intermediary market perfection = Intermediary market (Time);
With the gradual deepening of the cultural system reform and the increasingly perfect cultural intermediary market, this paper uses the table function to measure the perfection of the cultural
intermediary market. The specific table function is set as: \text{Intermediary market} = \text{Lookup}\{ (2005,0) - (2012, 0.9) \}, (2005,0.2), (2007,0.3), (2008,0.5), (2009,0.6), (2010,0.7), (2011,0.8), (2012,0.9) \}.

The number of graduates is expressed by the difference between the number of students enrolled in cultural and educational institutions and the number of ungraduated students, the initial value of which is obtained from the statistical yearbook.

\text{L3 number of graduates} = \text{INTEG} \left( \text{number of students enrolled} - \text{number of non-graduates}, 19572 \right);

\text{A3 Technology Innovation Power} = 0.001 \times \text{Number of Graduates} \times \text{Innovation Incentive Mechanism};

The power of scientific and technological innovation mainly depends on the number of graduates with relevant professional foundations and the perfection of innovation incentives. Due to the current professional misconduct in the employment of college graduates in China, the number of professionals related to culture is insufficient, which affects the motivation for innovation. Therefore, it is assumed that graduates who have engaged in this profession after graduation and have certain willingness to innovate in science and technology account for 1‰ of the total number of graduates.

6. Model validity test

Model validity testing is an important criterion for judging the predictability and accuracy of SD models. The ability of cultural science and technology integration is mainly formed through the interaction of various elements within the system. The number of completions of cultural and artistic science and technology research projects and the number of graduates are important variables for improving the ability of scientific and technological innovation and realizing the integration and innovation of culture, science and technology. For this reason, this article uses "Chinese cultural relics." Based on the Statistical Yearbook (2006-2013) and using the 2005 value as the initial value, the validity of the model was tested using the Vensim PLE software. The results are shown in Table 1.

| year | Number of cultural and artistic science and technology research projects completed | Number of graduates |
|------|---------------------------------------------------------------------------------|---------------------|
|      | Simulation value | Actual value | Error rate | Simulation value | Actual value | Error rate |
| 2005 | 300               | 300          | 0          | 19572           | 19572        | 0          |
| 2006 | 351.823           | 360          | -0.0227    | 20863.4         | 21166        | -0.0143    |
| 2007 | 304               | 244          | 0.2459     | 22147.5         | 22772        | -0.0274    |
| 2008 | 336.066           | 333          | 0.0092     | 20115.8         | 20237        | -0.00599   |
| 2009 | 384.534           | 390          | -0.014     | 21132           | 20918        | 0.0102     |
| 2010 | 325.452           | 315          | 0.0332     | 22061           | 22165        | -0.00469   |
| 2011 | 220.467           | 215          | 0.0254     | 21453           | 21775        | -0.0148    |
| 2012 | 251.64            | 259          | -0.0284    | 21760           | 21828        | -0.0031    |

It is not difficult to see from Table 1. Except for 2007, the error rate of the system simulation value and the actual value is small, and the average error rate is less than 5%. The reason for the large error rate of the completion number of cultural and artistic science and technology projects in 2007 is 2007. The number of cultural and artistic research and development institutions decreased, and the number of senior titles decreased from 972 in 2006 to 944 in 2007, resulting in a decrease in the number of scientific research projects, which led to a significant decline in the number of scientific research projects in 2007. Therefore, according to the system structure, the principle of system function is determined. From the overall perspective, the model can better simulate the path and implementation of cultural science and technology fusion innovation in reality, and meet the scientific and rigorous requirements of research.
7. Parameter sensitivity analysis
System dynamics is a simulation of real-world systems. The research object is complex, and the function description of the relationship between variables has a certain degree of subjectivity. Therefore, in order to make the model simulation analysis and policy recommendation more scientific. In this paper, the sensitivity analysis method is used to study the more sensitive parameters and policies in the model. After the simulation and the observation of the changes in the relevant behavior curves, it is found that the cooperation between industry, universities and research institutes, the perfection of incentive mechanism, the perfection of cultural intermediary service system and market demand. Four variables, such as prediction accuracy, are more sensitive to the model.

(1) Industry, university and research cooperation. Under the condition of keeping other variables unchanged, the ability of industry-university-research cooperation will be increased by 0.1 from the current value, and the sensitivity analysis of the cooperation between industry, university and research institutes can be known (see Figure 2). The cooperation between industry, university and research institutes will be promoted to develop in depth and direction. Output has a significant positive impact. Through the cooperation of industry, university and research institute, on the one hand, it can realize the sharing of benefits and risk sharing on the basis of satisfying the utility of both parties. Participating in the cooperation of industry, university and research institute not only obtains invention patents, utility model patents and design patents, but also greatly enhances its technological innovation ability. On the other hand, the ability of scientific and technological innovation is the basis of the ability to transform science and technology. Through the transformation of science and technology, the path of cultural communication, the external manifestation of cultural products, and the scientific and technological connotation and humanistic connotation of cultural products are enhanced. Finally, cultural creativity is enriched. The cultural content of “content is king” integrates innovation goals.

![Figure 2. The influence of industry-university-research cooperation on integration innovation](image)

(2) The degree of innovation incentives. When keeping other variables constant, through continuous debugging of the model, it is found that the degree of perfection of innovation incentive mechanism is positively correlated with the output of cultural science and technology integration innovation (see Figure 3), and the degree of perfection of cultural innovation incentive mechanism is to determine cultural technology. The main factors driving the innovation of personnel science and technology. At the same time, whether the incentive mechanism of cultural enterprises and research institutions is competitive and can meet the material and cultural needs of employees also plays an important role in promoting the behaviour of cultural and scientific personnel to actively declare scientific research projects. At present, the innovation incentive mechanism of Chinese cultural enterprises and research institutions is not perfect, and some incentive clauses have not been effectively implemented. Therefore, it is difficult for cultural and scientific personnel to form a “positive strengthening” effect, which limits
the innovation motivation and talent utility of cultural and scientific personnel. Increasing the ability of cultural and technological integration and enriching cultural and creative content has a negative impact.

![Graph showing cultural technology integration ability and creative content enrichment](image1)

**Figure 3.** The impact of incentive mechanism perfection on fusion innovation

(3) Market demand forecast accuracy. Figure 4 shows the simulation results obtained by adjusting the market demand forecasting accuracy by 0.1 when the other variables are kept unchanged. It is concluded that there is a positive correlation between the market demand forecasting accuracy and the output of cultural science and technology fusion innovation. However, since the market demand itself is not easy to be detected and evaluated, and is affected by the macroeconomic environment and the policy environment, the impact of market demand forecasting accuracy on the cultural and creative industries is more prominent. Under the conditions of market economy, cultural innovation must be market-oriented, and the evaluation of social value and economic value of the form and content of cultural innovation in combination with market demand can enrich the creative content and satisfy consumers' demand for cultural and creative products.

![Graph showing market demand forecasting](image2)

**Figure 4.** The impact of market demand forecasting on fusion innovation

(4) The perfection of the cultural intermediary service system. Improving the cultural transformation ability and improving the feedback mechanism of science and technology can be realized mainly by perfecting the cultural intermediary service system. The cultural intermediary service system has a bridge role in the transformation of culture and science and technology. The cultural intermediary
service system referred to in this paper mainly includes the cultural market intermediary organization system and the cultural and financial intermediary service system. It can be seen from Figure 6 that the improvement of the cultural intermediary service system is improved by 0.1, the cultural science and technology integration ability and the richness of creative content are increased, indicating that the cultural intermediary service system perfection degree has a correlation with the cultural technology integration innovation output. However, compared with the accuracy of market demand forecasting, the impact of the perfection of cultural intermediary service system on cultural and technological integration and innovation output is not very significant at this stage in 2005-2010, and the relevant behavioural curve has changed significantly since 2011. The reason is because before 2011, the cultural intermediary service system has been in a slow development stage for a long time, and since the Sixth Plenary Session of the Seventeenth Central Committee of the Party in 2011, it has clearly proposed to improve the modern cultural market system, strengthen the construction of intermediaries, and increase financial support. After the resolution on cultural support, the cultural intermediary institutions were further improved, and the construction of cultural and financial intermediary service systems was gradually carried out, which greatly promoted the integration of culture, science and technology.

![Image of Figure 5](image_url)

**Figure 5.** The Influence of Cultural Intermediary Service System on Fusion Innovation

8. **Summary**

Through the system dynamics modeling and simulation, this paper establishes the realization path of cultural and technological integration innovation in the feedback mechanism of cultural science and technology fusion innovation and the main factors affecting the fusion of culture and technology, which not only makes up for the lack of quantitative research in the current cultural science and technology fusion innovation research. The lack of analysis also provides corresponding countermeasures and suggestions for promoting the integration of culture, science and technology. However, there is still some subjectivity in the selection process and parameter setting in the modeling process. Therefore, in the subsequent research, statistical correlation methods can be used to set the relevant parameter values to further improve the model operation. The scientificity of accuracy and conclusion.

**Acknowledgements**

Key Research Project of Humanities and Social Sciences, Department of Education of Anhui Province, “Study on the inheritance and innovation of Anhui Hangong opera in the view of the protection of intangible cultural heritage “(Project No. SK2017A0894).

**References**

[1] Freeman C. Networks of innovators: a synthesis of research issues [J]. Research Policy, 2001, (20): 86 - 92.
[2] Forrester J W. Industrial dynamics: A breakthrough for decision makers [J]. Harvard Business Review, 2008, 36 (4): 37 - 66.

[3] Caves, R. Creative Industries: Contracts between Art and Commerce [M]. Harvard University Press, 2002.