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Scientific Breakthrough Study of Extenics

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Abstract

Extenics is a frontier science which is a young and new discipline. This paper presents the scientific breakthrough or progress study of extenics over the past 33 years. This research framework is based on the National Research Council’s results in 2006, which identified five dimensions of scientific progress, which are Discovery, Analysis, Explanation, Integration, and development. We reached the conclusion that Extenics made some progress, according to the five progress dimensions. We provide guidelines for researcher’s future advancement.

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Keywords: Extenics; Scientific breakthrough; making progress

1. Introduction

The discipline of Extenics is defined as “a science which studies the possibility of extending things and rules and methods of developing innovation with formalized patterns, and is used to resolve contradictory problems.” (Cai, 1983) [1]. From 1976, Dr. Wen Cai started to do research related to Extenics, such as laws, theories and methods for dealing with incompatible problems. The paper ”Extension Set and non-compatible Problem”, which was published in 1983, marked the birth of new science discipline Extenics (originally called Matter-element Analysis) [2]. Extenics studies the paradoxical problem of objective world, at present, it has established the model of formal description and take advantage of the extension and extension transformation of things, it establish the extension method and extension engineering approach of resolving the contradiction problems. The essence of Extenics is to transform various problems seemingly contradictory or insoluble to solvable problems according to the extension methods.

Extenics is a young and new discipline, which has the chance for many breakthroughs. Every new discipline has the need for development, such as develop new theories, new methods, or integrated with other disciplines. We can study the path of Extenics’ development, then know how to make this new discipline improvement in
the future based on a scientific progress view. Also, we can foreshadow how Extenics might develop and evolve over long periods of time.

Scientific view of breakthrough has many kinds of models. Such as Sarton in 1936 state: “progress has no definite and unquestionable meaning in other fields than the field of science”. Basically, it is based on the nature of scientific progress and the paths that lead to realizing the potential scientific and social outcomes of scientific activity. Scientific progress is not just gathering theories, but also making integration with applications, then contribute to the discipline advancement [3]. It is not just summary how many new theories are generated, how many new methods are published, but also other issues, like the integration with other disciplines no matter they are old or new.

This research paper uses the scientific progress framework to assess the Extenics discipline. Some indicators will be used in this framework. Then discuss hidden discovers for the current Extenics discipline. An important goal of this research paper is to use the findings for describing avenues for future Extenics research.

2. Theory Literature

Extension theory, extension engineering, and extension innovation methods integrated together contributed to Extenics as a new interdisciplinary discipline.

Extension theory includes basic-element theory, extension set theory and extension logic. Basic-element theory discusses the extensibility of basic-elements and rules of extension transformation, and studies the extension models which combine qualitative and quantitative property (Jiang, 2013) [4]. Such as extensible analysis theory, conjugate analysis theory, and extension transformation theory.

Extension set theory is the extension from traditional set theory. It is a quantitative tool which depicts the mutual transformation of matters between the positive and the negative, and the process of quantitative change and qualitative changes (Yang, 2014) [5]. Like, extension set and dependent function.

Extension logic is a science that studies the transformation alteration between contradictions and consistency, and rules of reasoning. It is the logic foundation of Extenics (Jiang, 2013) [6]. Extension model is the basic framework of this logic. Extension reasoning is the important process here, which include basic-element extension reasoning, conductive reasoning and conjugate reasoning. Basic-element expression, extension of proposition and reasoning sentence together as the key element of the logic. Furthermore, reasoning of solving contradictory problems as the main results of the extension logic.

Extension engineering applies extension methods, such as divergent tree, decomposition and combination chains, correlative net, implication system and conjugate pair, superiority evaluation, true or false information judgment methods; basic transformations, compound transformations and transmission methods; rhombus thinking methods and transforming bridge methods to solve contradictory problems in such fields as engineering technique, social economy, management science, computer science, biomedicine, and traffic environment protection. All the methods are based on extension theory (Yang & Cai, 2013) [7].

Extension innovation method is the main method for innovation activity. It is kind of methods with the combination of formalization, quantification and logicalization. And extension innovation method can be seen from existing application achievements that they can be used in product innovation and technological innovation as well as other innovative activities such as organizational innovation and management innovation (Yang, 2013).

Scientific breakthrough study uses some scientific methods to judge this discipline made progress or not. “Science is a multi-layered complex system involving a community of scientists engaged in research using scientific methods in order to produce new knowledge” (Niiniluoto, 2015) [8]. Breakthrough or progress can thus manifest differently for distinct layers of science.

There are kinds of scientific breakthrough theories exist in the academic world. By far the best known modern theory of scientific progress is that of Thomas Kuhn (1962) [9], which focuses on the major innovations that have punctuated the history of science in the past 350 years, associated with such investigators as Copernicus, Galileo,
Lavoisier, Darwin, and Einstein. Science, in Kuhn’s view, is usually a problem-solving activity within clear and accepted frameworks of theory and practice, or “paradigms.”

There are also evolutionary models of scientific development. In evolutionary views, science continually produces new ideas, which, like genetic mutations, are essentially unpredictable. Stephen Cole (1992) [10] emphasized a distinction between the frontier and the core of science that seems consistent with an evolutionary view. Work at the frontiers of sciences is characterized by considerable disagreement; as science progresses over time, disagreements are resolved as processes such as empirical confirmation and paradigm shift select out certain ideas, while others become part of the received wisdom. Extenics is such a frontier science that is heavily debated.

3. Framework

The literatures gives us a preview of scientific progress history, which means it presents kinds of models in the past decades. Then the choosing of an appropriate model is important to the assessment here. Based on many factors, such as easy to measure, this research paper choose a framework from a famous institution. The National Institute of Health (NIH) presents a distillation of insights from this research into a short checklist of major types of scientific progress. These broad categories may overlap or interdependent, because each kind of progress is possibly to affect the others, directly or indirectly.

Based on the National Research Council’s results in 2006, identified five dimensions of scientific progress, as depicted in table 1.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Discovery</td>
<td>Science makes progress when it demonstrates the existence of previously unknown phenomena or relationships among phenomena, or when it discovers that widely shared understandings of phenomena are wrong or incomplete</td>
</tr>
<tr>
<td>Analysis</td>
<td>Science makes progress when it develops concepts, typologies, frameworks of understanding, methods, techniques, or data that make it possible to uncover phenomena or test explanations of them</td>
</tr>
<tr>
<td>Explanation</td>
<td>Science makes progress when it discovers regularities in the ways phenomena change over time or finds evidence that supports, rules out, or leads to qualifications of possible explanations of these regularities</td>
</tr>
<tr>
<td>Integration</td>
<td>Science makes progress when it links theories or explanations across different domains or levels of organization</td>
</tr>
<tr>
<td>Development</td>
<td>Science makes progress when it stimulates additional research in a field or discipline, including research critical of past conclusions, and when it stimulates research outside the original field, including interdisciplinary research and research on previously under researched questions</td>
</tr>
</tbody>
</table>
4. Analysis and Results

4.1. Discovery

“Science makes progress when it demonstrates the existence of previously unknown phenomena or relationships among phenomena, or when it discovers that widely shared understandings of phenomena are wrong or incomplete” (NRC, 2006) [11]. One aspect of discovery is identifying a problem or anomaly which can’t be fully explained with existing theories and concepts. Reconsidering the significance of a previously discovered problem also belongs here. Scientific discoveries originate from individuals or small groups and evolve in unpredictable ways. The more important the discovery, the more unpredictable is the reaction to the discovery (NRC, 2006) [11].

In 1983, Dr. Cai defined the discipline of Extenics as “a science which studies the possibility of extending things and rules and methods of developing innovation with formalized patterns, and is used to resolve contradictory problems”. According to the definition, we can identify that the current methodologies are not enough to solve innovation problems. Extenics uses formal model to do the research of the possibility of expand thinking, so the previously rules and methods of solving the paradoxical problem of science are not complete, Extenics discovered a lot of methods or rules to explore the widely shared understandings of phenomena. Such as Extenics theories include basic-element theory, extension set theory and extension logic contribute a lot to discover the wrong or incomplete unknown phenomena or relationships through a scientific methods and rules.

4.2. Analysis

“Science makes progress when it develops concepts, typologies, frameworks of understanding, methods, techniques, or data that make it possible to uncover phenomena or test explanations of them. Thus, knowing where and how to look for discoveries and explanations is an important type of scientific progress. Improved theory, rigorous and replicable methods, measurement techniques, and databases all contribute to analysis” (NRC, 2006) [11]. Researchers should be aware of the limitation of limited knowledge, so they are in need for sharing ideas and concepts within or beyond their own field, thus this behavior gives them foundation to develop new advancements.

There is much evidence to support the analysis dimension, or we can say Extenics have an obviously scientific breakthrough from this perspective. Extenics created a lot of improved theory, rigorous and replicable methods, and measurement techniques, all of them contribute to the breakthrough. Extension theory, included basic-element theory, extension set theory and extension logic is a great example of improved theory. Extension engineering applies extension methods, such as divergent tree, decomposition and combination chains, correlative net and others is another example of improved frameworks of understanding. Extension innovation methods as the kind of methods with the combination of formalization, quantification and logicalization, represent the improved methods, techniques (Jiang, 2013) [6].

4.3. Explanation

“Science makes progress when it discovers regularities in the ways phenomena change over time or finds evidence that supports, rules out, or leads to qualifications of possible explanations of these regularities” (NRC, 2006) [11]. It is important to question observed phenomena and improve the understanding about them. Question the observed phenomena lead to its understanding and improvement.

Extenics as a new discipline, is used to resolve contradictory problems. Contradictory means different opinions about the same problem. The reason of different opinions is the current theories are not efficient any more to answer the current problem, such as current problem evolved. Extenics as a framework to solve the
evolved problem with evolved theories. Such as the extension set logic, extension set theory, extension logic and others. All of existence of the framework of extenics is to question the observed and unable to solved phenomena, using the Extenics methods to improve the understanding about them, then continue to solve the observed phenomena. So the mechanism of Extenics is a nature of explanation.

4.4. Integration

“Science makes progress when it links theories or explanations across different domains or levels of organization. Thus, science progresses when it produces and provides support for theories and explanations that cover broader classes of phenomena or that link understandings emerging from different fields of research or levels of analysis” (NRC, 2006). Sharing boundary is becoming one of the trait of field progress. Integration is a continuing process and even exists within scientific fields. So integration is always play a significant role for progress.

Extenics made plenty progress from this dimension, many authors published research papers and books about the integration of Extenics and other disciplines. Such as in 2015, Xingsen Li, et al. published "An extension collaborative innovation model in the context of big data." on International Journal of Information Technology & Decision Making. In 2013, Li, Zhong, et al published "A prediction model for Yellow River break-up dates based on Extenics data mining." on Fuzzy Systems and Knowledge Discovery (FSKD), 2013 10th International Conference on. IEEE. Also, we can check the researchers from different preexisting fields collaborate to work on a common set of problems or not. Furthermore, if there are theories are tested and adopted in other fields could also prove the integration. From data driven view, co-citation Analysis is an acceptable method to show how much is the integration is at the moment.

4.5. Development

“Science makes progress when it stimulates additional research in a field or discipline, including research critical of past conclusions, and when it stimulates research outside the original field, including interdisciplinary research and research on previously underresearched questions. It also develops when it attracts new people to work on an important research problem” (NRC, 2006) [11]. Scientific progress sometimes arises from efforts to solve technological or social problems in environments that combine concerns with basic research and with application. So the stimulation could be in a field or other fields, furthermore, the simulation even could be within or outside the academic area.

Extenics is always in the process of development, and it never stop [12]. More and more papers are published, and an increasing number of authors are becoming interested in the Extenics research, the funding to support is also higher than previous years [13]. Many Extenics activities are organized in the past and future years, such as in 2013, the “1st International Symposium on Extenics and Innovation Method & the 30th Anniversary of the Foundation of Extenics” was held in Beijing, China. Highly promising junior scientists choose Extenics to pursue new concepts, methods, or lines of inquiry, and students are increasingly attracted to the Extenics field, as indicated by enrollments in new courses and programs in the field.

5. Conclusion

Extenics as a new discipline, has a history of 33 years now, based on the previous section’s analysis, it has some scientific breakthroughs according to the five dimensions of the framework. It developed some concept, methods and technologies. On the other hand, it attracted more researchers with high quality publications. Moreover, it integrated with other disciplines, such as the integration with data management, engineering and other fields.
Another goal of this research paper is to give some guidelines for future, based on our framework, Extenics should according to these five dimensions to make more progress, such as do more integrations, and publish more papers or books, then finally transfer from a frontier discipline to a mature discipline. The framework could also be improved, such as adding more dimensions, or combine some dimensions. We should improve it as future work.

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References