Postprint of EI-Based Research on Disciplinary Characteristics of Knowledge Co-occurrence in Domestic Aviation Institutions

Authors: Ma Minghua, Liu Jianguo, Ma Yue, Wanpeng Su

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Abstract

[Purpose / Significance] Through discipline characteristic analysis based on knowledge co-occurrence, this study provides reference for discipline construction and library information resource allocation of domestic aviation institutions. [Method / Process] By extracting document discipline classification codes from journal papers of aviation institutions indexed by EI, utilizing methods such as term frequency statistics, word co-occurrence analysis, and social network analysis, this paper analyzes discipline characteristics of domestic aviation institutions, and introduces the Pearson correlation coefficient indicator. Through network graph centrality features, the discipline cross-integration characteristics under conditions of extremely strong correlations among aviation institution disciplines were obtained. [Results / Conclusions] Discipline topics of aviation institutions exhibit long-tail distribution characteristics and the "80/20 phenomenon"; in discipline knowledge co-occurrence, discipline association and cross-integration formed a knowledge graph of six category zones and four discipline clusters.

Full Text

Research on the Subject Characteristics of Knowledge Co-occurrence of Domestic Aviation Colleges Based on Engineering Index

Ma Minghua, Liu Jianguo, Ma Yue, Su Wanpeng
The Library of Civil Aviation University of China, Tianjin 300300

Abstract

[**Purpose/significance**] This study aims to provide a reference for the discipline construction and library information resource allocation of domestic aviation colleges through analyzing subject characteristics based on knowledge co-occurrence. [**Method/process**] By extracting literature subject classification codes from EI-indexed journal papers of aviation colleges, this research analyzes the disciplinary characteristics of domestic aviation institutions using word frequency statistics, word co-occurrence analysis, and social network analysis methods. Additionally, the Pearson correlation coefficient index is introduced to obtain interdisciplinary integration characteristics of aviation colleges under conditions of strong disciplinary correlations through the centrality features of network maps. [**Result/conclusion**] The findings reveal that subject themes in aviation colleges exhibit a long-tail distribution characteristic and the "80/20 rule." In disciplinary knowledge co-occurrence, subject associations and intersections form a knowledge map comprising six categories and four discipline clusters.

Keywords: aviation; social network; interdisciplinary integration

1 Introduction

Discipline construction represents a long-term, fundamental strategic task for higher education institutions and constitutes the top priority in university development. The increasing differentiation and integration of scientific development mean that discipline construction is no longer merely a matter of individual disciplines, but must be studied and explored based on discipline clusters to thoroughly investigate the essential connections among internal elements within these clusters. This work relates to the construction and development of various educational levels in universities, determines whether disciplines and majors possess adaptability, competitiveness, and vitality, and affects the ability of institutions to cultivate high-quality talent, produce high-level research outcomes, and better serve national construction and social development. Furthermore, characteristic discipline construction embodies the core competitiveness of universities, and studying characteristic discipline construction from the perspective of disciplinary knowledge co-occurrence represents an important measure for enhancing comprehensive institutional strength. Aviation colleges possess distinctive aerospace characteristics, and researching the features of key disciplines in these institutions holds practical significance for improving their core competitiveness and optimizing library information resource allocation.

2 Research Methods

This study primarily employs word frequency statistics, word co-occurrence analysis, and social network analysis methods to construct disciplinary knowledge co-occurrence maps based on collected data for statistical analysis.

Word frequency statistics is a quantitative research method that uses mathematical statistical techniques to transform literature expressed in language into data represented by numbers. **Word co-occurrence analysis**, built upon word frequency statistics, is a method for statistically analyzing keywords that appear together in literature, first proposed in 1986 by French bibliometrician M. Callon and colleagues [1-2]. This method is based on the assumptions that authors carefully select the words they use and recognize certain connections between different words within the same article. If such connections are recognized by a sufficient number of authors, they can be considered meaningful within a particular disciplinary field [1,3].

Social network analysis is a commonly used method in social science research. A social network consists of multiple nodes (social actors) and the connections between them (relationships among actors). This approach incorporates concepts and processes related to "relationships" into its explanations, treating objects as network graphs containing many nodes connected by lines. Social network diagrams emphasize not individual characteristics but rather the connections between individuals [4]. Theoretically, any scientific, academic, or other community, or even a company, university, or the entire world, can be viewed as a social network. Ma Feicheng and colleagues mapped concepts in co-word networks to individual nodes in social networks and used social network analysis to map the knowledge domain of domestic life cycle theory research, providing a macro-level understanding of its research status [5].

Relevant literature on aviation discipline research from the perspective of discipline construction based on the EI database is relatively scarce. Chen Suqing and colleagues approached from the angle of improving SCI and EI paper citation rates, conducting statistical comparisons of journal paper indexing quantities, journal distributions, and languages across four aviation colleges, and formulated policies to enhance citation rates [6]. Liu Hua and Xu Guoyan used CNKI's China Academic Literature Network Publishing Database to conduct statistical studies on highly cited papers in domestic aviation fields regarding journal distribution, research institutions, authors, and funding support [7]. The limitation of these studies lies in their failure to examine the issue from the perspective of the main body of aviation college discipline construction, offering limited practical guidance for university discipline construction.

This paper primarily conducts word frequency statistics and co-occurrence analysis on EI subject classification terms provided by paper authors, uses Netdraw software to draw social network knowledge maps, and analyzes aviation discipline characteristics based on these maps.

3 Data Collection and Extraction

The aviation discipline is a highly comprehensive, interdisciplinary engineering theory discipline involving aerospace, mathematics, physics, materials, electronics, communications, mechanical automatic control, and various other fields. The number of major domestic aviation colleges is limited. Accordingly, the scope of aviation institutions was determined through online investigation, identifying 14 schools with aerospace as their primary disciplinary orientation (referred to as "university type"), including Beihang University, Northwestern Polytechnical University, Nanjing University of Aeronautics and Astronautics, Nanchang Hangkong University, Shenyang Aerospace University, Civil Aviation University of China, Zhengzhou University of Aeronautics, Civil Aviation Flight University of China, North China Institute of Aerospace Engineering, Guilin University of Aerospace Technology, Xi'an Aeronautical University, Xi'an Aeronautical Polytechnic Institute, Changsha Aeronautical Vocational and Technical College, and Zhangjiajie Institute of Aeronautical Engineering. Additionally, 14 universities with secondary-level aerospace discipline training (referred to as "secondary college type") were identified, including the School of Mechanics and Aerospace Engineering at Hunan University, the Department of Aerospace Engineering at North University of China, the School of Aeronautics and Astronautics at Shanghai Jiao Tong University, the School of Aerospace at Xi'an Jiao Tong University, the School of Aeronautics and Astronautics at Zhejiang University, the School of Aerospace Engineering and Mechanics at Tongji University, the National Defense Education College and Armed Forces Department at Harbin Engineering University, the College of Aerospace Science and Engineering at National University of Defense Technology, the School of Aerospace Engineering at Tsinghua University, the School of Aerospace Engineering at Beijing Institute of Technology, the School of Astronautics at Harbin Institute of Technology, the School of Aeronautics and Astronautics at Dalian University of Technology, the Department of Aeronautics at Xiamen University, and the School of Air Transportation at Shanghai University of Engineering Science.

In the EI COMPENDEX database, detailed literature information for EI papers from these 28 institutions published between 2009-2013 was retrieved. The retrieval formula for university-type institutions was ({University English Name} wn all) AND (2009-2013 WN YR), while for secondary college-type institutions it was ({Secondary Unit, University} wn all) AND (2009-2013 WN YR). After removing conference papers, a total of 31,748 journal papers (document type JA) were obtained.

3.1 Analysis of Publication Volume of Aviation Colleges

Statistical analysis of EI-indexed publications from aviation colleges between 2009-2013 reveals extremely unbalanced research output, as shown in [Figure 1: see original paper]. The top three institutions in terms of publication volume are Northwestern Polytechnical University, Nanjing University of Aeronautics and Astronautics, and Beihang University, with 8,912, 8,736, and 7,131 EI-indexed papers respectively during 2009-2013. The combined total of these three aerospace-focused institutions is 24,781 papers, accounting for 78% of the overall publication volume. Among the top 10 institutions in the aviation field, four secondary college-type institutions rank in the top 10: the School of Astronautics at Harbin Institute of Technology (5th), the School of Aerospace Engineering at Tsinghua University (6th), the School of Aerospace Engineering at Beijing Institute of Technology (7th), and the College of Aerospace Science and Engineering at National University of Defense Technology (9th). These institutions are key domestic science, engineering, or military universities with relatively strong research capabilities in their aerospace colleges. Vocational colleges such as Changsha Aeronautical Vocational and Technical College rank in the bottom five, directly reflecting their very limited research capacity.

3.2 Subject Theme Extraction

The EI thesaurus consists of two main components: a descriptor list and subject classification codes [8], with the latter used for computer-based classification retrieval. This study specifically conducts bibliometric analysis on the subject classification code field (hereinafter referred to as the "subject theme field").

3.2.1 Subject Theme Frequency Analysis Using Bibexcel to extract EI subject theme fields from the literature information, a total of 790 subject theme fields were extracted, with a cumulative frequency of 245,950 across all subjects, averaging 7.74 classification codes per article. Frequency statistics were conducted for each subject theme field, with results sorted and word frequency probabilities calculated. shows the top 20 subject classification codes by frequency and probability, revealing high probabilities for mathematics, computer software, data processing and applications, building material strength, materials science, mechanical properties, mechanics, numerical methods, chemistry, control systems, chemical products, solid-state physics, gases, liquids and solid-state physical properties, radar, broadcasting, and telecommunications.

3.2.2 Subject Theme Word Frequency Distribution By calculating probabilities for the sorted subject theme words, a disciplinary word frequency distribution curve can be plotted as shown in [Figure 2: see original paper], where the horizontal axis represents the rank order of each subject theme word (referred to as "word order," which corresponds to the discipline), and the vertical axis represents the probability of each subject's frequency in the total disciplinary frequency. The curve reveals the overall distribution trend, showing that the disciplinary word frequency distribution exhibits typical long-tail characteristics. Cumulative probability calculations for each discipline yield a cumulative probability curve shown in [Figure 3: see original paper], where the horizontal axis represents the number of disciplines being accumulated (referred to as "quantity") and the vertical axis represents the cumulative probability value (the mathematical concept of "cumulative probability"). The cumulative probability curve in [Figure 3: see original paper] shows that the cumulative probability for the top 160 disciplines is 79.8%, reflecting the "80/20 rule" in disciplinary frequency—during 2009-2013, the subject themes researched by aviation colleges were concentrated in 20% of the disciplines, which accounted for 80% of total occurrences, representing the main research areas of aerospace institutions.

3.2.3 Subject Theme Co-occurrence After data processing, a 790$×$790 co-occurrence matrix file for disciplines was obtained. The top 10 knowledge co-occurrence disciplines in demonstrate both the correlation between different disciplines (i.e., disciplinary synthesis and intersection) and their mutual support functions. Taking mathematics as an example, its high co-occurrence frequencies with computer software, data processing and applications, control systems, mechanics, and numerical analysis reflect its substantial support for these disciplines. Using the disciplinary co-occurrence matrix and Netdraw software, a social network composed of various disciplinary actors was created, containing 790 network nodes and 57,678 connections (ties). To facilitate analysis, this paper selects the top 160 disciplines with the highest frequencies based on the aforementioned "80/20 rule" characteristic of cumulative disciplinary probability, while also selecting 16 aerospace-related disciplines from the long-tail distribution to minimize information loss, resulting in 176 disciplinary nodes for constructing a discipline cluster co-occurrence map for in-depth analysis.

4 Pearson Correlation Index and Interdisciplinary Integration Map

4.1 Introduction to Pearson Correlation Index

Aerospace disciplines are highly comprehensive, resulting from the development of knowledge across multiple disciplinary fields. For example, the characteristic discipline "Aerospace Science and Technology" in aviation colleges is itself a comprehensive field, encompassing aircraft design, aerodynamics, structures, stealth technology, control systems, aviation materials, and other aspects. Research on advanced structural design of aircraft involves aerodynamics, solid mechanics, engineering mechanics, and other domains, demonstrating obvious interdisciplinary integration. The degree of interdisciplinary integration reflects the closeness of relationships between disciplines. This paper conducts deep mining of disciplinary co-occurrence terms in aviation colleges using the Pearson correlation coefficient index X,Y:

X,Y=cov(X,Y)/σXσY=E((X− X)(Y− Y))/σXσY

where cov(X,Y) is the covariance of observed disciplines X and Y, and σX, σY are the standard deviations of observed disciplines X and Y. This Pearson correlation index measures the correlation between selected disciplinary terms. Data matrix processing yields results ranging between [0,1]. If two disciplines show no interdisciplinary integration in any literature, the index is 0; values closer to 1 indicate stronger interdisciplinarity and integration.

4.2 Interdisciplinary Integration Map of Subject Groups

This study selects disciplinary co-occurrences with Pearson indices in [0.8, 1] representing extremely strong correlations, using betweenness centrality of disciplinary nodes as the metric for two reasons: (1) **Network node centrality** represents the power and status of nodes in the network. Nodes with high centrality have stronger influence on other disciplines or output more information to them, providing stronger support and serving as decisive factors in network development. Netdraw analysis software places high-centrality nodes at the network center by default, around which sub-networks tend to aggregate. (2) **Network node betweenness centrality**, derived from sociological theory, indicates that an actor occupying many communication network paths holds an important position due to their ability to control interactions between other nodes. Nodes with high betweenness centrality serve as bridges connecting other nodes, reflecting controlling and connecting functions in disciplinary networks. This paper uses node betweenness centrality to divide the strongly correlated co-occurrence network into subnets for analyzing interdisciplinary integration in aviation colleges. Nodes with high betweenness centrality are displayed with larger icons in the disciplinary network map, as shown in [Figure 4: see original paper], where dashed lines represent divisions of the entire network based on disciplinary associations, nodes represent selected disciplinary theme words, and solid lines represent the strength of associations and information exchange between disciplines—stronger associations are indicated by thicker lines.

5 Analysis of Subject Groups

5.1 Independent Subjects and Discrete Independent Subnet Subjects

Since this study selects Pearson correlation indices in [0.8, 1], disciplines with correlation values below 0.8 appear as isolated points or discrete independent subnets with few connections. The first category consists of isolated subjects that have no extremely strong correlations with other external disciplines, including rocket engines, industrial engineering and management, chemical plants and equipment, and airport sub-disciplines. The second category comprises discrete independent subnet subjects, such as instrument measurement-centered independent subnets (humidity, pressure, radiation measuring instruments, acoustics, optical measuring instruments, electrical and electronic measuring instruments, and mechanical and other measurements), space flight and propulsion fuel combustion-centered subnets (space flight, fuel combustion, gaseous fuels, and liquid fuels), theoretical physics subnets centered on classical physics, relativity, and quantum theory, and communication technology subnets including wired communications, optical communications, and telephone systems and related technologies. Independent subjects and discrete independent subnet subjects reflect the micro-differentiation of aerospace comprehensive disciplines. Since their relationships with external disciplines are not extremely strong, they can be processed separately. This finding has practical implications for university library resource allocation, allowing resources to be acquired individually or according to small-scale, correlated independent subnets.

5.2 Aerospace Science and Engineering Sub-discipline Group

The sub-discipline group network map centers on aircraft general topics, with aerospace disciplines represented by spacecraft, aerodynamics disciplines represented by fluid flow, and aircraft manufacturing disciplines represented by structural design all showing extremely strong correlations with aircraft general topics, forming integrated clustering characteristics. As a type of aerospace vehicle, aircraft development requires overall mechanical basic structural design that considers gas dynamics principles and airworthiness characteristics, reflecting consistency with the aerospace science and engineering disciplines of China's major aviation universities. The most distinctive colleges in China's major aviation institutions are aerospace science and engineering colleges, with research areas including overall design and manufacturing of various aircraft (airplanes, helicopters), aerodynamic performance, structural strength, flight mechanics and flight safety, dynamics and control, and other aspects. Their discipline settings include aerospace science and technology, mechanics, aircraft and helicopter design and manufacturing, aerospace propulsion theory and engineering represented by aircraft avionics and rocket propulsion technology, and air navigation and traffic control represented by aircraft navigation. Related to aircraft manufacturing are disciplines concerning mechanical design theory, while mechanics includes solid mechanics, (aerodynamic) fluid mechanics, and flight mechanics. Aerospace science and engineering also has strong military relevance, including research on national defense and military disciplines in rockets, missiles, and satellites. Additionally, the Aerospace College at Nanjing University of Aeronautics and Astronautics has established disciplines related to roads and railways, associated with tower construction and other fields.

5.3 Metal and Metal-based Materials, Photoelectric Information Functional Materials Sub-discipline Group

The fourth category in the sub-discipline group network map falls within aviation materials. Aerospace applications impose high requirements on materials, and reducing structural weight is an eternal pursuit in aerospace engineering. Materials used in aircraft directly affect performance, with high-quality composites accounting for an increasing proportion of aircraft structures. Advanced materials possess characteristics such as ultra-lightweight, high toughness, fatigue resistance, corrosion resistance, wear resistance, efficient heat dissipation, and formability, making them the preferred choice for aviation materials. Major aerospace universities emphasize materials discipline development. The sub-discipline group network reflects the interdisciplinary integration of metal and metal-based materials, photoelectric information functional materials (semiconductor materials), electromagnetic media materials, biological materials, and nanomaterials. The clustering of these sub-disciplines results from the professional structure of aviation materials disciplines and the internal driving force of advanced material applications in aviation. The discipline settings and research directions of materials colleges in major aviation universities demonstrate the close relationships in the sub-network map: the materials colleges at Northwestern Polytechnical University and Beihang University both evolved from early aviation metallurgy or mining and metallurgy departments, with five professional directions including aviation metal materials and heat treatment, forging, casting, welding, and non-metallic materials and forming. Their discipline settings include first-level disciplines such as materials science and engineering, chemistry, and optical engineering, and second-level disciplines including materials science, materials physics and chemistry, materials processing engineering, information functional materials, micro-nano technology, material structure failure and safety engineering, and applied chemistry. The professional settings of materials disciplines in aviation colleges enhance internal connections between different materials disciplines. Photoelectric information functional materials, biological materials, and nanomaterials all rank within the top 20% of subject terms by frequency. The increasing application of different materials in aviation research fields ultimately forms disciplinary subgroup clustering phenomena. With the upgrading of aircraft products, new materials continue to emerge and be applied in aviation, becoming a driving force for growth in this disciplinary subgroup.

5.4 Electronic Information and Automatic Control Sub-discipline Group

The fifth category in the sub-discipline group network map—the electronic information and automatic control subgroup—demonstrates complex integration, encompassing basic theoretical disciplines (mathematics), engineering disciplines (computers, artificial intelligence robots, mechanical automatic control, electronic information processing and navigation). Basic mathematics occupies the central position in the sub-network, considering applications of mathematical transformation, numerical analysis, mathematical statistics, and mathematical optimization in other engineering disciplines. Computer application disciplines are integrated to provide massive information data computation, rapid processing, aircraft computer navigation control, fine control of mechanical automatic control, and support for artificial intelligence robots, addressing issues such as large data volumes, complex information environments, timely data processing, visualization of abstract data, refined mechanical control, computer CAD engineering drawing, and image processing. Electronic information and automatic control disciplines within the same sub-discipline group indicate strong correlations between these professional disciplines. Electronic information engineering colleges in major aviation universities primarily establish disciplines in electronic science and technology, information and communication engineering, and control science and engineering, conducting research in aviation electronic integration technology, satellite navigation, modern air traffic management, information and communication engineering, and airborne/spaceborne synthetic aperture imaging. Automatic control departments mainly establish disciplines in control science and engineering, transportation engineering, electrical engineering, instrument science and technology, and mechanical electronic engineering, with research directions including control theory and control engineering, pattern recognition and intelligent systems, navigation guidance and control, systems engineering, detection technology and automation devices, and motor electrical appliances and their control. At Northwestern Polytechnical University, both the Electronic Information Engineering College and the Automatic Control College establish first-level discipline control science and engineering, with second-level discipline aviation navigation control involving control and information, satellite navigation, airborne radar and remote sensing information acquisition, control and processing, and transmission. The second-level discipline detection and imaging related to SAR radar synthetic aperture imaging and pattern recognition and intelligent systems are also closely integrated with electronic information and automatic control. This conclusion suggests that universities could consider merging departmental structures based on overlapping research and teaching between electronic information and automatic control colleges to achieve collaborative discipline construction, optimize faculty allocation, and improve efficiency. For library resource allocation, electronic information and automatic control resources can be jointly acquired according to their strong correlations, with physical resources shelved in close proximity to facilitate reader access and reduce search time.

5.5 Aviation Composite Materials Sub-discipline Group

The sixth category in the sub-discipline group network map—the aviation composite materials subgroup—differs from the fourth category's focus on metal and metal-based materials and photoelectric information functional materials. Instead, it clusters aviation composite materials such as ultra-high-temperature inorganic non-metallic materials, coating materials, and polymer materials. Represented by ceramic matrix high-temperature resistant materials and advanced thermosetting and thermoplastic resin matrix polymer materials, inorganic non-metallic materials feature small structural weight, strong integrity, stable physicochemical properties, resistance to aging and weathering, and unique characteristics in durability, high-temperature resistance, waterproofing, fire resistance, making them applicable in aviation [9]. According to the strongly correlated disciplinary subgroup map, basic disciplines (chemistry and related organic chemistry, polymer chemistry, polymer physics, inorganic chemistry, electrochemistry, etc.) and physics-related disciplines (atomic and molecular physics, plasma physics, solid-state physics, etc.) that support inorganic non-metallic materials, coating materials, and polymer materials are located at the center of the sub-discipline group network. These disciplines are also required courses for composite materials and polymer materials majors in major aviation colleges. The sub-map demonstrates the interdisciplinary integration of chemistry, physics, and composite materials science. Although aviation composite materials and metal and metal-based materials both belong to aviation materials research and theoretically should constitute one subgroup, the study reveals differentiation within materials discipline subgroups, with aviation composite materials beginning to form a new subgroup cluster. In the network map, the two subgroups form separate integrated clusters connected by chemistry and physical chemistry as bridges. This suggests that aviation materials discipline resources can be constructed separately for these two subgroups.

5.6 Connections Between Sub-discipline Groups

The discipline cluster knowledge map reflects connections among four subgroups that collectively constitute China's aerospace characteristic discipline structure system. The aerospace engineering subgroup, represented by overall aircraft design and manufacturing, forms the main research area in the aerospace field. The metal and metal-based materials and photoelectric information functional materials subgroup and the aviation composite materials subgroup provide support for aerospace development. As aviation materials directly affect aircraft performance, the saying "one generation of materials, one generation of aircraft" illustrates the importance of aviation materials development for aircraft advancement. The electronic information and automatic control subgroup primarily involves airborne avionics systems and automatic control, representing an important subgroup within the aerospace discipline cluster. Airborne avionics systems enhance aircraft performance, autonomous control and decision-making, and flight safety assurance, while automatic control plays crucial roles in aviation electronics and advanced materials manufacturing.

6 Conclusions and Implications

Through research on disciplinary knowledge co-occurrence in aviation colleges, the study reveals the following characteristic features: disciplinary themes exhibit a long-tail distribution (the "80/20 rule"), where 20% of disciplines account for 80% of total disciplinary theme occurrences, forming the main body of aviation college disciplines. In disciplinary knowledge co-occurrence, subject associations and intersections form a knowledge map comprising six categories and four discipline clusters.

The purpose of disciplinary knowledge co-occurrence research is to provide strong scientific evidence for discipline development. The conclusions offer the following implications for characteristic discipline construction and information resource allocation in aviation colleges:

1. **Discipline construction** in aviation colleges should focus on aerospace characteristics, centering on the aerospace engineering subgroup, electronic information and automatic control subgroup, metal-based materials and photoelectric information functional materials subgroup, and aviation composite materials subgroup.

2. **Library resource allocation** should be guided by the macro-level aerospace discipline clusters, increasing resources across the four subgroups. At the micro-level, allocation within specific disciplinary fields

should follow the internal connection characteristics of each subgroup. For controlling disciplines involved in inter-subgroup connections, resource allocation should be prioritized.

3. **Establishment of secondary college reference rooms** in aviation colleges should focus on the integration and differentiation of discipline clusters. Electronic information and automatic control should be appropriately integrated, while aviation materials disciplines could establish two functional reference rooms according to subgroup differentiation.
4. **Subject librarians** in aviation colleges should develop comprehensive understanding of the four discipline clusters to provide rapid consulting services for resource users. Alternatively, libraries could establish four corresponding subject librarian positions, with each librarian specializing in information consulting services for one subgroup.
5. **Characteristic resource database construction** should be guided by relevant theory, building around aerospace characteristics and targeting the four discipline clusters to collect and organize aerospace electronic and paper materials, achieving integration of aviation characteristic resource databases.

It should be noted that this study's data comes from EI-indexed literature and does not cover cross-data source situations. The selection of disciplinary knowledge co-occurrence terms differs from previous ranking-based approaches by employing the long-tail distribution characteristic of word frequency for term selection, upon which disciplinary knowledge co-occurrence maps are constructed and analyzed. The limitation lies in the static historical focus; research on dynamic evolution processes of disciplinary knowledge could serve as a future research direction.

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Note: Figure translations are in progress. See original paper for figures.