Implications of EU Framework Programmes for China' s Research Informatization: Postprint

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Abstract

Recently, the "ZTE incident" has revealed that "the situation where key core technologies are controlled by others has not been fundamentally changed." At the recently concluded 2018 Academician Conference of the Two Academies, researchers have all sensed that China' s current development requires innovation more than ever before. Having participated in the research and development of multiple EU Framework Programme projects, the author deeply recognizes that project implementation models, research philosophies, and innovative approaches exert significant influence on innovation. This article examines EU projects from two dimensions: project implementation models and research infrastructure construction. Finally, from methodological and conceptual perspectives, it identifies the current status and existing problems of research informatization in China, and summarizes insights offered by the EU Framework Programme' s project implementation models and infrastructure construction methods for China' s research informatization and even scientific and technological innovation.

Full Text

Enlightenment of European Framework Projects on China' s e-Science

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Abstract

China has made substantial investments in scientific research in recent decades, yet research output remains disproportionate to input. A critical factor underlying this imbalance lies in the implementation models, research philosophies, and innovation approaches adopted in research projects. Drawing on extensive participation in EU Framework Projects, this paper examines European collaborative research models and research infrastructure development strategies. It analyzes the current state of e-Science in China, identifies key challenges, and distills actionable insights from European practices to advance both e-Science and broader scientific innovation in China.

Keywords: European Framework Projects; research infrastructure; e-Science

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Introduction

The recent ZTE incident has starkly exposed China' s persistent vulnerability in core technologies and critical components. For instance, in integrated circuits, essential materials and devices such as semi-insulating silicon carbide substrates, MEMS device glass powder packaging, electronic information functional ceramics, and high-performance nitride ceramic substrates and boards remain 100% import-dependent. Photoresist self-sufficiency stands at merely 5%, while dependence on foreign suppliers reaches 80% for mid-to-low-end chips and over 90% for high-end chips. China' s monthly demand for 300mm silicon wafers alone faces a shortage of 800,000 units. The 2018 Academician Conference of the Chinese Academy of Sciences and Chinese Academy of Engineering underscored that China' s development needs innovation more urgently than ever before.

Paradoxically, China' s research funding is substantial—enviable even to many developed nations—yet output fails to match investment. A primary reason is that research models and philosophies remain constrained by isolated, narrow-domain, "solo-effort" approaches. Research objectives overly emphasize SCI publication counts, patents, or simplistic quantitative metrics, which restricts collaborative innovation and the development of scientific research infrastructure.

e-Science, as a crucial methodology for promoting scientific innovation, must adhere to the fundamental principle of "user-oriented, demand-driven, and application-guided." Beyond hardware deployment, e-Science infrastructure construction must prioritize technically substantive innovation, focusing on core and cutting-edge technologies while maintaining close alignment with international frontiers. Projects should adopt open industry standards—whether IT standards (e.g., W3C, OASIS) or domain-specific standards (e.g., OGC for environmental geosciences). Project outcomes should include usable platforms and infrastructure (software, scripts, libraries, algorithmic models, data infrastructure), proposed or refined industry standards, and high-impact publications. Evaluation should prioritize infrastructure usability and reliability rather than vanity metrics like patent or publication counts, ensuring both frontier advancement and practical applicability.

EU Framework Project Implementation Models

EU Framework Projects refer to scientific research initiatives under the EU Framework Programme—officially the "Framework Programme for Research, Technological Development and Demonstration" launched in 1984. As one of the world' s largest official science and technology programs, it is funded by the European Commission with broad participation from EU member states. From Framework Programme 1 through 7, the initiative has evolved into a global platform for multi-domain collaboration, addressing internationally competitive scientific challenges. Framework Programme 7 concluded in 2013, succeeded by "Horizon 2020" (2014-2020) with €80 billion in funding to maintain Europe' s scientific leadership.

EU Framework Projects encompass various categories, including collaborative R&D projects and talent programs (e.g., Marie Curie). Collaborative R&D projects, the largest category, require participation from at least three different EU member state institutions, including at least one industrial or enterprise partner. These projects exemplify the e-Science philosophy and offer valuable implementation models.

Multidisciplinary Integration. Projects are organized horizontally into work packages, with each partner leading one package. Typical packages include dissemination activities and application/test case development. Each work package is vertically subdivided into tasks, with multiple partners collaborating on each task—organized by discipline rather than by institution or geography. This structure ensures deep interdisciplinary integration.

Regular Communication Mechanisms. Partners maintain systematic communication through biweekly teleconferences, quarterly face-to-face meetings, continuous email exchanges, regular instant messaging discussions, and technical workshops. Projects establish dedicated Wikipedia entries, document management systems, and issue/bug tracking platforms, with full respect for intellectual property rights.

Focus on Software, Algorithm Libraries, and Platforms. Regardless of domain—materials science, environmental geoscience, biology, multimedia arts, or engineering—IT R&D constitutes a major component, with over half of project funding allocated to software, algorithmic models, platforms, and data infrastructure development.

User-Oriented, Demand-Driven, Application-Guided Philosophy. All projects include one or more real-world application or test cases. R&D teams comprise domain experts, IT developers, project managers, and industrial partners. Development is driven by solving concrete problems in these cases, ensuring broad applicability of resulting technologies, products, or services. Projects continuously explore new demands and challenges, maintaining a forward-looking orientation.

EU Scientific Research Infrastructure Development

Research infrastructure plays a pivotal role in e-Science. In Europe, beyond Framework Programme funding, the European Strategy Forum on Research Infrastructures (ESFRI) is particularly noteworthy. Established in 2002 by EU member states and the Commission, ESFRI has a 16-year history of supporting coherent policy development, promoting multilateral initiatives, establishing a 10–20 year European research infrastructure roadmap, and tracking implementation progress.

Research infrastructure encompasses facilities, resources, and services supporting high-level research across disciplines—from sociology to astronomy, genomics to nanotechnology. This includes large scientific installations, specialized habitats, libraries, databases, biological archives, integrated small-scale research facilities, high-speed networks, data infrastructure, research vessels, satellites, telescopes, synchrotrons, networked computing facilities, and technology/knowledge service centers. These can be single-sited, distributed, or virtual, driving major discoveries, technological development, and international collaboration.

ESFRI Success Cases **neuGrid: A Distributed Infrastructure for Neuroscience.** Launched to develop a global imaging laboratory based on grid/cloud computing for Alzheimer' s drug development, neuGrid has created core infrastructure for disease marker development on massive brain imaging datasets. Its grid-based programs have been integrated into practical tools for early diagnosis and marker research. The infrastructure has achieved initial unification with two North American counterparts (LONI in the US and CBRAIN in Canada), with funding agencies collaborating on a global imaging laboratory. neuGrid remains the first and only distributed infrastructure dedicated to neuroscience.

Instruct: European Hub for Structural Biology. Instruct is a dynamic, integrated research infrastructure for structural biology, established in 2008. It provides cutting-edge technologies, expertise, and training through an integrated platform that creates and disseminates novel methods, offering strategic leadership for European structural biology. The UK-based operations team coordinates 16 centers and 4 affiliated centers across Germany, France, Israel, Italy, Portugal, the Netherlands, and the UK, providing access to advanced technologies and encouraging integrated approaches to key research challenges.

SHARE: Research Data Repository on Population Aging. SHARE provides open, free data services to help researchers understand aging' s societal impact in Europe and inform health, social, and economic policies. Analyzing SHARE data helps EU nations prepare for welfare system challenges posed by demographic shifts. Launched in 2004, SHARE is building a multidisciplinary, cross-national dataset on health, socioeconomic status, and social/family networks, with over 45,000 individuals aged 50+. SHARE collaborates closely with the US Health and Retirement Survey (HRS) and English Longitudinal Study of Ageing (ELSA), and is establishing partnerships with South Korea, Japan, China, and India.

Current Status and Challenges of e-Science in China

e-Science has gained significant attention in China. The 2016 "13th Five-Year National Informatization Plan" mandates enhanced cloud computing and IoT innovation, PUE 1.5 for new large data centers, optimized national data center layout, and cloud-based national research infrastructure. However, due to systemic differences, substantial gaps remain with Europe and the US in R&D, application, philosophy, methodology, talent cultivation, and evaluation.

Persistent "Solo-Effort" Research Models. Despite large interdisciplinary projects, research often reverts to small-scale, narrow-domain, closed "solo-effort" models once funded. Research groups are typically institution-based with minimal cross-group interaction, yielding technologies ill-suited to real needs.

Limited Interdisciplinary Vision. Many teams remain confined to familiar specialties, reluctant to engage in multidisciplinary work due to concerns about funding eligibility or expertise mismatch. This severely constrains innovation, whereas interdisciplinary collaboration often yields breakthroughs.

Infrastructure vs. Research Conflict. A pervasive attitude holds that "we can conduct research and secure funding without platforms or infrastructure," or that "students should use manual methods." Consequently, many major projects conclude with only publications or hardware purchases, leaving no reusable software, platforms, or data infrastructure. At international conferences, foreign professors frequently note China's limited contributions to open-source software.

Misconceptions About e-Science Implementation. Common fallacies include "develop first, find applications later," treating projects as mere hardware deployment without innovative R&D, or showcasing technologies without addressing core user needs. Development often pursues advanced technology for its own sake, focusing on simplistic metrics like user counts or data volume rather than genuine scientific impact. The e-Science philosophy is straightforward: user-oriented, demand-driven, and application-guided.

Reflections and Recommendations for China's e-Science

Addressing these challenges requires systemic change. As a national research institution, the Chinese Academy of Sciences (CAS) should lead by abandoning isolated research models and championing team-based, interdisciplinary collaborative innovation. Data sharing, knowledge sharing, and open innovation require robust research infrastructure.

1. Demand-Driven Project Design. Before launching e-Science projects, fundamental questions must be answered: Who are the actual users? What are the application scenarios? Which scientific problems will be solved? Which disciplinary teams will participate and how? This prevents the "develop first, apply later" pitfall.

2. Inclusive R&D Teams. Major national projects should invite dedicated IT developers and industrial partners, following EU models, to collaboratively build supporting infrastructure integrated with real applications. Project completion should evaluate software, platforms, and data infrastructure innovation, not just publications and hardware.

3. Holistic Evaluation Criteria. Rather than emphasizing quantitative metrics (e.g., data volume), evaluation should assess societal benefit and sustainable research ecosystems—such as mechanisms encouraging voluntary sharing of valuable data—and comprehensive support for scientific research.

4. Policy and Management Drivers. Following ESFRI' s example, China should promote interdisciplinary and sustainable innovation through funding policies. Project proposals should encourage development of innovative, technically substantive, sustainable infrastructure. Completion reviews should assess usability, reliability, and alignment with actual research needs.

5. ESFRI-Inspired Infrastructure Model. CAS could adopt an ESFRI-like approach: treating CAS as the European Commission and its branches as member states. Under CAS leadership, one or more branches could initiate domain-specific research infrastructure in their areas of strength. Construction units need not be limited to branch-affiliated institutes; instead, a "Call for Proposal" mechanism could select partners nationwide or globally, with funding 倾斜 toward this open model. For example, if the Shanghai Branch leads materials genome infrastructure construction, it could solicit proposals from universities and institutes across China and beyond. Multi-phase funding would tie continued investment to infrastructure usability and reliability, avoiding superficial outcomes.

6. Open, International Standards. China' s research infrastructure development should embrace global integration, adopting universal methods, standards, and approaches. Policies and funding should actively promote these practices.

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