Analyzing Trends in Science & Technology Innovation

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This project is part of the larger NSF-supported grant on Science and Technology Innovation Concept Knowledge-base (STICK). Previous research in trends of information technology innovations have found helpful patterns by studying the frequency of mention of key terms in trade and scholarly articles in bibliographic databases (Fig. 1).

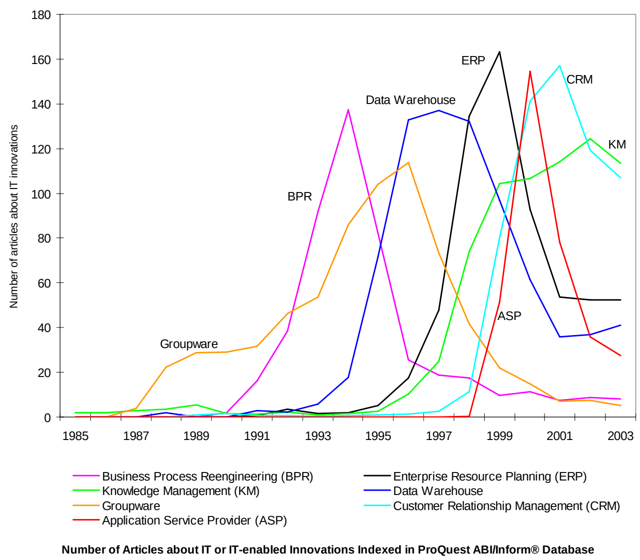

Figure 1: These trend lines show the number of articles mentioning seven key terms over two decades

The current efforts on this project extend this work to even more diverse sources of information and a richer model of technology innovation that includes academic papers, patents, trade press articles, news, blog mentions, product adoptions, organizations, people, and more careful topic analysis. Our work focuses on the development of ontologies to guide database schema design and two case studies of innovation trajectory analysis.

STICK Project Goals

The Science & Technology Innovation Concept Knowledge-base (STICK) project's goal is to overcome the bias in the Science of Science and Innovation Policy (SciSIP) towards popular or ultimately successful innovations by providing the much needed data and tools for analyzing innovations of all possible outcomes. This comprehensive endeavor enables SciSIP researchers to build and test theories that explain the differentiated trajectories of science and technology innovations and their associated communities. The project also spans disciplinary boundaries by bridging the artificial divide in SciSIP research between the production and the use of innovations, piecing together a holistic view of the dynamic supply and demand in the innovation ecosystem. Specifically, the project builds a large-scale, multi-source, longitudinal database, Science & Technology Innovation Concept Knowledge-base (STICK), and develops a set of visual analytic tools for monitoring and understanding the emergence and revolution/evolution of innovations in three exemplar science and technology fields: information technology, biotechnology, and nanotechnology.

The knowledge-base captures innovations, the individual and organizational actors associated with the innovations, and the relationships among the innovations and the actors through a hybrid approach that combines computational analysis of text (e.g., natural language processing) and social information processing (e.g., social tagging and collaborative writing by the users of the knowledge-base). State-of-the-art visualization tools are customized for SciSIP researchers and other innovation stakeholders to visualize innovation networks and analyze patterns and trends. The design of the knowledge-base and toolset is grounded in a demonstration study on the popularity of innovations. The study aims to address important questions concerning the complex relationships among innovations and the evolution of communities, with implications to the popularity and ultimate success of innovations.

Broader Impacts: STICK will be institutionalized at the University of Maryland at College Park as a free public service that offers web access to the data and tools developed in this project. This service also produces quarterly reports on the status of science and technology innovations, including the National Innovation Popularity Index, analogous to the Consumer Confidence Index for the state of the economy. This research-based service will be designed as a tool for science and technology education. For most fields where specialization is the theme nowadays, students' and the public's interests increase with the capability to monitor and make sense of the fast-changing arenas where innovations emerge, converge, and diverge. For scientists and engineers, STICK's visual analytic toolset helps accelerate scientific discoveries and innovations by identifying and establishing collaborations within and across innovation communities. Finally, STICK will help science and technology policy makers monitor and understand the evolutionary paths of innovations, appraise the significance of innovations in rigorously charted terrains, and proactively foster, promote, and advance innovations with benefits to the society.

Tree Visulization Innovation Trajectories

One of our first case studies was a 20-year review of the innovation trajectories for three strategies for exploring tree-structured data: treemaps, cone trees, and hyperbolic trees (Fig. 2). These were introduced in academic papers in the early 1990s, which all became widely cited, although substantial follow-on work by academics grew only for treemaps starting after 2000. Patents were filed by Xerox PARC for cone trees and hyperbolic trees mainly in the late 1990s. The University of Maryland did not file patents for treemaps but refinement patents were filed by others. A flurry of trade press articles accompanied the commercial introduction of hyperbolic trees in the late 1990s, but subsided, while trade press articles on treemaps gained when The Hive Group (www.hivegroup.com) and others began marketing commercial versions.

These distinctive innovation trajectories shown by these three sources are a starting point for understanding the determinants of success for innovations. A few of the determinants of success are the entrenched alternatives, resistance to change, interactions with existing technologies, intellectual property rights, perceived usefulness and ease-of-use, availability of free versions, influence of entrepreneurial individuals, and responsiveness of the trade press. This complex mix of personalities, ideas, institutions, and economic constraints calls for a comprehensive theory that may better predict innovation outcomes so as to guide entrepreneurs and policy analysts.

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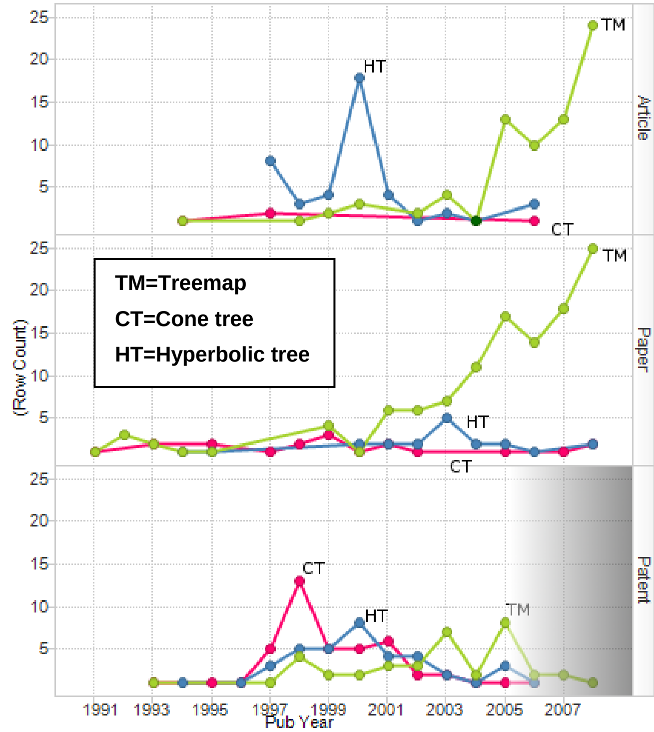

**Fig. 2: These histograms of publications for to each innovation show the number of trade press articles, academic papers, and patents published each year. **

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