Integrated Methodology for Finding Emerging Technologies Using Publications, Patents and Roadmaps

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Introduction and Motivation

Manufacturing in the United States is a national imperative, because of its impact on wealth, jobs, innovation and economic security. In June 2011, the White House launched the Advanced Manufacturing Partnership (AMP) with the explicit goals of strengthening U.S. manufacturing competitiveness and creating high-paying jobs. One challenge is to create technology investment strategies for various competing fields of advanced manufacturing.

Envisioning the future is always an integral part of any major initiative, and undoubtedly more so for the AMP. Identifying what technology to invest in and when to invest are particularly important for the AMP, since its goal is to accelerate pulling or pushing transformative, cross-cutting technologies rapidly across the technology "valley of death,"- To achieve this, developing an approach for identifying the readiness of a technology for AMP investment is critical.

This challenge motivates us to undertake this study. Our proposed integrated approach involves studying existing research papers, patents and technology roadmaps (TRMs) to set the foundation for spotting transformative technologies that are "ripe" for production scale up or pre-pilot production, and are worthy of investment by a public-private partnership from a national perspective. We hope that this approach will provide an analytical framework for identifying, on a continuing basis, a set of emerging technologies for public-private partnership investment.

Proposed Approach

The proposed effort comprises three steps -- Identification, Analysis, and Triangulation. In Step 1, using text mining software, we extract keywords by applying Natural Language Processing (NLP) to the publication records and perform keywords' clustering. We also examine International Patent Classification (IPC) codes of the patents. In Step 2, we study TRMs and search for key terms describing the driver technologies for growth and technological development. Finally, in Step 3, we combine the results of aforementioned publication, patent, and roadmap analyses to help identify the emerging technologies that are gaining importance over time.

Illustrative Case

For the demonstration of this systematic approach, we focus on a particular field -- Carbon Nanotubes (CNTs). Considering a time period from 2008 to 2012, we download 25,928 publications from Compendex; use PubWEST to obtain 9,153 patent records, and collect 13 roadmaps available online. Using VantagePoint [www.thevantagepoint.com] software, we obtain emerging clusters and IPCs as shown in Figure 1 and Figure 2, respectively. Also, the key technologies identified in TRMs are shown in Table 1.

Figure 1: Emerging clusters of keywords obtained from publications using ClusterSuite (O'Brien *et al.*, 2013) in VantagePoint

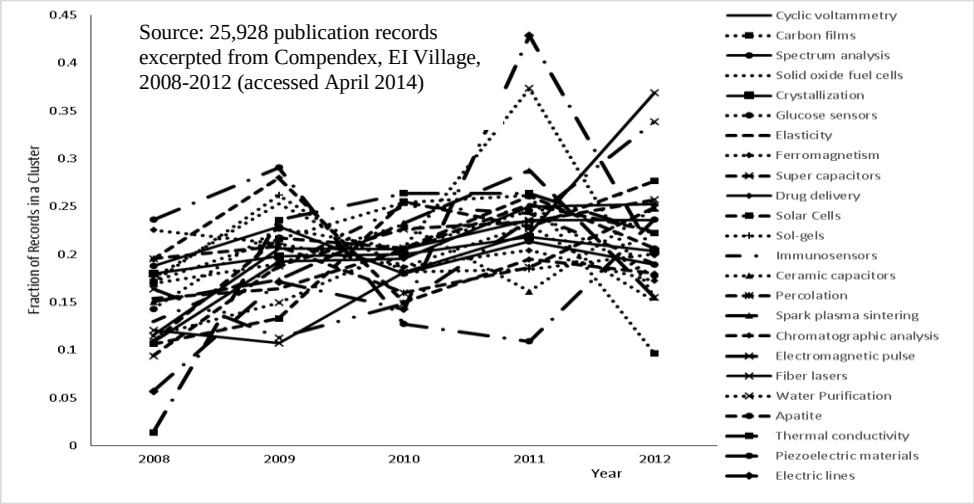

Figure 2: Top 24 emerging IPC codes from patents' analysis (IPC codes have been shortened and given a meaningful name)

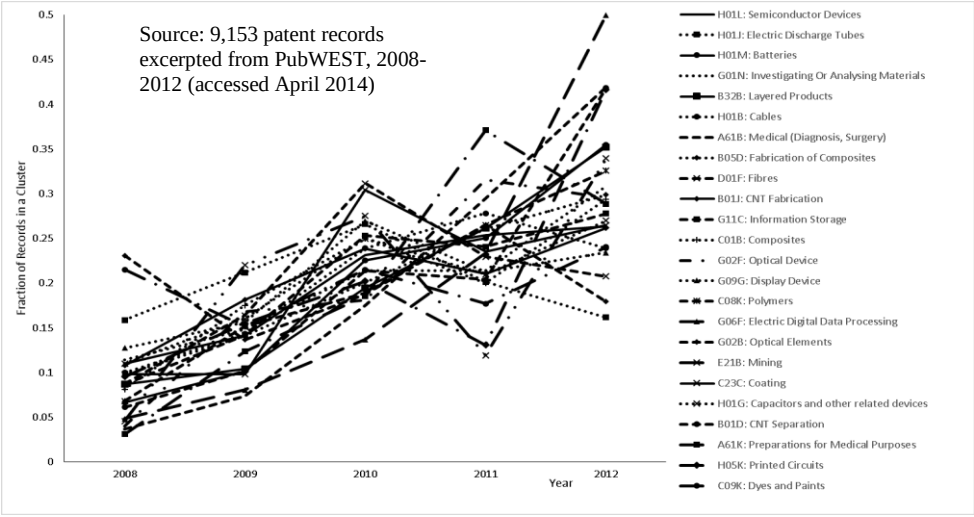

Table 1. Key technologies obtained from 13 TRMs (Downloaded from Internet)

Semiconductors	Emission Display	Spectroscopy	Coating
Electronics	Batteries	Electromagnetic Shielding	Actuator
Integrated Circuit	Nano-springs	Molecular Bearings	Memory
Atomic Precise Manufacturing	Automobile	Sporting Goods	Photonics

In an attempt to triangulate the aforementioned results, it appears that Fuel cells, Batteries, Medical Devices, Sensors, Optical Devices, Display Devices, Films, Electric Cables, Super-capacitors and Composites are the major emerging technology areas wherein CNTs will have large volume applications. Moreover, our results are in line with the ones mentioned in a CNT roadmap by Endo *et al.* (2008). It has also been noticed that a time-period of five years may not be sufficient to draw out clear conclusions. So as a part of future work, we plan to consider a time-period of 10-12 years.

References

VantagePoint, www.theVantagePoint.com (accessed May, 2014).
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Endo, M., Strano, M.S., & Ajayan, P.M. (2008). Applications roadmap for Carbon Nanotubes, NT08 Conference.