Basic research often does not have an earlier sign of whether and how it might be practically valuable. Research has found a recurring pattern that many scientific breakthroughs emerge as multiple lines of research converge. The question is: Is it possible to recognize a fruitful path ahead of time? In this chapter we discuss lessons learned from studies of both hindsight and foresight of identifying and recognizing the most important discoveries and innovations.

4.1 Hindsight

What can we learn from the past? How were scientific breakthroughs made?

4.1.1 Hibernating Bears

Black bears hibernate for 5~7 months. When they wake up, they are as strong as ever. In contrast, if we are inactive for as short as several days, we may start to get weaker rather than stronger. We could start to lose our bone mass and strengths. People who are unable to maintain their usual levels of activity need to be very careful. For example, astronauts spend days in space need to have specially designed programs to keep themselves strong.

What makes the difference between human beings and black bears? This is the type of questions that everyone could see its value even before it gets answered. Seth Donahue and colleagues at Michigan Technological University started off with the good question. They were able to isolate a bone-building biomarker in the blood of black bears. The research has great commercial implications for osteoporosis treatment and prevention.

Their publication records show that their 2004 paper, entitled “Bending properties, porosity, and ash fraction of black bear (Ursus americanus) corti-
cal bone are not compromised with aging despite annual periods of disuse,” was cited 13 times by 2010, whereas their 2006 paper, entitled “Hibernating bears as a model for preventing disuse osteoporosis,” was cited 3 times. The practical value is more explicit in the 2006 paper. Donahue’s technique was licensed to a company founded in 2007 called Auros to make the therapeutic compounds for osteoporosis patients. Their story became one of the 100 successful stories in 2010 of how federal funding enables basic research and create jobs (The Science Coalition, 2010).

The connection between the basic research and its practical value is easy enough to spot in this case. The successful commercialization had made it easier for the funding agencies to justify their funding decisions when the research was in its cradle.

Scientists, social scientists and politicians frequently credit basic science with stimulating technological innovation, and with its economic growth. Despite a substantial body of research investigating this general relationship, relatively little empirical attention has been given to understanding the mechanisms that might generate this linkage. Researchers considered whether more rapid diffusion of knowledge, brought about by the norm of publication, might account for part of this effect (Sorenson & Fleming, 2004). They identify the importance of publication by comparing the patterns of citations from future patents to three groups of focal patents: (i) those that reference scientific (peer-reviewed) publications, (ii) those that reference commercial (non-scientific) publications; and (iii) those that reference neither. Their analyses strongly indicated publication as an important mechanism for accelerating the rate of technological innovation: Patents that reference published materials, whether peer-reviewed or not, receive more citations, primarily because their influence diffuses faster in time and space.

In parallel to the role of citation data in modeling and visualizing scientific revolutions, patent citation patterns play an important role in the construction of knowledge diffusion examples (Jaffe & Trajtenberg, 2002).

There are a number of extensively studied knowledge diffusion, or knowledge spillover, cases, namely liquid crystal display (LCD), nanotechnology (Braun, Schubert, & Zsindely, 1997; Meyer, 2000), and tissue engineering (Chen & Hicks, 2004).

In addition, knowledge diffusion between basic research and technological innovation (see Meyer, 2000; Narin & Olivastro, 1992), is also intrinsically related.

Empirical evidence shows a tendency of geographical localization in knowledge spillovers (Jaffe & Trajtenberg, 2002). Further studies have revealed profound implications of social dynamics. Agrawal, Cockburn and McHale (2003) show that social ties between collaborative inventors play a stronger part than geographic proximity in knowledge diffusion: inventors’ patents are continuously cited by their colleagues in their former institutions.

Singh (2004) considered not just direct social ties but also indirect ones in social networks of inventors’ teams based on data extracted from U.S.