Foreseeing Emerging Technologies: Towards a Scoresheet-Based Methodology

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"The future will surprise us, but we must not let it dumbfound us"

- Kenneth Ewart Boulding (1910-1993), Economist and Futurist

INTRODUCTION

There is scarcely any doubt that technological innovation has been an area of remarkable progress in recent decades. The cumulative effect of the thousands of innovations that have come to market has been to make technology central to human existence, be it in business, education, government or in everyday life. However, humankind's track record in *foreseeing* technology innovation - in terms of its rate, direction or impact – has been somewhat less than stellar. Early examples of foresight failures include Thomas J Watson, then IBM Chairman, opining that the world would need no more than 5 computers, and Lord Kelvin's celebrated 1895 dismissal of the possibility of powered flight. In the early 1970s, *Scientific American* wrote that the electronic watch was unlikely to become cheap enough to sell in large quantities - yet, by 1976, quartz watches were selling cheaply in large quantities.

More recent technology predictions that were off the mark – often egregiously - include 3G (third-generation telecommunications technology), the dot.com bubble, Iridium and AT&T's huge underestimate in 1984 for the cell phone market that led it to ignore that market. The ability to foresee the potential of emerging technologies is a big prize indeed – companies can boost the ROI on R&D expenditure manifold, they can predict much better which new products of theirs or their competitors' will succeed – yet this problem has received remarkably little focus.

What are the reasons behind this rather underwhelming track record in foresight? The successful emergence of a technology of importance to business is a function not just of innate superiority but of initial conditions, the scale of investment, the clout of entities backing that technology, and the actions of consumers, competitors and collaborators. Prediction needs the understanding of complex interactions between phenomena which straddle multiple disciplinary boundaries – technology, economics, sociology, organizational behavior, psychology, anthropology, culture, and so forth. Kochikar (2006) and Kochikar and Ravindra (2006) point out a few flaws in our view of technological evolution that further confound our ability to predict new technologies, and suggest some remedies. It has been our endeavor to devise a methodology that corporate managers can use to foresee the potential of emerging technologies, and we present here some early results of such a methodology that is under development.

PREVIOUS WORK

The import of factors other than sheer technological superiority that play a role in a technology gaining widespread business use has been recognized (Griliches 1957, Bresnahan and Pai-Ling 2005). Shapiro and Varian (1998) have identified various factors that determine technology success, including network effects, standards, pricing strategies, and so forth.

Yet, the literature is sparse when it comes to methodologies. In their seminal article, Brody and Stabler (1991) note that faulty predictive ability often implies an improper allocation of resources to R&D within corporations, and there is a need to improve prediction accuracy in order to boost the returns on R&D efforts. As SRI (2006) notes, "the management literature is short on practical solutions for methodically gleaning early signals of change from the surroundings or for cultivating a futures orientation in employees and managers."

Adner and Levinthal (2002) draw parallels with biological evolution (speciation) and provide insights that managers can use in understanding technological evolution. However, they provide no methodology for predicting or foreseeing emerging technologies.

Christensen et al (2004) have presented an exhaustive theoretical framework that can be used to systematically scan the future landscape and spot complex, usually business model-related, changes. However their methodology needs an understanding of 3 theoretical approaches that form the bedrock of their approach: the theory of disruptive innovations, the theory of resources, processes and values (RPV), and the value chain evolution theory (VCE).

SRI (2006)'s SCAN methodology is a promising step in the right direction; it envisages an approach that is strongly driven by intuition and interaction between groups of individuals who collectively have expertise in a set of disciplines including anthropology, business, economics, international affairs, communication, arts, marketing, life sciences, and chemical and electrical engineering. This methodology is suitable for answering open-ended questions such as, what technologies are emerging on the horizon?

We propose a methodology that is simple to use, and at the same time produces reliable results. The methodology is aimed specifically at answering the question, "what are the prospects for emerging technology X in my company (industry)?", where X represents a specific, identified emerging technology. Typically, technologies considered would be those that have shown promise in early applications, that have some backing entities who have invested in them, that have generated some buzz among the *cognoscenti* as well as the lay public, and that are poised on the cusp of widespread adoption.

A METHODOLOGY FOR FORESEEING THE POTENTIAL OF EMERGING TECHNOLOGIES

The methodology takes explicit cognizance of the multi-disciplinary nature of the technology foresight problem, and employs a scoresheet-based approach for arriving at a measure for the potential of a given technology. The methodology holds considerable promise for bridging the current yawning gap in the state of art in this important space – that of technology foresight.

Although, given the immense complexity of the problem, it is probably impossible to design a methodology that is based on purely objective inputs, our approach is a significant step in that direction. Apart from relying on easily available data, it is designed to need 2-3 people at the most to apply it in the context of a given technology and industry. The method is also, as outlined in the previous section, relatively closed-ended and focused. It can thus be used in conjunction with more open-ended approaches.

Our methodology is also designed to produce results that reflect the specific needs of the user and his/her industry, as a given technology may hold different potential for different environments. Finally, the methodology is quick to use and involves minimal effort.

Any approach that offers a modicum of hope for solving the thorny problem of foreseeing the potential of an emerging technology must take into consideration the complex canvas of factors and phenomena that impact success. Our methodology thus encompasses a multitude of factors: supply side or "push" factors, demand side or "pull" factors, as well as characteristics of the business and cultural environment within which the technology seeks to emerge as successful.

We consider the following classes of factors:

Market Action – measures of investment, market forecasts from analysts…, existing implementations if any.
Technology Features – measures of feature richness, pricing, and quality attributes of the technology concerned.
Consumer Psychology – measures of "soft" appeal
Applications – existence of applications by which the consumer or target audience can leverage the technology concerned.
Environmental Factors – competing and complementary technologies, standards, characteristics of the ecosystem,

Each such class is modeled as a 'dimension'. The methodology identifies 17 measures of market action, 30 technology features, 14 measures of consumer psychology, 5 measures of application characteristics, and 9 environmental factors.

Each factor is assigned a score on a scale of 1 to 5 and the score is entered into a scoresheet designed for the purpose. Importantly, not all the factors need to be scored – the users may choose to score as many as they feel sufficiently comfortable / knowledgeable scoring. In examples given, 18-25 factors were scored.

An important characteristic of the methodology, and one that vastly enhances its utility, is that the output is displayed graphically, as a radar plot (also called Spider Chart or Kiviat Diagram). Among other things, the spider chart allows the user to see readily and graphically the dimensions where the methodology has high potential / falls short.

We now present the use of the methodology for gauging a few emerging technologies.

Sample Emerging Technology: Utility Computing
The output produced is as in figure 1. As can be seen, consumer psychology is something of a concern, as organizations may not be overly keen on allowing applications, which often encode proprietary business logic and use sensitive data, to reside outside their enterprise boundaries. Thus, this technology may be more acceptable to an organization where such sensitivity and confidentiality are relatively less important.

Absence of applications is also a major handicap. Thus, a conservative CIO may be less likely to consider switching to utility computing. On the other hand, an intrepid CIO may, on seeing this plot, still decide that absence of applications is not going to deter him/her – as long as market action is high, and the features supported are adequate.

Sample Emerging Technology: Open Source
Here, (figure 2) technological features are a concern area. On drilling into the scoresheet, it can be seen that this shortfall on this front arises primarily from concern about support /maintenance. Customizability also is not a significant area of comfort. The applications dimension is also relatively anemic as robust, industrial-strength business applicaitons using the open source platform are lacking. Once again, it is up to the individual organization's risk appetite to decide whether to proceed with using open source.

Figure 1. Potential plot for utility computing

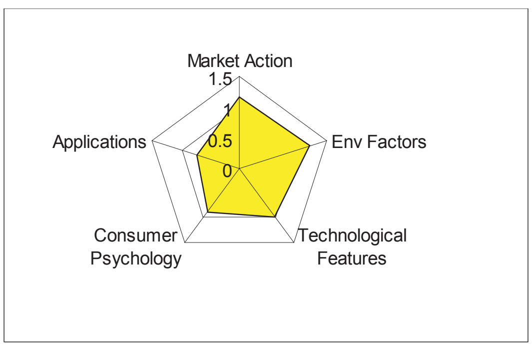


Figure 2. Potential plot for open source

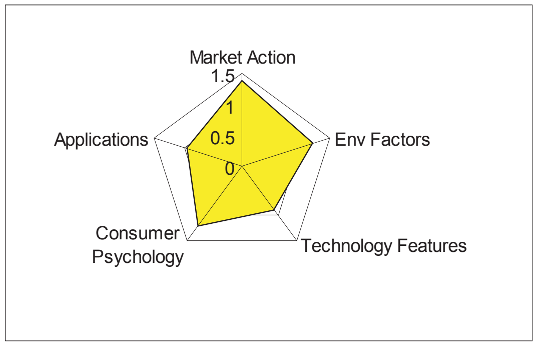
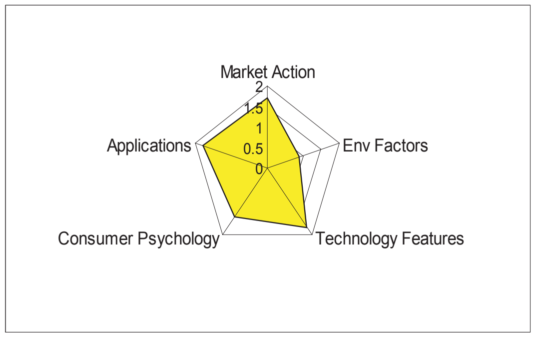


Figure 3. Potential plot for Firefox browser client



The consumer psychology dimension is also a moderate area of weakness – while concern about IP infringement is no longer a major deterrent, willingness to switch from conventional technology platforms is still not too high.

Sample Emerging Technology: Firefox Browser Client
Here too (figure 3), consumer psychology is a dimension where this technology is trumped – again, willingness of potential users to switch is low. However, the dimension along which this technology well and truly falls short is environmental factors. Clearly, the clout of the incumbent, which is a factor that carries significant weight under this dimension, is just too high!

USING THE METHODOLOGY

The methodology is intended to be used by corporate managers who are interested in gauging the advisability of / need to adopt an emerging technology in their business.

For example, a CIO of a large corporation may seek to decide whether s/he needs to invest in Open Source / Utility computing. The actual scoring may be done by the manager along with one or two technology specialists from within the organization. No expert in the technology concerned is called for. Also, since a given organization is likely to evaluate a relatively small number of emerging technologies, the effort involved is not significant.

The radar plot computation methodology also involves weightages at the factorial as well as dimensional levels, which can be adjusted based on the specific business characteristics, risk appetite, and so forth. It is also worth noting that managers may assign different ratings to individual factors, depending on their industry's needs, their company strategy, or individual preferences. Thus the methodology is not designed to produce a single, 'logically correct' output, but will produce outputs that differ slightly to reflect the needs and drivers of the user and his/her environment.

CONCLUSION: THE WAY AHEAD

The problem of accurately foreseeing how appropriate an emerging technology is for business use has proved itself to be as important as it is intransigent. We have presented a methodology that represents a significant step towards a solution. While considerably more piloting in more varied real life business environments remains to be done, the methodology has shown promise of substantially ameliorating the technology foresight deficit.

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