



# FORESIGHT

Winter 2011

Issue 20

THE INTERNATIONAL JOURNAL OF APPLIED FORECASTING

**Who Should Own the Business Forecasting Function?**

**Supply Chain Forecasting: Classification for Forecasting and Inventory**

**Forecasting Intelligence: Forecasting Future Technology**

**Forecast Process Improvement:**

**Getting Your Forecasting and Planning Fundamentals Right**

**Sales and Operations Planning: How S&OP Changes Corporate Culture, Results from Interviews with Seven Companies**

**Review of *This Time Is Different: Eight Centuries of Financial Folly***



## Forecasting Future Technology

Roy L. Pearson

### INTRODUCTION

In *Foresight's* Summer 2008 issue, I wrote a piece called “Looking at Tomorrow Today: The What, Why, and How of Futuring for Forecasters.” The article described methodologies for developing foresight about future changes, in order to anticipate shifts or breaks and their probable causes before your forecast errors become a cascade. I suggested setting aside one morning each quarter to review and brainstorm about possible “ifs” and what some of these would mean for your business. Identifying relevant “ifs” is worthwhile, even if the “whens” are currently unpredictable. Futuring can show you relevant “ifs” that can cause breaks with the past, and help you identify warning signals for impending “whens.”

The torrid pace of technological change is a force that affects individuals, governments, and businesses. Possible future changes are everyone’s concern, especially identifying and forecasting future disruptive technologies. The National Research Council (NRC) has published two outstanding reports, *Persistent Forecasting of Disruptive Technologies* (2009) and *Persistent Forecasting of Disruptive Technologies--Report 2* (2010), plus a summary, *Persistent Forecasting of Disruptive Technologies--Report 2 (Free Summary)*, all available free from the National Academies Press at <http://www.nap.edu/>.

### THE NRC REPORT

“[Technological] innovations, and the disruption they produce, have the potential to affect people and societies and therefore government policy, especially policy related to national security. Because the innovations can come from many sectors, they are difficult to predict and prepare for. The purpose of predicting technology is to minimize or eliminate this surprise. To aid in the development of forecasting methodologies and strategies, the Committee on Forecasting Future Disruptive Technologies of the National Research Council was funded... to provide an analysis of disruptive technologies.” (NRC, 2009, vii)

In 2009, the committee selected three existing forecasting systems to use as examples, based on the criteria that each attempted to forecast and track multiple technology arenas of general interest. Each system solicited the viewpoints of multiple experts, and the committee was able to access each system and meet at least once with a senior staff member. The three systems were:

- The Institute for the Future’s X2 system (now Sigtific)
- Delta Scan (now part of the *Foresight* program in the UK’s Department for Business, Innovation and Skills)
- TechCast

In this article I selected TechCast as a source for tracking some key technology futures because of its “strengths in ease of use and in quantifying the probability of occurrence, impact, and forecast timing” (NRC, 2009, p. 104) — in short, it provides quantitative predictions of “when” as well as probabilities for “if.” Additionally, I am very familiar with TechCast as a member of its expert panel (please note that I have no financial interest in TechCast).

Forecasting and strategic planning require insights into how technology will influence the future environment of your enterprise. You can get a head start in building these insights by exploring what others consider to be strategic technologies and how they will evolve. TechCast (<http://www.techcast.org>) offers you a potent beginning to your explorations.

### WHAT TECHCAST DOES

TechCast analyzes about 70 technological innovations in seven fields: **E-Commerce** (10 innovations), **Energy and Environment** (12), **Information Technology** (17), **Manufacturing and Robotics** (8), **Medicine and Biogenetics** (11), **Space** (5), and **Transportation** (9). A review of the specific innovations should convince you that there are many whose adoption will have a substantial impact on anyone and any enterprise.

The specific innovations listed by field (with three duplicated in two fields):

**E-Commerce:** Digital Convergence, E-Government, Entertainment, E-Tailing, Global Access, Online Publishing, TeleWork, Video Conferencing, Virtual Education, Web 2.0

**Energy and Environment:** Alternative Energy, Aquaculture, Climate Control, Genetic Crops, Green Business, Hydrogen Economy, Nuclear Fusion, Organic Farming, Precision Farming, Recycling, Smart Grids, Water Purification

**Information Technology:** Artificial Intelligence (AI), Biocomputing, Biometrics, Broadband, Cloud Computing, Grid Com-

puting, Intelligent Interface, Intelligent web, Optical Computers, Pervasive Networks, Quantum Computing, Smart Phones, TeleWork, Thought Power, Video Conferencing, Virtual Reality, Wireless Internet

**Manufacturing and Robotics:** Designed Materials, Mass Customization, Micro-Machines, Modular Homes, Nanotechnology, Power Storage, Smart Robots, Smart Sensors

**Medicine and Biogenetics:** Artificial Organs, Body Monitoring, Cancer Cure, Child Traits, Genetic Crops, Genetic Therapy, Grown Organs, Life Extension, Personal Medicine, Synthetic Life, Telemedicine

**Space:** Contact, Humans on Mars, Moon Base, Space Tourism, Star Travel

**Transportation:** Automated Highways, Eco-Bikes, Electric Cars, Fuel-cell Cars, High-speed Trains, Hybrid Cars, Hypersonic Planes, Intelligent Cars, Small Aircraft

### THE TECHCAST METHODOLOGY

TechCast utilizes a modified Delphi process with the five elements shown in Figure 1: scanning; analysis; real-time experts’ review and estimates; aggregation and publishing of the experts’ estimates and comments and continual updating. The fifth is process repetition.

For each technological innovation, numerous and varied sources are scanned for information. An analysis is prepared with four parts: a summary, selected adoption and forecast data, detailed descriptions of the pros for trends driving the event, and the

Figure 1: The Five Elements of the TechCast Forecasts

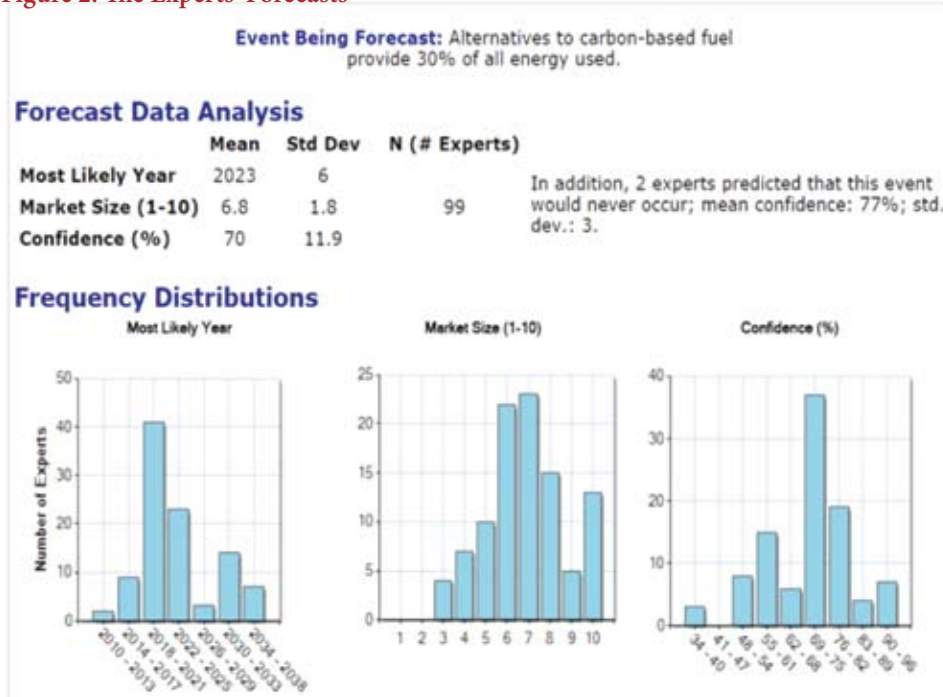


cons opposing the event.

The focus is the event to be forecast, which for about 70% of the technologies is stated as reaching 30% usage or market penetration, regarded as the adoption rate where technological innovations have reached the takeoff stage of diffusion. Three typical examples would be “Alternatives to carbon-based fuel provide 30% of all energy used,” “All-electric vehicles constitute 30% of new car sales,” and

“Nanotechnology is used in manufacturing 30% of products.” For some of these technologies, the event is a 50% adoption rate; and for a few (such as synthetic life and a human on Mars) the event is simply the occurrence. Thus the TechCast focus is when—if ever—a technological innovation will become a significant force to be reckoned with. The adoption rate is evaluated specifically with respect to the 19 countries in the G-20 group of nations, accounting for around 85% of world GDP.

Figure 2. The Experts’ Forecasts



About 100 experts from various fields, many of whom are practicing futurists in their organizations and nearly half of whom are from outside the U.S., then review the analyses online and enter their estimates regarding the most likely year when the event will occur, the likely market size when the technology matures, and their confidence in their estimates.

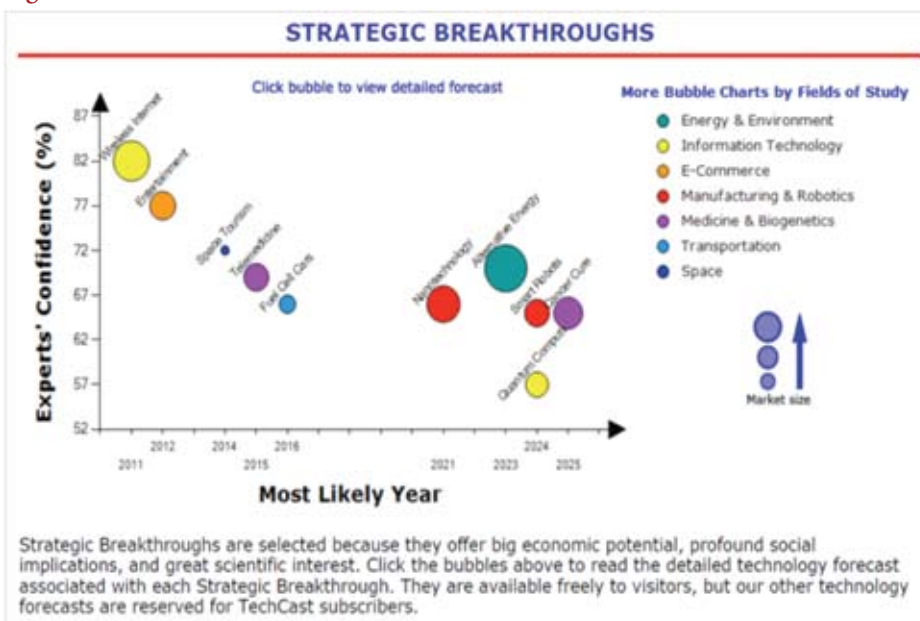
The website software aggregates the experts’ estimates in real time and reports the mean, standard deviation, and frequency distribution for each of the three estimated values (year, market size, confidence), as illustrated in Figure 2. Therefore, site users as

well as the experts get quantitative estimates to review for each technological innovation. The site definitely fulfills the NRC requirement of being persistent, since the experts frequently review the analyses and results, adjusting their own estimates as they deem appropriate, with any changes immediately reported in updated results. For example, I review all of the technologies about nine times annually.

### USING TECHCAST

On the home page is a list of recent information and news postings; on the right-hand side is the entry

Figure 3. The Bubble Chart



point for access to featured articles about technology's future. There's also a "Hot Issues" button, giving access to analyses of some current technology concerns ("Global Megacrisis Survey: Four Scenarios on a Pessimism-Optimism Axis," "What to Do about Global Warming?"), with a survey on each topic that you can take and see the results.

Your main target is technology forecasts. Also on the right-hand side of the home page, there is a bubble-chart icon labeled "Strategic Breakthroughs." Click on the icon and you will go to a chart (Figure 3) plotting 10 technology innovations against the experts' confidence in the adoption year, with bubble size proportionate to likely market size.

Clicking on any one of the 10 bubbles brings you the full analysis and summary of the experts' estimates. You get the quantitative technology forecast shown in Figure 2, plus a summary, selected adoption and forecast data, and pros and cons related to this event—easily, quickly, in very readable form. Most event reports also include public comments from some of the experts supporting their estimates.

These 10 free technology reports provide an understanding of what TechCast offers. To view the full reports for all 70 technologies and other member features, you must be a subscriber (currently \$950/year). However, any visitor to the site can go to the home page and select "Forecasts" to see a summary table of all the technology forecasts by field, or any of the seven fields by themselves, with the mean values for most likely year, market size, and the experts' confidence in the forecasts.

Each forecast summary alone offers useful insights. You can sort the table by any

Figure 4. Forecast Summaries

Latest Technology Forecast Results MANUFACTURING & ROBOTICS Nov 10th, 2010				
Click on column headings to sort table				
Fields of Study	Technology	Most Likely Year	Market Size (1 - 10)	Expert Confidence (0 - 100%)
Manufacturing & Robotics	Smart Sensors	2015	3.3	65
Manufacturing & Robotics	Smart Robots	2024	4.7	65
Manufacturing & Robotics	Power Storage	2019	5.4	68
Manufacturing & Robotics	Nanotechnology	2021	5.7	66
Manufacturing & Robotics	Modular Homes	2021	4.4	64
Manufacturing & Robotics	Micro-Machines	2022	4.3	63
Manufacturing & Robotics	Mass Customization	2017	4.9	66
Manufacturing & Robotics	Designed Materials	2018	4.5	65

of five columns (Figure 4)—Fields of Study, Technology, Most Likely Year, Market Size, and Expert Confidence—providing different perspectives. For example, if your interest is manufacturing, sort by fields or select just the "Manufacturing and Robotics" field and look at the forecasts for the eight technologies in this field. The most likely years for the technology innovations to reach the event-adoption rates (all eight are 30%) fall between 2015 and 2024, and all show sizable markets at maturity, signaling a nearly 10-year period of substantial innovation is quite probable.

For another view, sort the full list of forecasts by most likely year, and consider how the events cluster. You will see that the experts on average think 12 of the events most likely will occur in 2015 with another 12 from 2016-18, supporting the view that the U.S. and the rest of the industrialized world could experience a technology-driven boom beginning in mid-decade. Finally, if your main interest is in identifying large new technology markets, sort by expected market size – keep in mind, these are not expected until sometime beyond the year that the takeoff adoption rates are reached.

### CAN YOU BELIEVE THE EXPERTS?

Do you trust these experts' views? To decide, you may wish to review who they are. Click on "About Us," select "Experts," and you can

view biographies for most of them. Because diversity of views is crucial, the TechCast expert panel is selected to encompass a large sample of authoritative, leading thought on science, technology, and society in general. The panel members include high-tech CEOs and executives, working scientists and engineers, planners, futurists, social scientists, and consultants. The Delphi process enables TechCast to pool available knowledge and diverse expertise to reach consensus forecasts. However, the true test will be the accuracy of the forecasts. In-depth assessment of accuracy is in progress, and will be ongoing; an article with findings to date is posted on the website. So far, TechCast has tended toward optimism, with the typical forecast about three years ahead of the actual arrival date that lay 10 years out on the planning horizon. Over time, however, the process has been refined, more information is available online about emerging technologies, and the number of participating experts has expanded, all factors that can contribute to increased future accuracy.

Do you regularly scan and evaluate the future, in your enterprise or personally? Volunteer for the expert panel. To quote the TechCast website: “Anyone qualified may join the Ex-



**Roy Pearson** is Chancellor Professor Emeritus at the Mason School of Business of the College of William and Mary, where for three decades he taught forecasting in the MBA program; he currently teaches short courses there in forecasting and future studies. He continues to be an active forecaster of the Virginia

economy and its businesses.

**Roy.Pearson@mason.wm.edu**

pert Panel. Experts receive a free subscription (worth \$950/yr), prominent visibility, consulting work, professional contacts, and an opportunity to participate in the best online technology forecasting system. In return experts must maintain a profile and spend a few hours each year completing the Expert Survey and providing comments.” You will find it lots of fun—and thought provoking!

## CONCLUSION

The TechCast site offers useful insights to any visitor about the likely timing for the adoption of many strategic technological innovations in the major world economies, and examples of implementing horizon scanning and the Delphi process. For subscribers and the panel of experts, it also provides a quick way of assembling reports about multiple technologies of interest, with documented evidence and quantified estimates, providing a base for considering cross-impacts as well as digging deeper for any particular technology.

## REFERENCES

Committee on Forecasting Future Disruptive Technologies, National Research Council (2009). *Persistent Forecasting of Disruptive Technologies*, The National Academies Press. Free PDF downloadable from <http://www.nap.edu/catalog/12557.html>.

Committee on Forecasting Future Disruptive Technologies, National Research Council (2010). *Persistent Forecasting of Disruptive Technologies – Report 2*, The National Academies Press. Free PDF downloadable from <http://www.nap.edu/catalog/12834.html>.

Committee on Forecasting Future Disruptive Technologies, National Research Council (2010). *Persistent Forecasting of Disruptive Technologies – Report 2* (Free Summary), The National Academies Press. Free PDF downloadable from <http://www.nap.edu/catalog/12834.html>.

Pearson, R. (2008). Looking at tomorrow today: The what, why, and how of futuring for forecasters, *Foresight*, Issue 10 (Summer 2008), 9-14.