Technology Outlook and Enterprise Impact Analysis
Case Study: Future Mobile Technology and Applications

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ABSTRACT

This case study describes the application of modern foresight techniques to the problem of developing a flexible enterprise Research and Development (R&D) strategy. It covers a general, grand scale collaborative technique for selecting focus areas and developing general strategy plus a more tightly focused and rigorous information organizing tool for making deep dives into the selected area. The selected area for this case study is future mobile technology and applications. The enterprise in question is a multinational corporation known for its solid research and development efforts in information technology. An example of the insight derived from our study is the scenario of the cell phone as tour guide.

Keywords: future, R&D strategy, signpost, information mining, mobile technology.

1. INTRODUCTION

This paper is a case study describing the application of new techniques to the general process by which an enterprise develops its R&D strategy. The process is called the Impact of Future Technology (IoFT). The new techniques form a rigorous information organization tool. They have been built around the concept of a signpost (v. [4]). A signpost is a recognizable potential future event that would be so significant for the enterprise that it would be actionable at the strategic initiative level. The methodology includes ideation, information mining, scenario envisioning, and the selection of signpost events upon which to base a set of contingent strategic initiatives.

IoFT is a general process for guiding enterprise R&D Strategy. It involves a set of foresight techniques including collaborative ideation on a grand (enterprise-wide) scale, scenario envisioning process and signpost analysis. An advantage of the signpost method is that it ties scenarios to the advancing current state of reality, facilitating the development of a flexible, contingency strategy (cf. [3]). The signpost method brings with it an information mining tool called, Business Insights Workbench (BIW, [4]), which we use to produce reports called technology landscapes.

IoFT techniques for technology outlook and impact analysis have been used by several enterprises including IBM (for its Global Technology Outlook (GTO), public sector agencies, and commercial enterprises In the case study of this paper, the IoFT selected focus area is future mobile technology and applications. The paper will describe briefly the IoFT ideation process that led to this selection. Then it will cover in more detail the application of the signpost method to this selection, including the construction of a "radar screen" on which ideas, visions, technology landscapes, potential future events, and signposts are placed to provide a visual representation of current information about the selected focus area. We will elaborate on the use of BIW to build technology landscapes and explore trends. We will include a short version of an example scenario that provides significant foresight for the area. Then we will illustrate the generation of candidate signposts and the selection of a final deliverable set of signposts and contingency recommendations.

2. INITIAL FOCUS AREA SELECTION

In our case study the Research Division of the enterprise produces an annual technology outlook and impact analysis report. At the beginning of each annual cycle, ideas for topic areas relevant to the enterprise are solicited from every part of the Research Division and from many other parts of the enterprise.

These ideas are gathered, filtered, and aggregated through a series of collaborative tools and meetings held in a geographically distributed network of locations. Similar ideas are coalesced. Ideas are selected for further consideration based on subject matter expert estimates of the likelihood of significant advances in the relevant field in the near future. A final selection of a few focus areas is made at the Research Division headquarters according to an evaluation matrix composed of relevance to the enterprise's business strategy, level of potential impact, availability of the related expertise, etc. For this paper we focus on the process from the selection of the topic of future mobile technology and applications for an enterprise in Information Technology industry .

3. IDEATION

Since we had already elicited extensive brainstorming related to the focus area, we selected 32 ideas as the basis for our ideation process. These ideas were aggregated into 10 visions and evaluated for impact and maturity. The analysis for each of the 10 visions is to be finally integrated and prioritized into a coherent and consolidated report.

Here we list only the five ideas that were aggregated into one vision:

- ❑ Mobile phones will be the key to social networks of the future, finding local communities as you travel and interacting either remotely or live.
- ❑ A tour package includes a loaner cell phone with GPS that works on the tour and carries all electronic tickets, passports, permissions, etc., as if it were a smart card and a credit card.
- ❑ Live video feeds of activities are provided for tourism.
- ❑ A mobile phone will act as a hotel room key.
- ❑ A mobile phone remotely controls devices depending on the detected destination of a traveler, e.g. turning on air conditioning in time to cool a room for arrival.

These ideas were aggregated into the vision we call, phone as tour guide.

Each of these visions represented the ideas behind it; but also offered a basis for expansion into a scenario. Rather than expanding each vision into a scenario, we evaluated the visions for potential impact on the enterprise and for time to maturity (i.e. how soon we expect the commercial realization of the potential). These evaluations allowed us to place the visions on our two-dimensional radar screen.

The radar screen has a horizontal axis labeled maturity. Maturity is plotted on a five point scale:

1 = commercial off the shelf
2 = mature in 3 years
3 = edge of business planning horizon
4 = intermediate future
5 = edge of intermediate future

Figure 1. (Time to) maturity scale

The business planning horizon is roughly three to five years out. We divide the future into three major segments: the near future, the intermediate future, and the deep future. This division is knowledge based. Rather than attempting to assign dates to events beyond the business planning horizon, we assign the 3, 4, or 5 ratings based on how much we know about how the idea, vision, or event might be realized. The deep future is reserved for ideas for which we have no potentially feasible plan and no assurance that the event will even occur. For this study we filtered out deep future ideas and used them only as brainstorming suggestions for near or intermediate future ideas.

The vertical axis on the radar screen is also plotted on a five point scale and represents a very rough (log scale) estimate of the relative magnitude of impact on the enterprise.

The radar screen also shows estimated influence as arrows between the bubbles that represent visions. Pictured is the radar screen after some lower priority visions have been dropped and other visions have been added because they provide plausible paths toward the high priority visions.

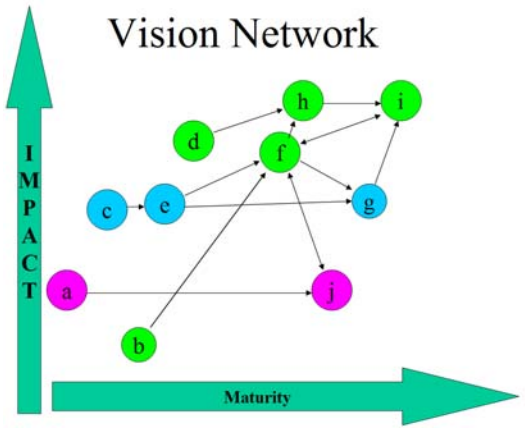

Figure 2. Vision Network on Radar Screen

a = phone as social interface
b = phone as sensor
c = smart card convergence
d = phone with software definable radio
e = wireless active smart card
f = phone as application plug-in
g = phone as smart card
h = wireless comm. Convergence
i = phone as tour guide
j = phone as speech translator
Final set of visions

Figure 3. Index for vision network

During the ideation process, visions are prioritized according to a linear combination of impact and maturity that values high impact and low (near future) time to maturity. Note that impact and maturity are not

independent. Since they are only rough estimates, the precise linear combination doesn't matter. The important visions are those on the upper left frontier of the radar screen.

Below we plot other objects in the same two-dimensional radar screen. Evaluations on each of the two basic dimensions are qualitative and performed by a team of generalists and subject matter experts using a modified Delphi process described in [5].

4. INFORMATION MINING

After the early ideation process had produced an initial set of visions, we began to explore the current landscape of mobile technology and applications as represented by patent activity. Subject matter experts suggested a set of search terms and we used our information mining tool (BIW) to build up a taxonomy corresponding to the terms with significant patent activity. We focus much more on patent trends than on raw numbers of patents; but we require sufficient activity to be able to identify trends with confidence. BIW provides a comparison and ordering of trends of patent activity corresponding to a given taxonomy of patents. Pictured is our radar screen with bubbles corresponding to each class within our taxonomy. The size of the bubble describes the relative trend, larger bubbles indicating a more rapidly increasing trend of patent activity. In many fields, including mobile technology, patent activity seems to be a good proxy for industrial R&D investment (roughly 3 years in the past).

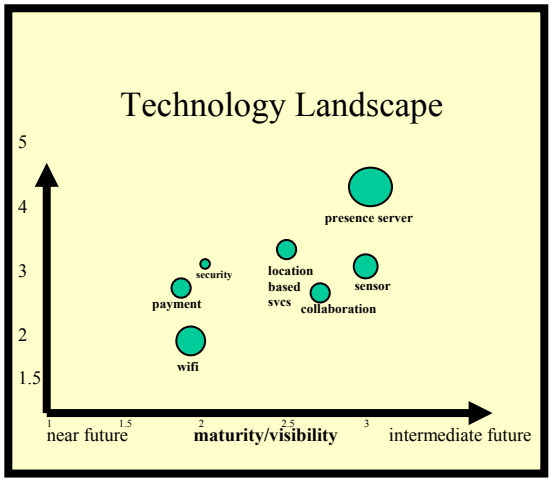

Figure 4. Technology Landscape on Radar Screen

BIW also facilitates discovery of atypical patents that do not fit well in their assigned classes, though they fit well within the scope of mobile technology. These atypical patents sometimes provide new ideas and visions for the ideation process and often suggest candidate signposts. The following example list was obtained by human selection from among the least typical but recent patent activity in the "location based services" class:

7,155,305	home appliance identification and control
6,973,322	personal travel agent using push services
20040259574	location privacy management

Figure 5. Example atypical patents

5. SCENARIO ENVISIONING:

Our approach to scenarios is a variant on scenario envisioning [1] with reduced emphasis on immediate strategic assessment and increased emphasis on vision exploration. Following is an abbreviated version of one of the scenarios constructed to explore high priority visions resulting from the ideation process. We typically structure scenarios as first person reports from someone in a relevant industry, written in the style of a popular magazine article rather than a technical journal. Exploring a day in the life of someone who lives within the world of the vision helps to extrapolate consequences and likely influence relationships with other visions. It also helps us generate relevant candidate signposts. Each part that suggests a signpost is formatted in italics.

Phone as tour guide

(in which a tour packager issues a loaner cell phone with GPS, RFID tag and RFID reader to each tour participant and the phone serves as guide, reservation manager, electronic ticket manager, credit card, location based service advertiser, alarm clock, security alert manager, biometric authenticator, and remote device manager)

Remember the days when you used to receive tickets, maps, instructions, and reservation confirmations as a package of pieces of paper from your tour packager? *Now everything is electronic (including your passport) and all you receive is a cell phone.* I am a customer service representative (CSR) for Round-the-World Tours and my job has gotten much easier with almost 100% adoption of our new cell phone based tour service management by all our service vendors.

I'm sure you will not be surprised to learn that I work from my home in India. When a client signs up for a Round-the-World tour via our automated web or phone service, I am not even in the loop. But often a client wishes to contact a real live human, and our automated systems simply don't anticipate all requirements. In any case, the client receives, by express mail, a preprogrammed special loaner cell phone. I am available to assist the client in learning to use the cell phone. I am also available to deal with late arrival of the phone, phone failure, loss of the phone, assistance in call forwarding to the phone, and last

minute changes in itinerary. Most of these things could be handled by our automated systems; but in stressful situations, people prefer not to have to think about how to navigate an automated system. Instead, they fall back on human-human connection. …

Our phone is the next best thing to a personal tour guide and assistant. If you are traveling in a family group, it has a walkie-talkie feature that allows instant communication up to about half a mile. And, it has a speed dial connection to me….

A few days before your tour is scheduled to begin, you receive a recorded reminder in both voice and text modes. *If the GPS locator in your phone detects that you are not moving toward your embarkation point at a rate that will get you there reasonably on time, you receive warning messages. If our system determines that you will miss the embarkation, we reschedule with a best fit.* I receive lots of calls from people who have arrived at their embarkation point, only to discover that they have lost or left behind the needed cell phone. Not to worry – replacements are immediately available. We anticipated the problem when we detected that the cell phone would not reach the embarkation point on time and that our calls to you were not being answered. That kind of service is why you picked Round-the World Tours.

Security is no longer an issue and trusted transactions can be done from your phone with simple to use technology.

Your phone provides you with travel directions to reach the tour embarkation point and during any personal side tour. We encourage you to use it because it helps us anticipate your other needs. *When you reach a public carrier or hotel, the phone serves as your reservation, electronic ticket, and almost universally accepted credit card. Since vendors have varying levels of technology for electronic commerce, your phone contains three separate systems, at least one of which is extremely likely to be recognized by any given vendor.*

One really nice service that works at all the big hotel chains is **just in time check-in**. *This service runs an automated check-in protocol as you near your destination. Your phone gives you your room number and directions to find it. Better yet, it arranges for various amenities in the room to be started at appropriate times so that the room is completely ready for your occupation without any energy having been wasted. Booking meals is almost as simple.*

Now that you've arrived at your destination and checked in, the fun begins. Your itinerary is conveniently loaded into your phone and simple icon menu driven selections allow you to pull it up and start your tour. Today you are scheduled to visit the Chartres Cathedral just South of Paris. After reviewing your itinerary and making some last minute selections, you're on your way.

A taxi is waiting outside to take you to the train. Your electronic train tickets are already loaded into your phone. The taxi fare is sent directly to your phone over a Bluetooth link. You accept it and it's automatically paid for as you leave for the train station. Your phone points the direction you need to walk to get into the train station. As you enter, the screen continues to suggest the route to the departure gate. You wave your phone over the gate, it opens and you embark.

As you leave the train station, your phone guides you through town to Chartres Cathedral. This is your first visit to this historic Church and you want to learn as well as tour. Your phone is there to help. Its GPS system senses your exact location. As you point your phone (camera) at any object, you see it as if you were taking a still picture but with text labels popping up to describe it. The text is in the language you understand and can be read aloud by the phone via speech synthesis. *The phone recognizes and faintly outlines architectural objects of importance, from flying buttresses to the individual statues, labyrinth floor, and stained glass windows.* If you want to know more you select the text label and another menu opens up that allows you to access its history.

As you walk, your path is recorded. Your visual observations are uploaded to your web site so you can watch them when you return to your room. Your (speech or text) comments are recorded as personal captions for the pictures you take.

On your trip back you're contently looking out of the train and notice a building you know is famous but can't quite identify. You simply point your phone's camera at it and ask, "what building is this?" *Fortunately your camera knows where you are and has access to huge libraries of data and photographs from around the world. It quickly identifies each scene.*

We are just testing deployment of biometric authentication phones that stop working and send distress signals if they are out of your possession. These phones also sense a few important medical conditions (like fever) and can be set to alert you or to send such alerts to me.

My job will be even easier when your standard cell phone already has all the devices we use so it can be remotely programmed to act the way our loaner phones now work. The whole transaction system will be even simpler when the next generation intelligent wireless communication devices are standard for both your phone and every vender cash register. We know this next generation system is coming. The standards have already been adopted world-wide and almost all governments have allocated the appropriate operating frequency bands. But the current RFID systems are

working well now. Our vendors need an incentive to invest in the change. We don't know when the change will actually take place; but I'm looking forward to it
I'm not worried that the new automation will result in no need for me. There will always be glitches and CSRs will always be needed to respond to you and fix the problem.

Scenario research

As we produced this scenario, we researched likely sources of data that could be used for signposts that could indicate whether we were moving toward or away from its vision. We also looked for terms that could be used for more focused information mining. For example, we found the following authoritative information sources:

http://www.technologyreview.com/Infotech/18746/	Technology Review: Your phone as a virtual tour guide
http://www.tia.org/	Travel Industry Association
http://www.sdrforum.org/	Software Defined Radio Forum

Figure 6. Authoritative information sources

Associated with each scenario produced and with each important vision, we supplemented subject matter expertise with environmental scanning [2]. This scanning helped to provide authoritative information sources, important recent developments, and sets of good search terms for future monitoring of visions and signposts.

6. SIGNPOSTS

In the course of scenario research and information mining we uncovered hundreds of good ideas. Selecting the most significant of these ideas and filtering for ideas within scope and timeframe (near to intermediate future), we generated and evaluated 48 candidate signposts. Turning a good idea into a signpost is a complex task with extremely variable success (v. [6]).

For example, in ideation that led to the scenario of phone as tour guide, we used backcasting to create several visions in the area of the smart wireless card. One way we might see the future unfold would be for multiple services to be offered for wireless smart cards first and then for cell phones to integrate wireless smart cards.

The good idea here is the commercial availability of multiple travel-related services for wireless smart cards. If this idea were realized we would expect a market for the same services adapted to mobile phones (the mobile phone integrating more services in one device, providing built in electrical power for better range, and providing location based services via local cell or GPS). Our task was to translate the idea of travel-related services for wireless smart cards into a signpost.

A rough first draft for this candidate signpost was as follows:
Draft 1: ***A wireless smart card, with applications including at least passport, hotel room key, programmable portable itinerary, and transportation ticket, is adopted by at least two major tour packagers and two major hotel chains.***

This draft is not sufficiently specific for reasonable people to agree on whether the event has happened. We chose to solve this problem by making the sets of major tour packagers and major hotel chains well defined, by means of an authoritative information source, the Travel Industry Association. This association maintains publicly accessible member lists in various categories including tour packager and hotel chain. Another potential source of ambiguity is the meaning of the term "adopted," which we changed to "offered in public advertising." Passport applications depend on political, legislative, and bureaucratic factors that may not be correlated with other automation and mobility advances in the travel industry, so we decided to drop it from the list. The result was as follows:
Draft 2: ***A wireless smart card, with applications including at least hotel room key, programmable portable itinerary, and transportation ticket, is offered in public advertising to clients by at least two TIA member tour packagers and two TIA member hotel chains.***

Note that there are a number of variations on this candidate signpost that could also indicate that we are moving toward the vision of phone as tour guide on or near the following vision path:
c *smart card convergence*,
e *wireless active smart card*,
g *phone as smart card*, and
i *phone as tour guide*.
For example, we could add a larger list of applications and require some threshold number. The variants would all be different ways of describing recognizable events corresponding to the idea of a multi-application wireless smart card being adopted by a significant portion of the travel industry. Another variation of this candidate signpost would broaden the form factor and architecture from smart card to mobile device with battery power, possibly including a cell phone. But this version would not indicate the same vision path and would correspond to very different recommended actions.

We don't know whether the path <**c,e,g,i**> bbbwill be taken. Our signpost is designed to indicate that we are following this path. Contingent on the signpost is the opportunity to convert from smart card to cell phone, integrating many otherwise separate and independent travel related services. Following is a table containing a small selection of signposts and corresponding, contingent recommended actions from our study.

Signpost	recommended action
1 *Commercial offering of cell phone with software definable radio encompassing at least CDMA and GPS, GSM, WiMax, bluetooth, UWB, and one of the wireless sensor network protocols (e.g. ZigBee).*	*Develop and build a (grid style) processing, data aggregation, data storage, and visualization infrastructure that meets the standards offered and manages software radio specifications as a special class of location based service.*
2 *Wireless smart card, with applications including at least hotel room key, programmable portable itinerary, and transportation ticket, is offered in public advertising to clients by at least two TIA member tour packagers and two TIA member hotel chains.*	*Partner with a cell phone manufacturer to produce a similar offering integrated with the cell phone.*
3 *A commercial WPAN (e.g. bluetooth or ZigBee) offers a service that connects a mobile phone to an application only temporarily associated with the phone owner.*	*Develop and build a (grid style) processing, data aggregation, data storage, and visualization infrastructure that automatically manages such services.*

Figure 7. Signposts and recommended actions

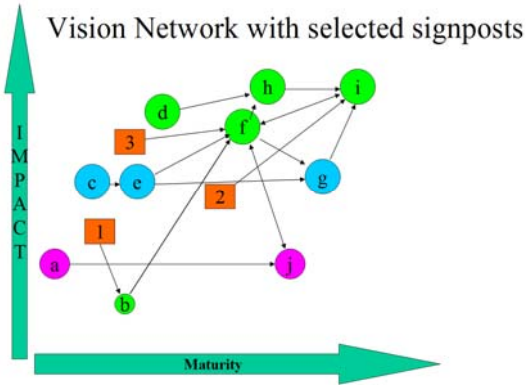

Figure 8. Vision network with signposts

7. CONCLUSION

The figures on this page display three signposts with contingent development and deployment strategic initiative recommendations.

We suggested that the enterprise consider these initiatives (among several others not reported) as potential undertakings, performing cost-benefit analysis in order to prioritize them against other similar ongoing or scheduled initiatives that compete for a limited budget. We also suggested that immediate research be performed to verify the feasibility of these recommendations.

There are two significant differentiators of the IoFT approach:

1. the use of the formally defined concept of a signpost to organize knowledge about the future and
2. the use of information mining tools to enhance subject matter expertise about current trends and about atypical (and thus more likely disruptive) advances.

We also added some systematic collaborative ideation techniques, new ways to build expert consensus, and more strategically focused use of modern foresight techniques including scenario envisioning, environmental scanning, and backcasting.

8. ACKNOWLEDGEMENTS

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