Technology Intelligence and Monitoring System (TIMS)

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Abstract

A Technology Intelligence and Monitoring System (TIMS) can prove to be enormously useful to an organization by identifying, in timely manner, developments in emerging technologies that could lead to new opportunities or pose threat. However, the effectiveness of such a system is dependent on deciding on what technologies to track, how to track them, and how to implement it to derive high value for the organization. This paper discusses how to prioritize technologies for tracking from a list of both the "usual suspects" and the "unusual" ones. Then it goes on to describe the sources for intelligence, emphasizing the use of a network of experts in order to get tacit and unpublished intelligence. Finally, the paper describes the desired characteristics of a system that automates intelligence gathering and provides insights on implementing it within an organization.

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1. Introduction

Technologies are the life blood of your organization. Interpreted broadly, technologies are the *collective know-how* that allows your firm to make products or deploy services. Thus, technologies play a key role in providing your company a competitive edge and make it grow profitably. To that end, it is very important that the employees of the firm involved in making technology related decisions be fully aware of what is going on in the outside world…what new technologies are emerging, how the existing technologies are progressing along, which companies are involved, what breakthroughs are likely to happen, and when such events would take place. Only then can the your firm can make sound decisions related to product development, technology investment, technology acquisition, and such. Do it right and you have access to opportunities before your competitors do. Do it wrong and your firm can literally be blown out of the water by a disruptive technology that you did not pay attention to.

This sounds well and good but how to properly implement an intelligence system is a different matter. You need to make several decisions, such as:

- What technologies to track?
- How to track them in a systematic manner?
- What should such a system include?
- How to implement the system so that the organization derives high value?

In this paper we have addressed these issues. In order to make the paper concise, the information provided is brief, meant to serve as a starting point in the process of developing and implementing a Technology Intelligence and Monitoring System (TIMS).

The first step is to decide what technologies to track.

2. What technologies to track?

One of the key challenges in developing a system for technology intelligence and monitoring is to decide what technologies to focus on. Just scanning or trawling to identify any interesting technology may be one approach but that may not be the most efficient or effective way to spend resources. On the other hand, by just concentrating on the current technologies---*the usual suspects*--- you may miss technologies that have been developed for some other applications but could be effectively repurposed in your application. A method to identify and track such *unusual* suspects is also need.

We recommend a two step approach toward selecting which technologies to track:

- Identify and prioritize the usual suspects, and
- Have a method in place to identify the unusual suspects

2.1. The usual suspects

Any researcher or manager in the R&D or product development function should be able to identify the usual suspects very quickly. These are technologies that have been around for a while or are known to be emerging. It is useful to classify these technologies as base, key, pacing and emerging as per definitions in the table below.

Technology Type	Characteristics
Emerging	• Early research stage or emerging in another industry • True potential is hard to assess • Competitive impact is therefore unknown • They hold the promise of change the basis of competition or radically transforming the industry
Pacing	• Have the potential to change the basis of competition in an industry if successfully developed • Often adapted from different industries • Occasionally permitting entry of a new class of competitor
Key	• The most critical to competitive success today • Yield a clear competitive advantage to those who master them better than competitors • The most successful companies in an industry will be those most proficient in them
Base	• Widespread and shared throughout the industry • They are a pre-requisite and offer little competitive advantage • Benefits are not important to the customer or are easily replicated, bought, or otherwise matched by competitors

The trick is to narrow down the list further to identify emerging technologies that could truly represent an opportunity or a threat. Perhaps we need to put more emphasis on those technologies that are an opportunity/threat in a near future and less emphasis on those that are still far out. So, determining *how fast* a technology is likely develop is of a great importance. The pace of technology development is represented by a roadmap, like the one shown below. In this roadmap, we identify how close a specific technology is to meeting the future requirements of a specific product (e.g., a large screen TV).

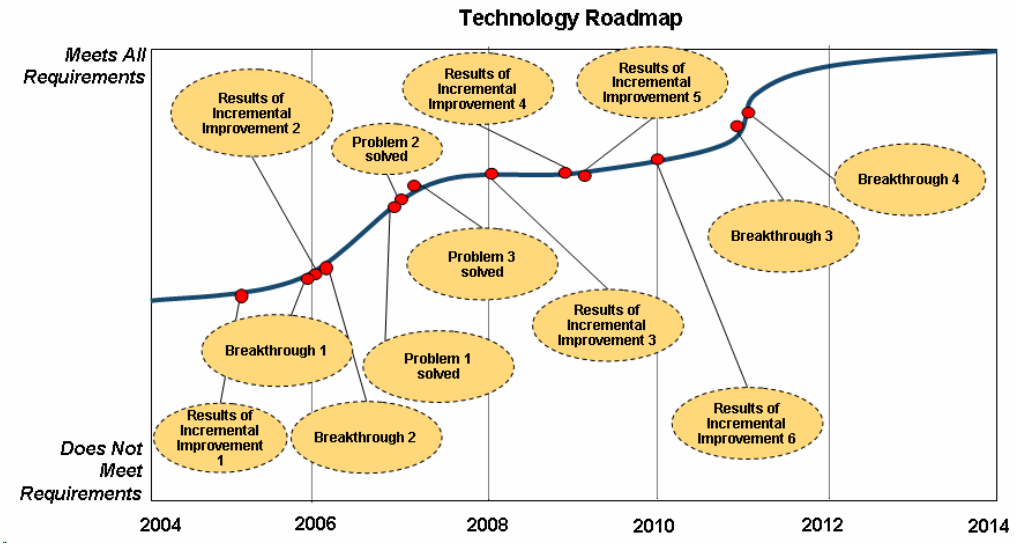

Figure 1: An example of a Technology Roadmap

If a collective picture of roadmaps of various competing technology is created, as shown below, then a picture of the "winning" or potentially disruptive technology will emerge.

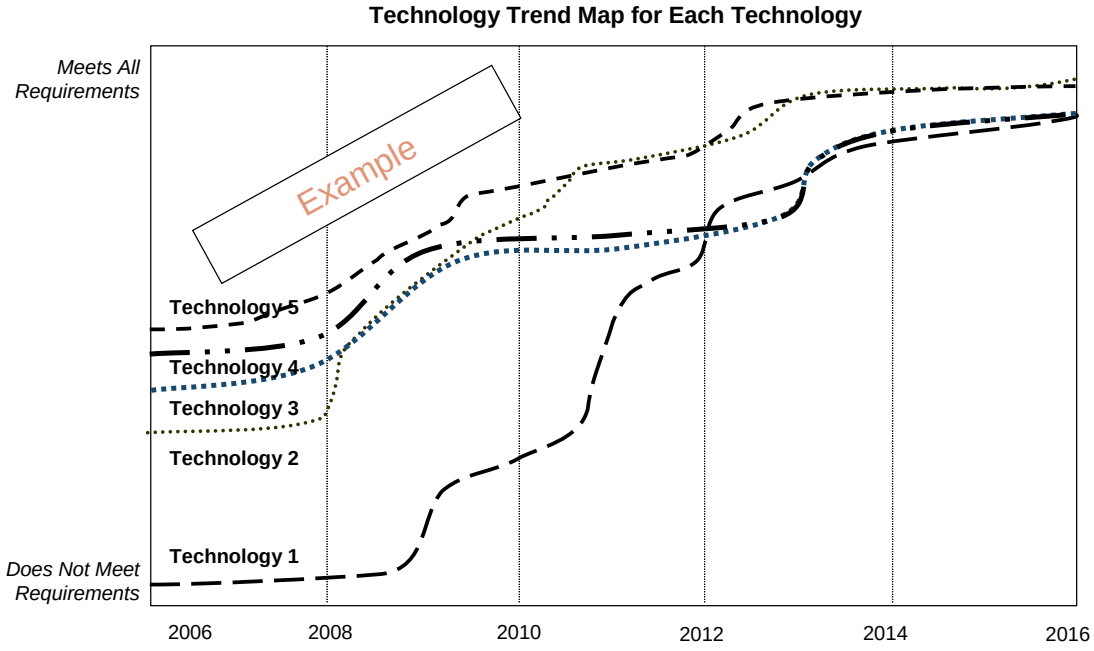

Figure 2: Competitive Technology Roadmap

In this map, it appears that Technology 2 will become a threat to Technology 5 in the time period while Technology 1, 3 or 4 will not. So, more effort may need to be devoted to tracking Technology 2 versus the other technologies.

A recent paper (ref.1) mentions another way of deciding which technologies to focus on. This methodology is based on TRIZ, the theory of inventive problem solving that was developed in Russia. A four step process is described: (i) define the relevant surroundings and competing technologies

(alternative systems), (ii) identify main parameters and functions that are relevant for the success of the system, (iii) predict the future of the different systems and their potential, and (iv) plot technology roadmaps. The main question that the TRIZ based system will answer is how the technology owner will evaluate the potential of his technology to accomplish the same primary function as being accomplished by the current technology. The answer to that will help determine which technologies to focus on.

Now let us look at how to identify the "unusual suspects."

2.2 The unusual suspects

Sometimes a company gets blind sided by technologies that appear to come out of nowhere. Frequently, these are technologies that are developed for some other application and then repurposed by an innovator to compete in a different area. Determining which technologies could be included as the unusual suspects is hard and somewhat speculative. One can look at "all" new technology developments and speculate their impacts, if any, on the company's product portfolio. That is possible, but there may be other alternatives to this needle-in-the-haystack approach.

One alternative approach involves using deductive logic as exemplified by a technique called the "Fault Tree analysis." (see Ref 4 for example). This technique is widely used in quantitative risk assessment in which the likelihood of a certain bad event (airplane falling off the sky) happening is analyzed. Using deductive logic, the analyst attempts to find what possible ways such an event could take place (wings breaking off, pilots becoming incapacitated, rapid decompression, etc.). This "Fault Tree" is further expanded until the analyst is able to determine in a comprehensive manner if some isolated event or combination of events may lead to the catastrophe.

The same technique can be applied to find an unusual suspect. We can start with the end point when something disruptive has happened and work backward to determine possible ways such a disruption could have occurred. Suppose we are responsible for scanning technologies that insurgents can use for developing the next generation explosives, and decide that reduction of odor is a major objective, which if achieved, would lead to a break through. Then, besides looking at the usual suspects of technologies for making explosives, we should also look at other applications where reducing odor would be an objective, such as in the nail polish! So, the solvent technology used in nail polish would become an "unusual suspect" that we may want to track. A Fault Tree that would systematically identify the nail polish solvent as an "unusual suspect" is shown below.

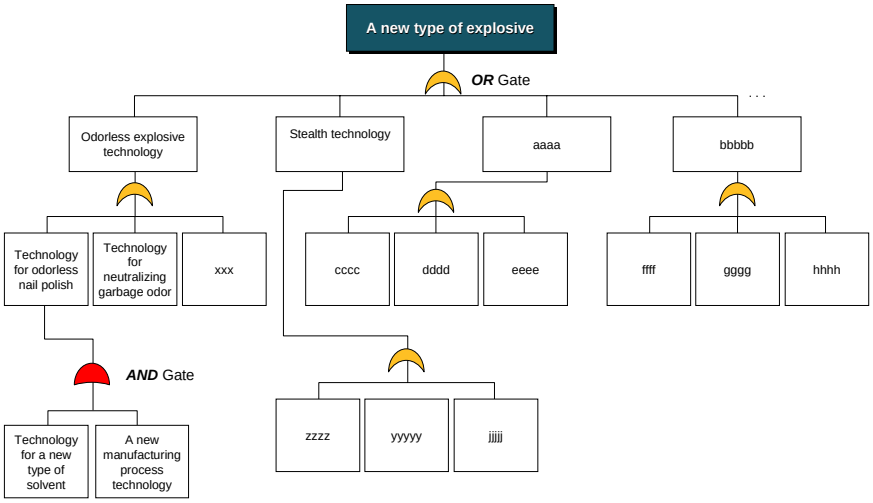

Figure 3: Application of a Fault-Tree to identify unusual suspects

A Framework developed by Kerr et.al. (Ref. 3) describes the various types of activities needed to keep track of technologies based on their awareness and provision, as shown below. The usual suspects are covered under "known technology awareness" part of the matrix, i.e., the lower row, while the unusual suspects under the upper row ("don't know"). What the matrix also defines are the two columns. The left column covers known intelligence provision, where the sources are internal. The right column defines external sources of intelligence.

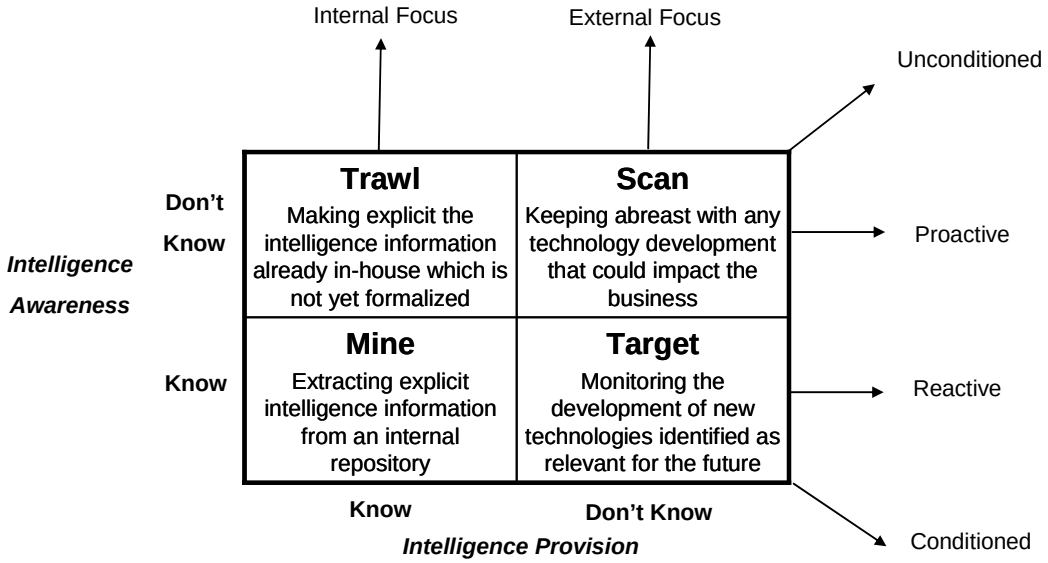

Figure 4: A Framework for Technology Tracking (Ref. 3)

As we shall see next both these sources are important.

3. Sources of Intelligence

So where does one get technology intelligence? There sources for technology intelligence can be classified as either external or internal to the company.

3.1 External Sources

Obviously, one of the first things one should do in gathering intelligence is to scan the on-line universe using a search engine such as Google. There are also other sources where specific emerging technologies will emerge, such as patent filing and disclosures. Information on funding activities…who is funding what technology development... is yet another source. Often it is useful to have the taxonomy of search area well defined, so that the developments in adjacent technologies are also covered.

One can actively look for information or have information come to you. The latter category includes RSS feeds from individual sources, and from an RSS aggregator which combines, as the name suggests, information streaming from hundreds of feeds and show relevant results. (See Newsgator, as an example of an RSS aggregator.)

Obtaining intelligence from such on-line sources is necessary but by itself not sufficient for many reasons. First, not all knowledge is available in an explicit format that a search engine can find for you. This is particularly true for new developments or new technologies that are just becoming public.

Second, it is hard to trust what is available on-line from a source that is not known to you. Third, it is safe to assume that this knowledge is also available to your competitor, so what you are uncovering is not exclusive intelligence.

The answer lies in creating and tapping into a *network of experts.* These experts can be academics, individual consultants, ex-executives of firms, or members of small boutique consulting firms. There are communities of experts that can be tapped into. The composition and size of the group depends on the subject matter at hand. Carefully selected external experts are a great source of intelligence. They would be aware of developments that have not been made available in a searchable format. They would not only provide raw intelligence but interpret it for you. Also, interviewing several experts in the same field would provide multiple perspectives, and sometimes even concensus, on a specific technology, what its current status is and what is the prognosis.

So much about the external sources. Let us now see how the intelligence that you need may reside in your own backyard, in your organization.

3.2 Internal Sources

Amazingly, one of the best sources of intelligence is the corporate knowledge base, both explicit (residing in electronic files and paper ones) as well as tacit, residing in the heads of the staff members located worldwide. There are several Business Intelligence systems that allow you to tap into the information available in the electronic format. It is now possible to get both structured (analyzed and organized) and unstructured information (email, word documents, audio and video files) found and made available.

The more interesting source is the *tacit* knowledge in staff members' head. To extract this, one needs to find out who may know about the subject of interest to you. For a usual suspect, the list may be relatively easy to create. Which person may know about the unusual suspects is another matter.

The corporate knowledge management system may have a cross referenced list of employees and their areas of expertise; this can be a starting point. However, these systems are notorious for not being kept up to date and so a newly acquired area of knowledge for an employee may not appear in the KM system.

Several companies have developed systems for solving this problem. A system such as Illumino by Tacit Corporation "privately keeps track of knowledge and expertise" of staff members. Another product by the same company, ActiveNet "continuously discovers each person's work focus, activity and business relationships by processing communications from such sources as documents, discussion databases, e-mail, instant messaging and digital workspaces."

Using systems such as this allows you to identify people who should be approached for intelligence on a specific technology. This way, you can benefit from the gossips at a conference the employee attended or something a vendor or customer mentioned about your competitor. This is not the type of intelligence that is available in electronic format in the corporate databases, and yet it could provide the type of intelligence you need to stay competitive.

The following section describes a system that assimilates and generates value form the intelligence being gathered.

4. Characteristics of TIMS

Identifying the technologies that need to be tracked, and the sources that would provide you the necessary intelligence are two important initial steps. However, this effort will be futile without having an on-going **system** to collect intelligence, interpret it, and make decisions. In this section, we share our thoughts on the design of such a system.

Figure 5 shows what an ideal technology Intelligence and Monitoring System (TIMS) should look like.

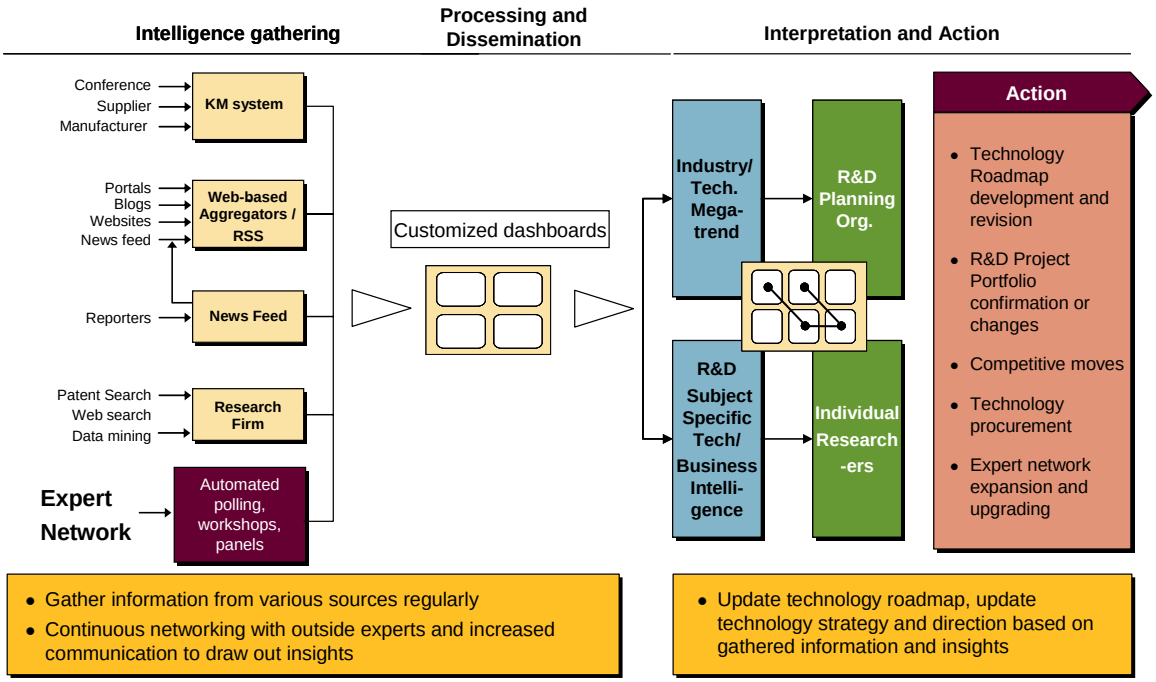

Figure 5: Technology Intelligence and Monitoring System (TIMS)

As depicted in the figure, the system should consist of various modules to gather, analyze it, and interpret information to make it "intelligence" that would support decision making in a company. The processed information is shown on a dashboard, the exact content of which would depend on the person looking at it. These persons, the analysts, are trained to connect the dots and draw conclusions.

Here is a brief description of each module:

Knowledge Management (KM) System: As mentioned above, the principal use of the KM system is to extract and provide internally available information in both structured and unstructured formats. This information is gathered from a variety of sources, such as conference memos written by staff members, communications with supply chain partners, and such. Also, it should have a provision for identifying internal experts based on the areas of expertise they have exhibited. These people can be polled or interviewed to gather tacit information that has not been entered into the electronic format on any company system.

On-line information: A module of the system should be devoted to gathering information from RSS feed, newsfeeds, and those from web-based aggregators (an example is Newsgator.com).

Research Firm: Occasionally, it may make sense to engage a research firm that takes in raw information from the on-line and expert sources and convert that into a digestible usable format. One module of the system should be devoted to obtaining processed information from such research firms.

External Network: This module manages relationships with the members of the expert network, polls them on a pre-determined schedule, and obtains their responses. We, at Monitor have developed a tool called TechForecast to automate many of these tasks. A screenshot of this tool appears below in Figure 6.

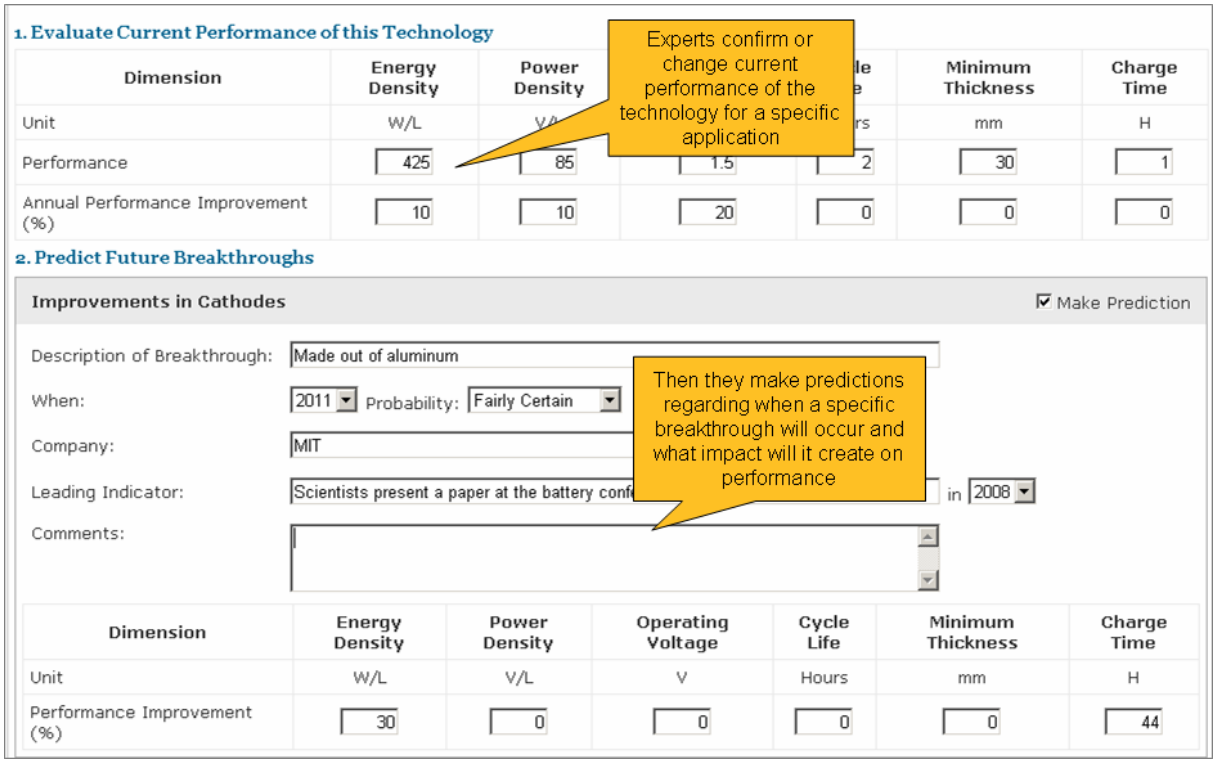

Figure 6: TechForecast, a technology intelligence tool

This tool focuses on gathering expert opinions on the road that a technology is likely to take from now to a specific time in the future (5-10 years from now)…a roadmap. The experts are asked to predict the likely breakthroughs, when they will happen, and how much improvement in technology performance they would entail. The tool then plots a roadmap for the technology, showing individual and aggregate opinions of the experts. Areas where there is a great deal of uncertainty are also highlighted to allow the user make judgment on the reliability of the forecast.

Dashboard: This is an important element of the system…dashboard(s) that summarize the information gathered in one place so that an analyst can study and interpret it. Most likely, the system will have a series of dashboards, each designed to satisfy the needs of a specific type of stakeholder. For example a researcher may be interested in the tactical information on a specific technology…who is doing what in the competing companies and universities. A senior member of the R&D organization, on the other hand, would like to obtain more strategic information on a whole set of emerging and competing technologies.

Interpretation: The dashboard provides information; it is the receiver's job to interpret it. The dots need to be connected in order to provide intelligence that is meaningful and can lead to making

decisions and taking action. At this point it is important to note that the technology intelligence system should be operated in conjunction with the process used for capturing other intelligence, competitive intelligence, market intelligence, and such (as a matter of fact, it may be difficult to separate these systems anyway). By doing so, the task of connecting the dots becomes more meaningful and valuable.

The task of interpreting the intelligence becomes easier if the receiver of the information has already thought through the questions that would constitute *intelligence*. Figure 7 shows an example of the types of questions that may be included in such a "cheat sheet" for a manager of R&D organization responsible for technology strategy.

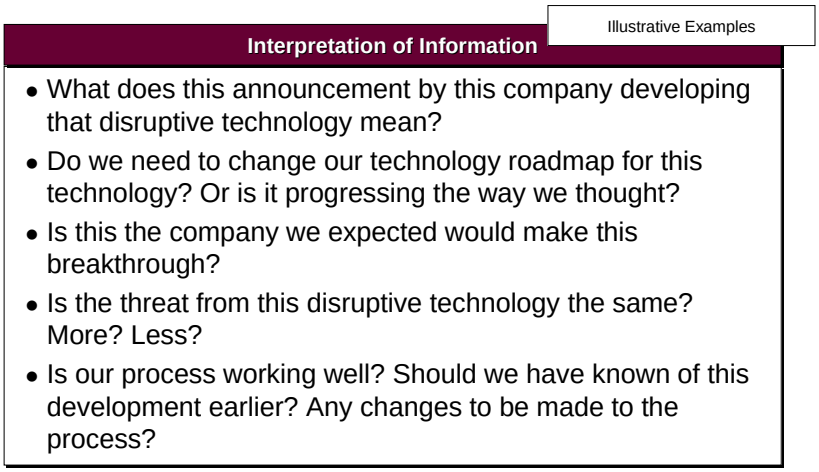

Figure 7: Interpreting technology intelligence information

Action: The intelligence created through interpretation of information can lead to making decisions and taking actions. The types of decisions that depend on such intelligence are:

- Should we shift resource allocation from one technology area to another?
- Should we think about partnering, licensing, cross licensing with this company?
- Is it time to place bets on this emerging technology?

Figure 8 shows the progression going from data, information and trends to intelligence to addressing the key issues surrounding strategic business decisions.

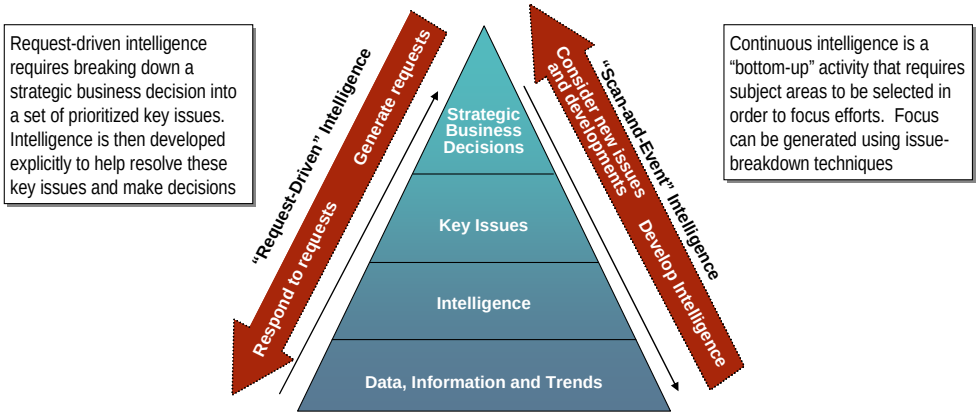

Figure 8: Use of Technology Intelligence and Monitoring System

As shown in the figure, the System can be used in the reverse manner as well. In this case, a user (say the CTO) needs to make strategic decisions, which she breaks down into issues and then identifies intelligence needs. These are then used by the System analysts to gather relevant information from the external and internal sources. So the System needs to be designed both for "user-pull" and "intelligence-push" type of situations. How often the "intelligence-push" is exercised depends on the technology and how quickly it is developing.

As eluded to in the discussion above, the technology intelligence system has to be integrated in the workings of the organization otherwise it will create limited if any value. Also, it is important to try and prevent "organ rejection"…the resistance to change and to something new and foreign. These are briefly discussed next.

5. Implementing TIMS

Implementing TIMS is a four step process, as shown in Figure 9

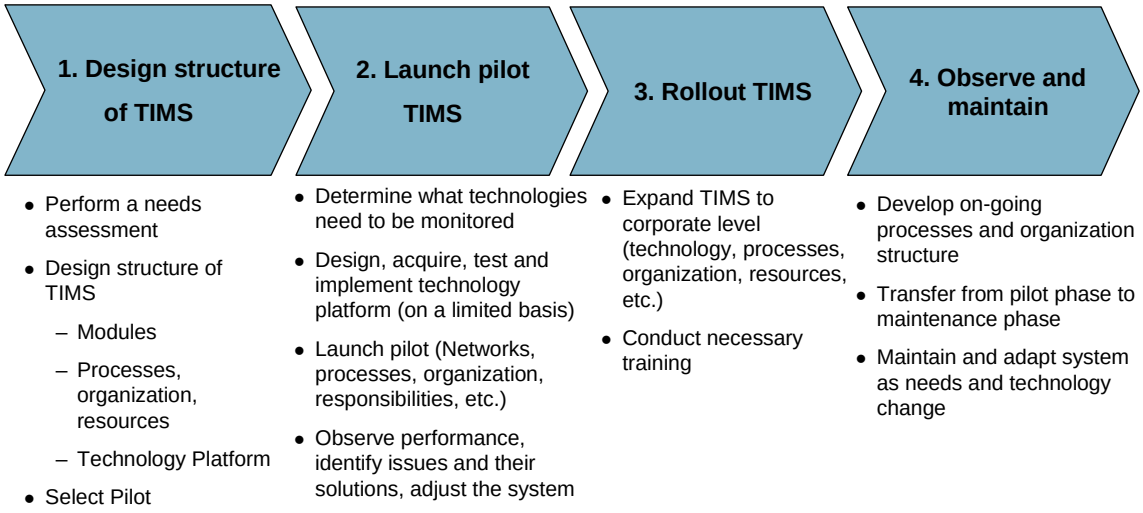

Figure 9: Process for Implementing TIMS

As illustrated in the figure, the Step 1 begins with an assessment of what are the needs of the organization. What types of decisions are made by whom at what level? What type of intelligence would prove of value? When would such intelligence be required, in what format? This type of interview will help define the scope and high-level value proposition of TIMS. We would know what TIMS should be able to do…a set of performance specifications.

The high level design of TIMS can then be created along the lines of the schematic shown in Figure 5. We need to determine what modules would be appropriate. Should we include both internal and external facing modules? Is it necessary to outsource a part of information gathering to an outside research firm? What type of network of experts should be considered? These are the questions that need to be addressed.

Next, the structure of the TIMS within the organization itself needs to be articulated. This includes defining the processes (and how they integrate with existing processes), organization (and how it fits within the existing organization), and resources (IT resources, people resources). The process definition needs to include

- The processes for creating, tapping into, maintaining, and growing the network of experts
- The processes for defining technologies of interest, receiving intelligence requests, providing on-going intelligence, performing the information gathering and analyzing activities, and so on
- The processes for internal intelligence gathering…converting tacit knowledge into explicit knowledge, requesting employees for information, receiving information, and so on.
- The processes for "connecting the dots", disseminating the intelligence to those who need it, making decisions based on the intelligence and taking action
- The processes for evaluating the performance of the system and upgrading it

The organization definition must be fairly detailed. Figure 10 is an illustrative example of the details that need to be worked out. It shows that for each process, there has to be someone with responsibility for deciding, approving, initiating, and performing.

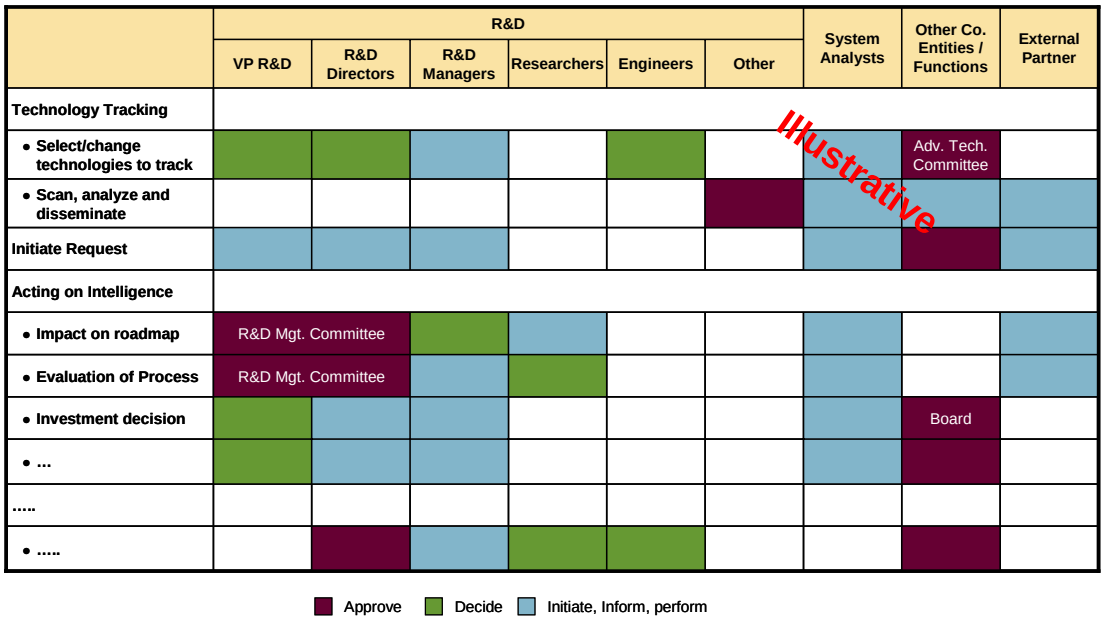

Figure 10: Defining responsibilities

In terms of resources, the firm needs to identify the people who would be operating the system. In larger firms, these positions could be full time jobs, perhaps affiliated with the "library" or information search function. In smaller firms, it could be a shared responsibility among 2-3 seasoned staff members. The IT resources for installing, maintaining, and upgrading the system need to be identified as well.

The technology platform is selected last. (It is a big mistake to do otherwise.) The platform for gathering, consolidating, inquiring, analyzing, displaying, distributing, and archiving information should be defined. This definition has to be in context of the existing systems for at least two reasons…to save money and resources, and to make it easier to fit the processes into the existing structure. So, having the system interface fit within the corporate portal structure would make sense. The staff members can receive intelligence dashboards and make intelligence requests using the structure with which he/she is familiar for other activities.

Finally, one or more pilots need to be selected to try out the system, identify bugs and fix them before rolling it out. The pilot can be a technology based, geography based or SBU based. At this point it is also important to identify the performance measures that will be deployed to evaluate the system performance.

In Step 2, the pilot(s) is launched and monitored. One of the first tasks under this is to determine which technologies to monitor. Both usual suspects and unusual suspects need to be identified and prioritized as discussed above. The technology platform is then acquired to implement the system (on a limited basis). A network of experts (in the technologies selected) is created, staff members are identified and trained/instructed, the process flow and instructions for running the processes are established and disseminated, and responsibilities are assigned, not only for running the system but also from observing it and identifying what needs to be fixed/improved. The pilot is then allowed to run for a fixed period (say 3-6 months) and improvements made based on the lessons learned.

Step 3 involves rolling out TIMS through the organization. This involves all of the tasks in Step 2, only on a larger scale. Finally, in Step 4, the system is observed, maintained, and upgraded as the technology improves, needs change, and additional tools are made available.

There are of course going to be some barriers to implementation of such a system. Based on our experience and those of others (see Ref.4 for example), we make the following observations:

- Staff members may resist the internal intelligence gathering operation. A system such as Illumino or ActiveNet described above, which identifies expertise of staff members based on "discussions, document, emails, instant messaging" would undoubtedly face concerns about privacy. Also, if the process requires any time commitment from the staff members, there will be resistance unless "what is in it for me" issue is addressed. Incentives such as public recognition for crucial intelligence provided to the company may be one way to negate these feelings. Having quick successes attributed to TIMS is another way to assuage concerns.
- It may be all right to have a manual system in place before the automation is introduced. The expert opinion can be gathered manually before an automated system is deployed. Same about the internal intelligence gathering. However, it will be a good idea to switch to an automated system soon afterwards to save cost and make the process more uniform.
- Although one thinks of barriers in terms of knowledge barrier, capability barrier, and willingness barrier, it is the last one that is the most important (Ref.4). This barrier is addresses by on-going communication on progress of system implementation. The participants have to see that their contribution is making a difference.

6. Closing

This paper has discussed a Technology Intelligence and Monitoring System which can give an organization a leg up in identifying potential new opportunities and managing risks from the threat of an emerging technology. This system can be quite complex and require a phased approach to implementing it. It would require a high level of commitment and dedication to make this system work properly and provide value. This is hard work but not undertaking it could have adverse effect on a company's competitive situation, financial performance, and sometime, the prospects of survival itself.

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