Technology Intelligence at Air Products

Leveraging Analysis and Collection Techniques

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Technology Intelligence as an integrated function is a relatively recent initiative at Air Products. This newness has allowed us to incorporate many of the latest tools and techniques into our intelligence process. In this paper, I will describe how these tools and techniques have been applied within the context of the Air Products intelligence process.

I'll start with a brief overview of Air Products and the way we look at intelligence. Then I will cover our intelligence alerting and backgrounder services, specifically pointing out the tools and techniques we use to access our in-house knowledge and web-based information sources, and for text mining. Finally, I will deal with the heart of intelligence,

analysis, and our team analysis process and techniques for structuring and communicating intelligence for actionable results.

OVERVIEW OF AIR PRODUCTS AND CHEMICALS

Air Products is a global gases, chemicals, equipment, and services provider serving customers in technology, energy, healthcare, and industrial markets. We take pride in being a chemical industry safety leader and are known for our innovative culture and operational excellence.

As a geographically diversified company, half of our approximately $8 billion in sales comes from outside the US. We have operations in more than 30 countries employing about 20,000 people. Air Products is the world's only integrated gases and chemicals company, which gives Technology Intelligence the opportunity to work on a wide variety of offerings. These offerings take Air Products into a multitude of markets and provide for many interesting analyses for Technology Intelligence (see Table 1).

With such breadth, we have many opportunities to learn about new markets and technologies and to make connections across them. Learning and connections are important components of our intelligence roles.

AIR PRODUCTS INTELLIGENCE FRAMEWORK

We view business intelligence as knowledge and foreknowledge of the competitive environment to support decision-making, with a primary emphasis

TABLE 1: AIR PRODUCTS

Products	Markets
Gases & equipment:	Adhesives and sealants
Cryogenic air separation of oxygen, nitrogen, argon	Aerospace
Hydrogen	Agriculture
Electronics gases, chemicals and services	Air pollution
Helium	Automotive
Specialty gases	Building and construction
Air separation equipment and technology, non-cryogenic air separation, LNG heat exchangers	Chemicals and refining
Homecare services	Electronics
Chemicals:	Energy
Emulsion polymers	Food
Amines	Furniture
Epoxy additives	Glass
Surfactants	Healthcare
Polyurethane intermediates	Metals
Polyurethane additives	Nonwovens
	Oil and gas production
	Paints and coatings
	Power generation
	Pulp and paper
	Rubber and plastics
	Textiles
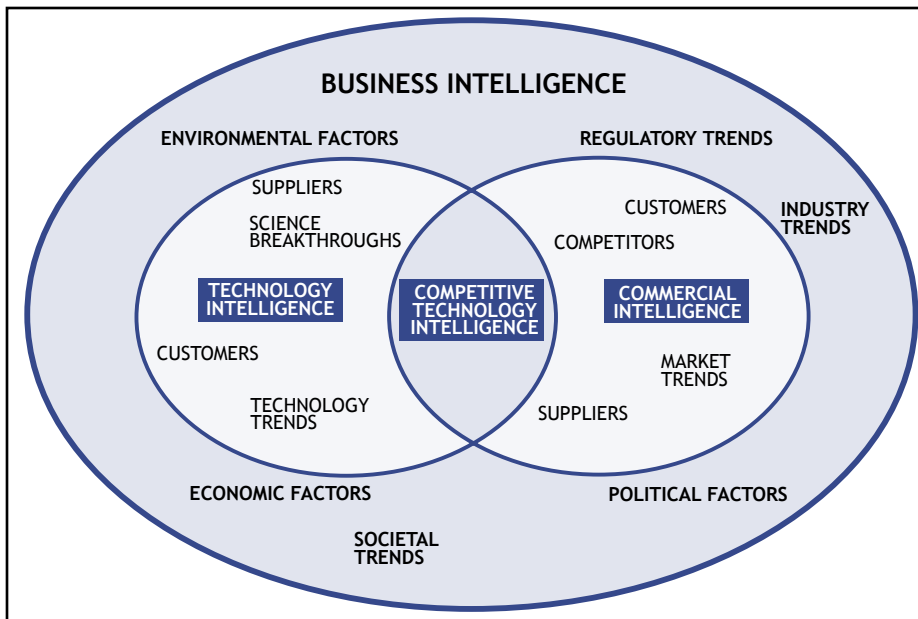
Figure 1: The world of business intelligence

This intelligence must be connected to decisions, so another role for the intelligence operation is to structure and communicate the intelligence for decisions. That line is dashed for a reason – in most organizations it is a problem area and the people on both ends of that line are equally unhappy about it: decision-makers often complain that they cannot get what they need for a decision and they get data dumps instead of insights; knowledge people often complain "how could that decision have been made; I knew relevant information about it and nobody talked to me." At Air Products, we view our role in intelligence as encompassing the whole realm from data through to connecting to the decision-makers.

Of course, there are other pieces in this process: decisions do not have much value unless they are implemented for advantage; there is always an aspect of adding wisdom and judgment along with the intelligence, and there are recycle loops as well.

to obtain early warning of new developments, capabilities, and strategies of competitors and potential competitors to support decision-making.

We want to know things in advance of them happening and we want to use the knowledge in our decision-making to gain advantage. We look at the whole world of business intelligence as depicted in Figure 1. The broader realm includes such factors as environmental, societal, and political trends. Commercial intelligence is just what it sounds like, focusing on competitors, customers, markets, and suppliers.

In technology intelligence, the major differences are emphases on science breakthroughs and technology trends. We actively work at anticipating and responding to new technology and science developments. Of course, the competitive technology intelligence realm is the overlap between commercial and technology intelligence.

INTELLIGENCE FOCUSED ON DECISIONS

Figure 2 shows how we view our process for developing and utilizing intelligence. First, data are filtered and organized to create factual information – the who, what, when, and where. When we analyze that information and gain insights, when we understand how something works or why somebody is doing something, that is intelligence – the deeper understanding and insights beyond the factual information.

TECHNOLOGY SIGNALS

The signals we receive about a technology over the course of a new product development and introduction increase in intensity (see Figure 3). Initially, very weak signals come from verbal information and gray literature (i.e., outside of mainstream publishers and databases).

Then we might see papers coming out, announcements of R&D alliances or joint ventures, and then perhaps patents.
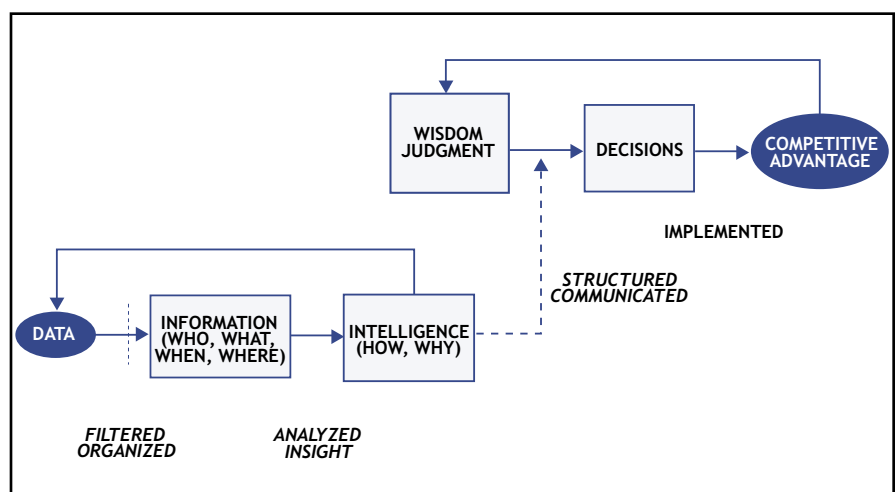

Figure 2: Intelligence leads to advantage

We perform patent analyses (discussed later in this paper), but patents might represent three to four year old decisions. We are usually interested in the early signals that give us more opportunity to take action.

INTELLIGENCE CHANGES DURING DEVELOPMENT CYCLE

If we take that chart of signals and convert it to an S-curve, we can see that our intelligence focus changes during the course of that development (see Figure 4). Early in an S-curve, we have a long period with very little progress. This is where our early warning system – our intelligence alerting or technology search activities – operates. Here we focus on opportunity generation, broad scanning for potential competitors, pre-commercial science, and new technology breakthroughs.

Figure 4: Intelligence focus changes during development

As we move into development, technology intelligence will be more focused on monitoring progress, trying to sort out the most likely competitors and technologies, and what trends and alternatives are really important. As we move toward the end of development, there is a more commercial bent to the intelligence. At this point, we have actual competitors and actual products, so the focus of the intelligence changes to be more oriented to problem-solving, e.g., we might be dealing with manufacturing costs or more specific features of a technology.

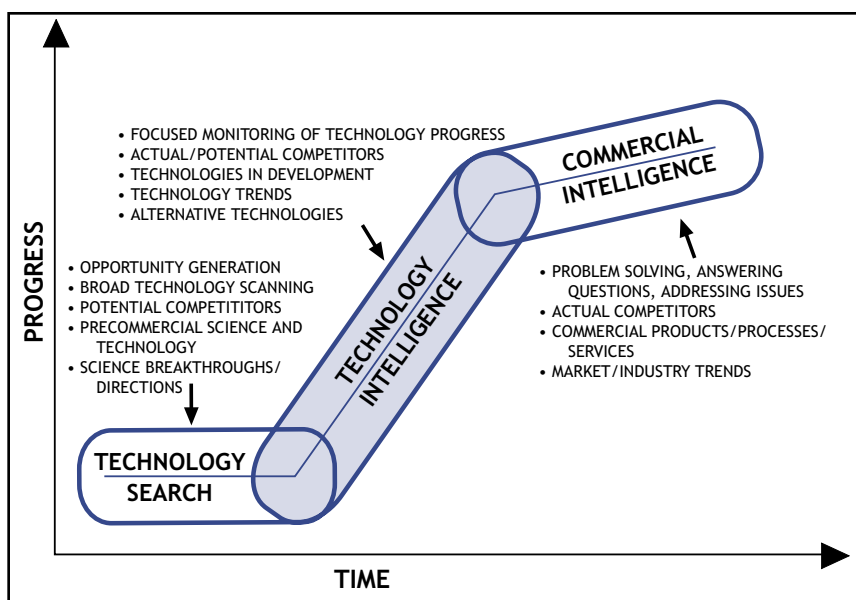The benefits related to intelligence change through the cycle as well (see Figure 5). Early in the S-curve, because the costs are low and the time is long, we mostly save time. We will be able to spot new options, avoid getting on false paths, and perhaps pick up peripheral inventions that will speed the progress of our own work.

As we move into development, much of the effort is related to avoiding surprises, reducing risks, perhaps hedging and, again, making sure we are on the right trends and dealing with the right competitors and products. As we move into the final aspects of product development, there is once again a more commercial orientation. We have actual products and competitors, and we might be positioning and watching for new technologies that might displace us.
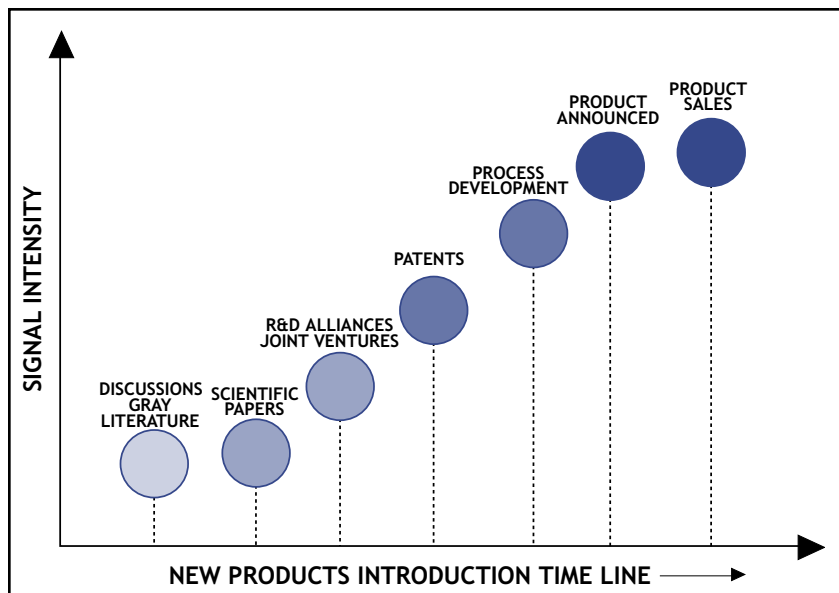
THE ROLES OF TECHNOLOGY INTELLIGENCE

With the frameworks I have just described, we have come to view Technology Intelligence as having the following roles.

Intelligence analysis

Much of what we do is aimed at supporting decisions – we help people decide among alternatives or directions and to resolve issues. We also do competitive evaluations and provide frequent support for strategy development. In addition, we have developed a core expertise in information analysis. By this, I mean we have an ability to handle a huge volume of information and make sense of it. Many of our clients would be overwhelmed by a very broad search on
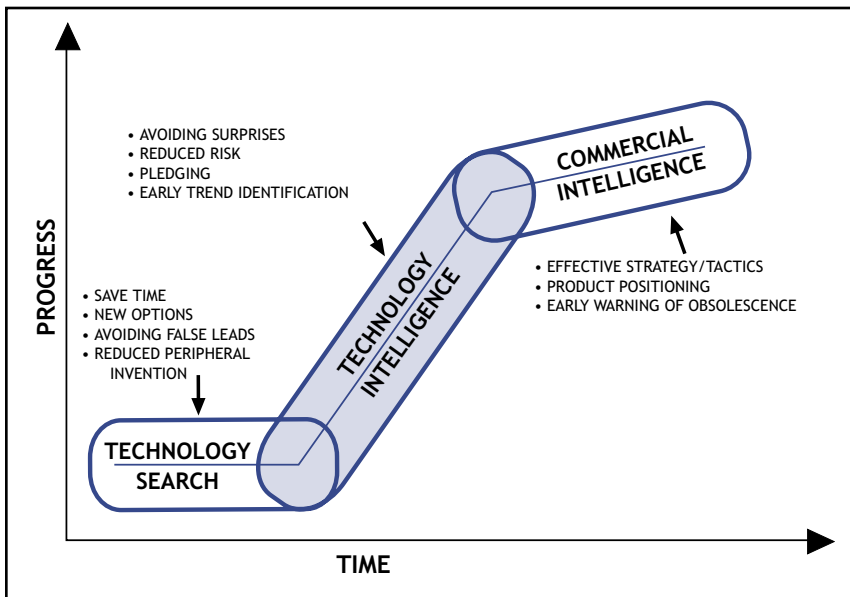

Figure 3: Technology signals

- AVOIDING SURPRISES
- REDUCED RISK
- PLEDGING
- EARLY TREND IDENTIFICATION

- SAVE TIME
- NEW OPTIONS
- AVOIDING FALSE LEADS
- REDUCED PERIPHERAL INVENTION

COMMERCIAL INTELLIGENCE

- EFFECTIVE STRATEGY/TACTICS
- PRODUCT POSITIONING
- EARLY WARNING OF OBSOLESCENCE

TECHNOLOGY INTELLIGENCE

TECHNOLOGY SEARCH

PROGRESS

TIME

Figure 5: Intelligence benefits change through the development

a topic such as environmental trends or greenhouse gas reduction; we like that work and view it as a challenge.

Early warning/intelligence alerts

Our early warning system is oriented to technology scouting, uncovering new developments and capabilities from around the world.

Access to gray and tacit information

We have developed a core expertise in acquiring and utilizing information from the internet and other gray literature sources, and verbal information and knowledge from people.

Intelligence backgrounders

These are our information (vs. analysis) products.

Tools

Several tools will be discussed later in this article – our Experience Database, which is our expert locator and repository for our Alerts, our Intelligence Web collection site, and our OuterLinks portal to external sources of information.

Functional development

This includes development of tools and techniques, and building and sharing best practices through Communities of Practice. We also spend a considerable amount of time integrating intelligence into the work processes of the company.

INTELLIGENCE ALERTS

I started our early warning system of Intelligence Alerts during a previous role in technology planning in 1988. Since

then, the alerting service has thrived, but both it and I have moved through several different organizations on different paths. We have now consolidated the alerting as an integral part of our intelligence operation.

We typically send 10-15 informational and 1-2 actionable Alerts every day. The actionable Alerts are deemed Priority Alerts and include a feedback form. From this feedback, we have learned that we get 1-2 "hits" per week, for over a 30% hit rate. We are confident in these numbers due to the high feedback rate of about 65%. More than 90% of our Alerts are of at least reference value.

The Alerts serve over 2400 internal clients. We have measured our penetration at more than 70% of our R&D organization and approximately 30% of the rest of the amenable company, and those percentages are increasing. With over 3000 Alerts per year, our customers say they have significant value and affect their actions (see Table 2).

Our favorite actions are the physical ones at the top of the list, where we can see the Alerts causing a new technology to be brought into the company. However, we are also happy about the new knowledge; after all, this is a key role for an R&D organization.

A typical Intelligence Alert is shown in Figure 6. We often add comments at the top of the Alert to attract the reader. We include a synopsis with a link to the full article. Whenever possible, we provide contact information or a way for us to support our internal client by finding a contact.

We have a feedback form on this Priority Alert. A hit is when somebody checks the 'no' box that they have not seen the information before and they answer 'yes, will follow-up' for the value to their work – quite a clear and rigorous standard. The form for our informational Alerts looks much the same, but only has the comments block without the feedback choices.

INTELLIGENCE BACKGROUNDERS

Another of our information products is our Intelligence Backgrounders, of which we produce more than 50 per year. These typically range from a few hours to a week of work and can cover such topics as getting more information about an Intelligence Alert, helping someone who is new to an assignment get up to speed quickly, investigating a rumor, or preparing somebody for a visit to another organization.

The Intelligence Backgrounders are oriented to factual information. One of our best information sources for our Backgrounders is our previous Intelligence Alerts. We store all of the previous Alerts and can very easily search them to

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TABLE 2: ACTIONABLE ALERTS SURVEY RESULTS

Customer value

- Useful: 80% said alerting is very useful or useful.
- New: 92% said at least half of the information is new; 30% said 90% of the information is new.
- Worth their attention: 48% forward and discuss more than 25% of Alerts; 70% forward and discuss 10% or more.
- Worth action: 18% take action on more than 25% of Alerts; 42% take action on 10% or more.

Actions taken from Alerts

- 3% started licensing/technology acquisition
- 2% started joint development
- 9% called the inventor
- 41% incorporated the new knowledge to improve their project
- 31% addressed the competitive threat
- 50% searched for additional information
- 16% pursued the opportunity

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provide quite a good compendium of recent events in a topic. We also mine the internet, other secondary sources, and our network of internal and (sometimes) external contacts. Some of the Backgrounders will instigate a later Intelligence Analysis.

We get very satisfying feedback from our customers about these Intelligence Backgrounders:

- "This was extremely helpful – there are a lot more technologies out there than I originally thought."
- "We are actually writing the patent on that and doing further testing based on the study result, which was very helpful."
- "This service consistently turns up information that would be difficult to find otherwise."

IN-HOUSE KNOWLEDGE: EXPERIENCE DATABASE

How do we know who should receive all of these great Alerts? How do we determine that they do not already know the information? We have developed an Experience Database

containing over 2400 profiles of potential Air Products recipients of our Intelligence Alerts. The information for these profiles comes from a variety of sources, but primarily from users filling in their own interests.

We learned long ago that the systems we use must be self-sustaining; if they require an *operator*, they will eventually collapse under the weight of that cost. Because the participants in the Experience Database receive valuable Intelligence Alerts, they have been very willing to spend their own time keeping their profiles up to date. If somebody has not updated their profile within six months, they receive an automatic reminder to do so. Our typical response is approximately 350 updates within the next ten days, indicating that people find the value of the Alerts and the expertise locator functions of the database to be worth their time.

The intelligence group adds to profiles as well, using readily available information already existing within the company (see Table 3). Two of the most useful and essentially free sources of this information are:

- the literature searches done within the company each month, which is a great way to find out what is of current interest, and
- our idea submission system, which we call IdeaTracker. We look at this every week to find out the latest ideas from people for whom we might provide useful information.

The highest impact source of internal interests is talking to people. We regularly interview people from around the company to find out their interests and how we can provide them with useful information. These interviews often result in requests for Backgrounders or Analyses in addition to a substantial increase in the Alerts for these clients.

Intelligence Alert – New LNG Technology Alliance - 15797

Addition of Aker Kvaerner to Linde, Shell Alliance
New LNG Technology Alliance
Full Article: http://www.norwaypost.no/content.asp?folder_id=6&cluster_id=26049

Synopsis: Aker Kvaerner, Linde and Statoil have entered a three-year LNG Technology Alliance.

The objective is to develop cost-effective technology and solutions for the offshore production, storage and offloading of liquefied natural gas (LNG), thus enabling the exploitation of larger gas fields in remote areas.

With interests in Nigeria, Venezuela and Brazil, Statoil wishes to play a greater role around the Atlantic margins in supplying LNG to the burgeoning USA market, while Aker Kvaerner and Linde foresee a promising future as suppliers of technical solutions and engineering studies. Annual growth of 5-10 per cent is expected for new LNG plant construction, according to a company statement.

This new Alliance is a natural successor to the successful Statoil - Linde LNG Technology Alliance, which has led to the development and qualification of the next generation of spiral-wound heat exchangers (SWHEs) and the Mixed Fluid Cascade liquefaction process (MFC). SWHEs have already been delivered to Shell for LNG projects located on the North West Shelf of Australia and in Brunei, and are en route for the Shell Sakhalin project and Statoil's Snohvit development.

See full article for more information.
Contact Information: This article did not supply followup information. Please contact Cheryl Cunfer (x16251) for assistance in locating contacts.

Stored Alert

Surces:
Norway Post

Feedback
Have you seen this information before?
☐ Yes   ☐ No

Was it valuable to your work?'
☐ Yes, will follow up.
☐ Yes, may follow up.
☐ Yes, has reference value.
☐ No value to work.

Comments:

[Submit]

Figure 6: A typical Intelligence Alert

TABLE 3: PROFILE SOURCES

- Internal presentations, including seminars, roundtables, R&D conferences, technology symposia, and R&D reviews
- Quarterly group reports
- Patents and publications by internal researchers
- Internal research reports
- Monthly Information Services search summaries
- IdeaTracker
- One-on-one interviews

A typical profile will include some organizational information and such things as affiliations, communities of practice, publications, and experience. The two most useful fields are the interests and expertise. We particularly focus people on putting their interests into the database. Our experience has been that most people eventually end up working on what interests them, so if we can identify those interests and feed people that information, they are far more likely to take action on the Alerts.

Our preference is that people put in context rather than just lists of interests. We would like to know, for example, the limitations of a technology or the ideal solution for a specific problem that, if solved, would open up a new market.

We also allow people to subscribe to distribution lists. We have several hundred of these distribution lists covering such areas as thin films, fuel cells, nano-materials, and their sub-topics. The distribution lists can result in such a large flow of Alerts for some internal clients that we worry that the significant and actionable information might get lost among all of the lower priority items. However, the distribution lists have proven to be popular with our clients.

INTELLIGENCE WEB

Another of our tools for capturing what we already know internally is called the Intelligence Web. This is an intranet-based application where people can submit intelligence reports. It is not meant to be a bulk repository of data, or even of information. It is focused on information that has been analyzed, where somebody has added value to it and is making that available to the company.

The Intelligence Web is structured on a community basis and the communities can be by topic, region, or even a project area or function. For example, all of the Technology Intelligence reports, other than those with extreme sensitivity such as a due diligence on an acquisition, are posted on the Intelligence Web. We have elected to make the Intelligence Web open across the intranet, figuring that we would acquire more submittals if people can find useful information there as well.

Again, we have designed this application to be self-sustaining. We can set up a new community on the Intelligence Web within one hour. Each community has its own administrator, whose functions are so simplified and efficient that it is not a barrier.

We encourage each new community to include fields for observations, interpretation, and follow-up action items, i.e.,

- What have we learned?
- What does it mean to us?
- What should we do about it?

These are key aspects that make an intelligence report valuable. In addition, we have fields to characterize the information in terms of the reliability of the source, the credibility of the information, how hard or soft is the information, and to categorize the information so that people who have subscribed by category will get an automatic email notification with a link to the report.

These kinds of features make an intelligence report more work than an email, but also far more valuable than an email. An email:

- may or may not go to the right people
- may go to more people than it should
- tends to take on a life of its own and lose the characterization that may have been very cautionary

The intelligence report can also have all discussions take place within the report and be retained along with it – again, something that is often lacking in emails. We can also attach documents and links.

The Intelligence Web reports can be completely customized by community. Although we encourage all communities to use similar fields for more robust searching, people can use whatever fields make sense to their business, technology, or topic. They can not only create their own fields, but they can change the order of the fields. They can create all their own values within each field and even change the order of those. All of this customization can be done by the administrator of the community.

The Intelligence Web has an off-line entry template that can be downloaded so people can fill in intelligence reports while they are at a conference and then upload them later. We have a simple search across communities and a much more robust search, including filters, within communities.

The Intelligence Web application is a highly robust tool that was developed rather inexpensively and has served us for quite a number of years now, with new communities added on a regular basis. But, the tool is a minor part of what is needed to make a successful intelligence collection site, and we have found the human processes to be lacking in some communities.

The tool is much less important than having an organization that ingrains a process for creation and submittal of intelligence to the system rather than through simple emails. A few of our organizations have been successful with this, but getting the human process in place has been far more difficult than implementing the tool.

ETHICS AND CONFIDENTIALITY

With global access to these communities, we need to be careful about ethics and confidentiality. Everybody who sets up a community is advised by our intelligence group on the ethics of collection and handling of confidential information. Our intelligence collection ethics policy has been in place since 1991.

We do regular presentations to the intelligence and market research community about our ethics policy and have a WebCast on Demand version posted. The ethics policy is linked into the Intelligence Web and other applications. In fact, before anybody files their first intelligence report, they need to read and approve the ethics policy. In addition, each community administrator has to approve new reports. Since these reports are meant to be analyses and high value-added intelligence, this is not a large number of reports per week and the approval process has never been a bottleneck.

Finally, for confidential information that we do not want posted on the intranet, we have the ability to put in a cover page report with a link to a secure server that is limited to the people who should have access.

COMMUNITY OF PRACTICE

Another of our mechanisms for accessing our in-house knowledge is a totally human process, the Intelligence and Market Research Community of Practice (CoP). We started an Intelligence CoP in January, 2002, after Technology Intelligence had been in place long enough to have developed some successes and best practices – we thought that we should share these throughout the company.

There are very few people at Air Products who perform intelligence full-time, but there are many people who have intelligence functions as a part of their job. We thought the benefits of propagating best practices would be very high since most of these part-time intelligence people would have limited opportunity to do training outside. Someone doing intelligence 10% or 20% of their time may be able to double their productivity with a little bit of sharing of best practices from others in the company.

The Community of Practice has met approximately every two months for one and one-half to two hours of very full agendas. We now have over 100 members in the CoP and have also utilized it as a network of expertise.

In 2003, a group of people in the company were considering starting a market research community of practice

as well. We view intelligence broadly enough to include market research and already had most of the people in our community. Rather than ask people to decide which meetings they wanted to attend, we incorporated the market research function more explicitly, reforming as the Intelligence and Market Research Community of Practice. We have spent most of the last year on market research topics.

Our major events over the last three years have included:

- an elicitation workshop given by Brad Ashton
- a trade fair and conference intelligence gathering workshop given by George Dennis
- a Special Librarians Day event emphasizing information resources for competitive intelligence
- an intelligence fair promotion

Our latest endeavor is our most substantial; we developed an entire market research curriculum that is now available company-wide via WebCast on Demand. We have 11 topics about market research and more than 14 hours of material. Seven of the sessions were developed and presented by Paul Hague of B2B International, and four by internal people. This content is very compact and high-density and we feel the entire series is equivalent to sending somebody to a full week off-site course.

The Intelligence and Market Research CoP website contains categorized lists of resources available both internally and externally, including training and functional information as well as specific content. In addition, all of the presentations made to the community are accessible.

INFORMATION SOURCES

Now that we know what people are interested in, what we already know internally, and to whom to send things; how do we find the great Alerts to send to people?

Our intelligence alerting has focused on the gray literature and, lately, the internet. Air Products has a strong Information and Library Services organization that focuses on published information, so our researchers can easily monitor published information in their topics of interest. We view the intelligence alerting system as complementary to this and we focus on a wide variety of unusual information sources. In fact, we specifically aim for the sources of information that people are not seeing otherwise; if a source becomes one that people would generally see, we no longer care to monitor it.

Website Watcher

We are currently monitoring over 800 internet sites for new information. About 700 of these are monitored weekly and over 100 of the better sources every day. We use a very simple tool called WebSite Watcher to monitor these pages. A similar offering is available from Copernic.

WebSite Watcher goes through all of the URLs that we have entered and compares the current page to the way the page looked the last time we viewed it. Those pages that have changed are listed in red at the top of the list. We can quickly scroll down through them to look at each page, which is displayed with the changed information highlighted in yellow. This easy reading capability allows us to go through a large number of sites very quickly, looking for new information that might be of interest to Air Products.

Web and internet sources

We include a wide range of sources in our monitoring list. Many of them are specialized technology and business news in various industries. We include company sites to monitor press releases and we watch a lot of R&D news wires. We also watch government and university technology transfer and news pages.

As we developed all of these great internet sites for monitoring technology, we thought that we should make them available to other people throughout the company, so Air Products has developed an intranet application called OuterLinks that has a hierarchy of links by various topics. We currently have about 3000 links, each of which has a short description as to why somebody might want to use it.

Besides our internet monitoring list, we gain information about new technology developments and capabilities from many other electronic sources. One of our best sources of Intelligence Alerts again demonstrates leveraging a system that was already in place.

The *airproducts.com* website contains many points where an external user can submit a question or a comment. These are forwarded to us for distribution to the appropriate people in the company and often provide information on new technologies and, in some cases, potential new business opportunities. We will often get two items in a week, of which one is quite good. Because of our knowledge of all the interests throughout the company, we can target these Alerts to exactly the right person who will take action on it.

We love to get information on small company developments and monitor those through SBIR and venture capital databases. We subscribe to many listservs and email newsletters for various topics of interest to Air Products. These very frequently have very fresh information and are excellent sources of Alerts.

Published sources

We still have a number of paper sources: we get specialty newsletters and various magazines that often have new technology information in them. In particular, the intelligence group watches many broader-based journals. Due to information overload, researchers have tended to narrow their reading to their core area. The intelligence group focuses on broad sources of new products and technology information, and keeps our researchers informed of things

that may be coming from outside of their core area.

Although we primarily deal with non-published information, we do watch a few published technical sources as well. For the most part, these only become Alerts when we can see a transfer of information from one field to another, for example, when something in a surfactant journal may be of interest to somebody in the membranes area who would not likely see it. In addition, we monitor some journals from other countries that may not be given the attention that the core journals get. This is a limited activity, although one that probably does fill a gap and is made much more efficient through the use of e-journals and tables of contents.

Human sources

Although the electronic information we monitor is highly efficient, our best information often comes from human sources. We cover a variety of conferences and trade shows that specialize in technology transfer or new developments, and develop direct contacts with universities, government labs, and other sources of technology in hopes of getting a flow of their latest developments as early as possible.

Recently, the number of these opportunities for direct contact with sources of technology has unfortunately diminished. Many universities and government labs feel that their web pages fill this role at much lower cost. However, our experience has been that conversation between one party talking about their capabilities and the other talking about their needs often results in opportunities that are not listed on any page.

TEXT MINING

Now that we have collected all of this great information, how do we make sense of it? The area where we have done the most work on text mining is in patent analysis, since patent information is the most structured and amenable to analysis. We routinely use several tools for patent analysis: BizInt Smart Charts, Micropatent's Aureka, and Search Technology's VantagePoint.

Working with the Intellectual Asset Management and Information and Library Services groups, we developed a patent analysis framework. We then integrated it into our intellectual asset management and offering life cycle management processes.

The patent analysis framework is aimed at answering the right questions at the right stage of development. There are 70 potential analyses, but only a few are required at the concept stage and some more at the feasibility stage. Most of the analyses are optional and are a resource for the researcher to better understand the estate. The analyses are also aimed at causing thinking about the data and interaction with them, and answering questions versus static reports.

The first step we recommend is to ensure that the proper search has been done; a lot of time can be wasted
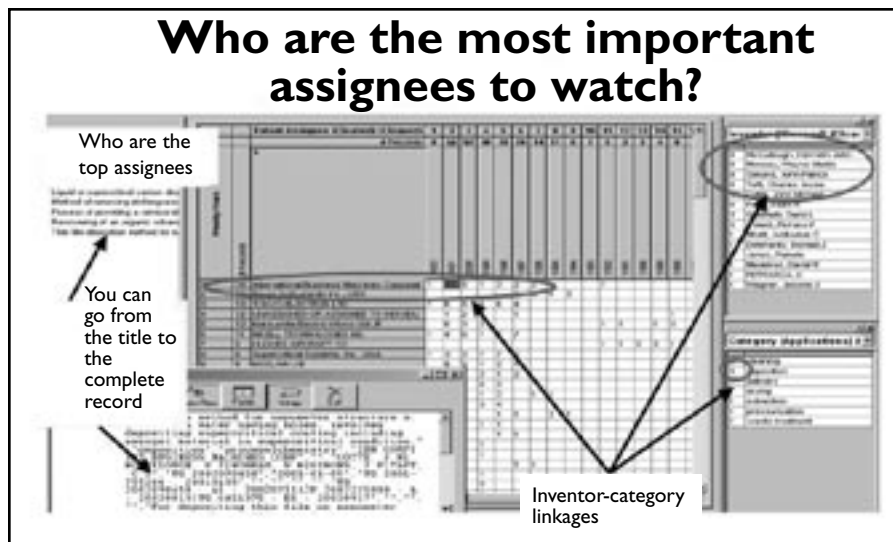
Figure 7: Patent analysis example using VantagePoint

aspects to answer that question. In this example, the assignees are listed by number of patents.

We can highlight any particular patent and link to the inventors contained in those patents and the categories in which those patents reside. To interact with this information, you can click on a title and go to the complete record to make sure that you are looking at the right information. You can think of this as a way to actually read the patents in pieces by the questions you are trying to answer.

In this particular case, one of the top assignees, IBM, had ten patent publications in the most recent complete year of the data. Beyond that, we are able to identify that nine publications had specific inventors, perhaps a team, who we might want to watch. Three of those publications were related to deposition, which might be an area of interest for us. This is a very robust screen of information to help us answer questions around the top assignees.

In other analyses, we might look for who is working with whom by doing a matrix of assignees versus assignees, and particularly looking at those that are off the diagonal so we can see one party who might be working with another party. Categorization also allows us to make very easy-to-understand visuals of various companies' interests. For example, we might do a series of pie charts for all the competitors playing in one area with the pie split by type of application of the technology.

Figure 8, which is just a standard Excel chart, again shows the power of categorization. We can see that recycle systems have come into play in recent years and that there seems to be a renewed interest in delivery systems. In addition, storage in this particular area has been largely ignored, suggesting a possible need.

The Aureka product has a Vivisimo-based clustering feature that can be used to both cross-check our categorization and identify additional categories. In addition, Aureka has Themescape maps. We have found these to be most valuable in an interactive mode, highlighting particular companies and seeing their landscape, seeing who is near whom and what is going on in more open versus more concentrated areas. We find these dynamic features much more valuable than the static display of what could be a highly debatable landscape.

on an analysis with incorrect information. The problems could be not including all relevant data, or including more information than is relevant to the topic, giving, for example, erroneous trends.

The next step is to organize, summarize and categorize the search. For this, the BizInt Smart Charts application and Excel spreadsheets are often used. We have found that categorization of the patents by our own terminology is critical to gaining the maximum understanding of the estate. We may characterize a patent estate by market, application, chemistry, process, or other issues that are important to the particular questions we are trying to answer. Once we have categorized, we are able to do analyses within the category, which ensures that we are not letting irrelevant patents dominate the trends.

THE POWER OF PATENT ANALYSIS

We do our analyses in several levels of increasing depth. Initially, we will focus on counts such as number of patents per year in each category of a technology or by organization. The next level would include more sophisticated statistical analyses, such as looking at citations. A third level that can sometimes be used includes very sophisticated aggregating algorithms, such as clustering by co-word analysis or mapping.

We also take care to merge expert analyses with the statistical analyses. Finally, we focus on summary tools for good structured communication of the insights we have learned that aim at the decisions we are trying to make. An example of what you can do with these new tools is shown in Figure 7.

The tool we used is VantagePoint from Search Technology and the question we are trying to answer is: who are the most important assignees to watch? By lining up the information gleaned from a set of patents in various windows on the same screen, you can start linking together various

TEXT ANALYSIS WITH TECHNICAL LITERATURE

There are many more analyses of patents that can be done within the tools I have mentioned and with other tools
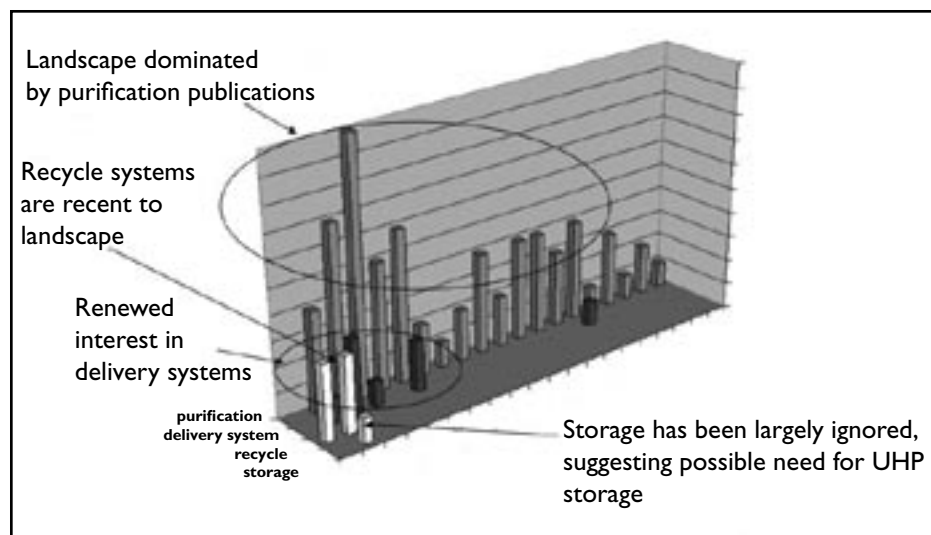
Landscape dominated by purification publications

Recycle systems are recent to landscape

Renewed interest in delivery systems

purification
delivery system
recycle
storage

Storage has been largely ignored, suggesting possible need for UHP storage

Figure 8: Patent analysis using categorization

as well. The natural question at this point though, is why are we not doing these analyses with technical literature as well?

Ultimately, we would like to do our searches of patents, technical and business literature, internal information, and the internet, and combine them and then analyze. The tools that will allow this are developing, as shown by Figure 9 from a proposal by Search Technology for Rapid Technology Information Products.

This would be based on VantagePoint, but driven in a much simpler fashion by pre-configured analyses and illustrations aimed at specific technology intelligence questions. The tool would be targeted at researchers rather than expert users, and would not require a lot of training or expertise. The simplifications would allow a researcher to analyze their searches within the same day.

Hundreds of potential questions have been suggested for these pre-configured analyses, and Search Technology is aiming to work with leading industrial companies to prioritize this list and further develop the tool. The questions may be about a technology assessment, comparison of organizations, comparison of technologies, forecast of technology, landscape, and so on.

The tool would generate multiple first-pass analyses profiling the literature data set in

relation to the specific objective. In preliminary testing, we found that it is also extremely useful for refining our searching and identifying the appropriate data set that is required to resolve an issue. Same day initial evaluation of combined literature sources would be extremely robust and valuable and we hope this development is successful.

Unfortunately, the information providers have not been as progressive as the tool developers and many information providers restrict the use of their information for analysis. Patent analysis has not been an issue because that is public information. However, information from literature databases comes with cumbersome license agreements that do not permit effective analysis of the results of searches. Some providers include specific clauses prohibiting analysis, constraints on downloading and storage of content, and charging mechanisms that are effective blocks to analysis.

An Information Analysis Interest Group of multi-national companies has been formed to work collaboratively with information providers to address this issue. This group includes Air Products, Procter and Gamble, Rohm & Haas, Kodak, DuPont, 3M, Novartis, Merck, Eastman, BASF, EcoLab, Ford, and Agfa, and has made significant progress with two
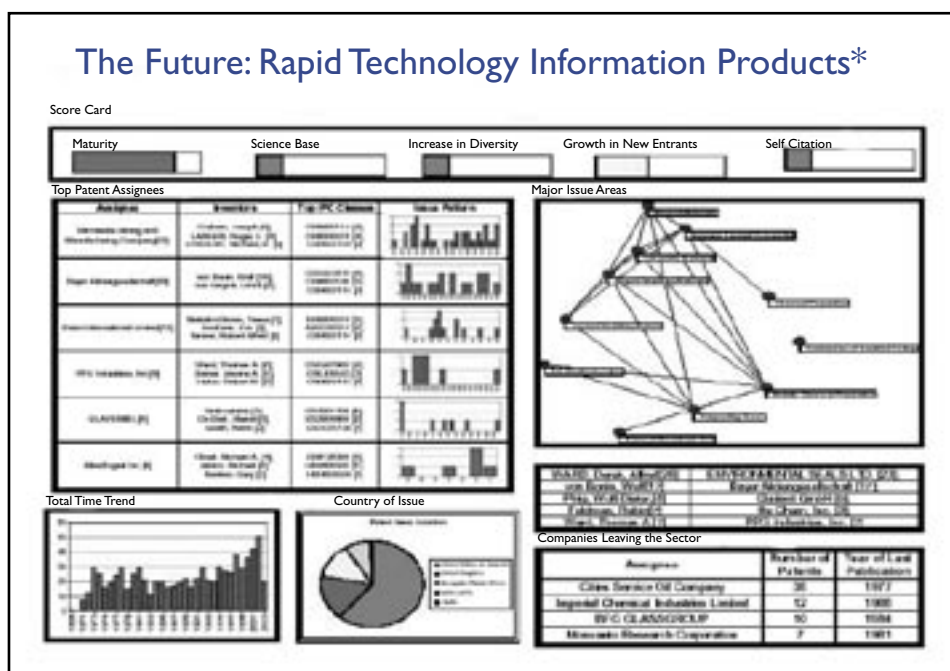

The Future: Rapid Technology Information Products*

Figure 9: A proposed one-page intelligence profile (Search Technology)

information providers. We hope that the dual developments of less restrictive information provider licenses and new literature analysis tools will soon permit us to meet our goal of effective analysis of information from multiple sources.

ANALYSIS PROCESS

The highest value added aspect of an intelligence group is analysis. We view our primary analysis role as helping people to make decisions they can implement for advantage. Besides decisions, we help people to resolve issues, to choose among alternatives, to pick directions, to develop strategies, and to determine our ability to succeed versus our competitors.

To perform these functions, we have developed an analysis process that works very well within the culture of Air Products.

Project definition

Our first step in this process is to spend significant time defining exactly what it is we are trying to do in a particular project:

- What is the decision we are trying to make?
- What is the problem we are trying to solve?
- What is the topic?
- Who is the client?
- What do they expect to get from us?

Although this does not take very long, it is critical to meeting our objectives.

Background Package development

Our next step is to develop a Background Package for the analysis. We do the research to collect factual information that will bring the analysis team to a consistent level of understanding. Most of this information will come from secondary sources, but often the most valuable information will come from our interviews of both internal and external people.

The Background Package is filtered and organized data: it is factual information that is the basis for the analysis. We gain insights by adding human interaction and tacit knowledge on top of it.

Team analysis

Our third step is a team analysis. Technology Intelligence does the bulk of the work in preparing the Background Package and we form some of our own opinions about the information. However, our more valuable role is to facilitate the team to come to a consensus about conclusions, implications, and recommendations.

As intelligence professionals, we would like to think that we can analyze any information and come to the right conclusions about it. However, we have learned that multiple brains bring far better analyses and actionable results. Our team analysis is aimed at bringing multiple perspectives, interaction, and consensus about the analysis.

The team is typically three-fourths core people in the topic of interest and others to challenge and make sure that we do not fall into conventional wisdom. The team is designed to bring multiple perspectives: we typically have technical and commercial people, people from various regions of the world, and often just good thinkers; we sometimes include external experts. The intelligence professionals play dual roles in these meetings, as both highly knowledgeable people about the topic and as facilitators of the process.

This approach is not rocket science: we are bringing the right information and the right people, working through a systematic process that extracts what is in people's heads, and making them talk to each other about the right stuff. We use a wide variety of systematic processes which I will discuss more fully below.

Conclusion documentation

After the team analysis, the intelligence professionals document our conclusions, implications, and recommendations: what did we learn, what does it mean to us, and what should we do about it? That format flows almost as a narrative and becomes a very simple and memorable output that drives action.

Our documentation is typically one to two pages of bullet lists covering the conclusions, implications and recommendations, with substantial attachments. Our attachments are often very large spreadsheets or tables, as well as all the background information used in the analysis.

Formal feedback

We receive formal feedback from our internal clients about our Intelligence Analyses. Our simple survey has an over 80% response rate. With questions on a scale from much better to much worse, we have received the following results:

- better resolution to my issue or decision
- much faster resolution to my issue or decision
- better consensus for taking action on the issue or decision

We are particularly pleased that we get the highest rating on speed. We are always personally frustrated with how long it takes to get things done, but our clients are telling us that this process gets things done faster than their alternatives.

Building consensus

A benefit that we had not anticipated when we first designed our intelligence process was its power for building consensus. The team analysis approach has the effect of causing all of the interested parties to see the same information and to have their opportunity to build on that information. It works them through a systematic process together and, at the end, they all feel that they were part of the decision.

TABLE 4: ANALYSIS BENEFITS

Defining the landscape
Identifying a threat or opportunity
Gaining key insights
Defining our position in a technology or market
Building consensus on direction
Identifying/understanding a trend
Changing or improving strategy

This has been a very elegant solution to gaining action and implementation of the results of an analysis. From our survey, we have identified several primary benefits of our Analyses (see Table 4).

Analysis tools

As I noted, our team analyses utilize systematic processes for understanding and gaining insights about the information. For technology analysis projects, we have used most of the tools in Table 5.

We feel no need to push a particular kind of analysis for a particular kind of problem. We look at the specific problem, what we know, what we want to know, and, to some extent, the dynamics of the group that will be involved, and then choose the appropriate technique for analysis.

In some cases, we hybridize these techniques, we modify them, or we merge them. Our goal is to get to the answer and we do not have to be compulsive about a particular technique.

Combining and validating sources

We certainly perform lots of secondary research and are often astounded by what we can find on the internet. However, we have learned that human sources often have the freshest information and the best perspectives, making them critical for validation.

We are continually and pleasantly surprised by how much we already know in-house. We use our Experience Database to locate internal people who have information that can help our Analyses. Those people often connect us to additional networks of internal and external people who know useful information. We make external calls to validate the information we have learned and to get additional perspectives.

To put all of this information together, we have tended toward big spreadsheets rather than elaborate and sophisticated graphics. We find that most of our people can look at a spreadsheet and get something out of it. We use visual tricks of color, bolding, and highlighting to make them more readable, but spreadsheets have tended to be the simplest and most effective technique.

Our team analyses also ensure that we are using valid and multiple sources of information, eliminating bias and bringing in a wide range of perspectives and insights.

Communications

Finally, we communicate our actionable results in a framework of conclusions, implications, and recommendations. A story telling what we have learned, what it means to us, and what we should do about it gives a memorable answer to take to management and that sticks through implementation.

Our write-ups are very simple and easy to read; they are usually bullet lists with attached tables. We also found that a follow-up presentation to the management of our internal client helps to consolidate the recommendation.

Our Analyses always result in a clear yes or a clear no so we can move forward. We have had many successes in coming out with a clear "no" answer to an opportunity. One of our biggest benefits to the company has been to stop recycle on decisions. The yes answer is sometimes a "yes, but" answer and this is fine. We will then appropriately say "yes, we should move ahead, but here are some cautions and concerns that we still have."

FUNCTIONAL DEVELOPMENT

As I noted earlier, we have developed a number of tools for use in intelligence and share them with the rest of the company. The Experience Database is used very frequently by others within the company as an expertise locator for finding other people who know things, as well as for accessing past Intelligence Alerts.

The Intelligence Web is our intelligence collection site, and OuterLinks gives access to good external sources of information. In addition, we have developed tools around patent analysis and rapid technology information analysis, and have evaluated a number of other analysis and search tools.

We spend a significant amount of effort integrating intelligence into the other work processes in the company.

TABLE 5: TECHNOLOGY ANALYSIS TECHNIQUES

Signals analysis
Directed brainstorming
Force field/driving forces analysis
SWOT: strengths-weaknesses-opportunities-threats
Literature and patent analysis
Technology characterization/attribute analysis
Technology forecasts
Alliance diagrams
Blindspot analysis
Experience curve/S-curve/technology lifecycle analysis
Scenarios
Roadmaps
Benchmarking
Six Thinking Hats

In particular, we are extremely well-integrated with our intellectual asset management and our offering life cycle management processes.

We share our learnings through an Intelligence and Market Research Community of Practice, a Knowledge Creation CoP, and a Decisions CoP. All of these efforts serve to make intelligence part of what we do in our normal work at the company rather than a separate operation.

SUMMARY

Technology Intelligence at Air Products has leveraged many new tools and techniques to bring value to the company. Our offerings of Analyses, Alerts, Backgrounders, Tools, and Functional Development have improved the company's decisions, resolving issues faster, better, and

with greater consensus. We provide early warning of new developments, key inputs to strategy, and insights into trends, threats, opportunities, and competitive situations, improving both the effectiveness and efficiency of thousands of people throughout Air Products. Why?

To know and not to do is not to know
– Lao Tzu, Chinese Taoist Philosopher, c600 BC

ACKNOWLEDGEMENTS

ANALYSIS EXAMPLES

Scenario Analysis/Directed Brainstorming/Opportunity Screen

We were faced with a very large potential area of opportunity and one that had a huge amount of conflicting information, so we chose to do scenarios. This was a very large project for us and included a significant amount of education about the process to those involved.

We worked with both a small core team and a larger, broader team that we utilized for vetting and, frankly, keeping us honest. We developed four scenarios and then led directed brainstorming sessions to identify the opportunities that might derive if each of those scenarios were to occur. The brainstorming resulted in more than 150 ideas that we were able to categorize into major business/topic areas and show that some would occur in multiple scenarios. In fact, the best opportunities were those that were insensitive to picking the right scenario – we could be a winner regardless of what happens.

After making a convincing argument that we could succeed in this area without worrying about which scenario actually came into play, we took on a somewhat non-traditional intelligence role of helping our internal clients screen through the opportunities. We set up criteria for two phases of screening and were ultimately able to weed down the list to actionable projects and programs that had a high degree of consensus because we involved a breadth of people throughout the process.

Equipment SWOT

In this case, we had what we thought was a differentiated equipment offering and could not understand why people were not buying it. We laid out

the differentiating questions for the SWOT analysis and included both the technology and business factors important to ultimate success of the offering.

Although we thought our technology was differentiated, we learned that the customer viewed it as performing pretty closely to the competitive offerings. The commercial factors were differentiating: we were late to enter and had a less substantial business presence than our competitors. The analysis pointed us to clear actions that could be addressed to make our offering more effective.

Market Screen

One of the people involved in the equipment SWOT came forward a few months later and suggested that we broaden our involvement in a market area where we were a niche player. For this analysis, we used a combination of more commercially-oriented intelligence techniques, the GE Business Screen and Porter's Five Forces analysis.

The GE Business Screen compares industry or market attractiveness versus our business strengths. For many of the attractiveness parameters, we used Porter's Five Forces criteria. We were able to distill the information down to a very simple table that included the business and technology criteria, priorities for each of the factors, and the positive or negative ratings.

Although we had some good niche positions, we were lacking some of the key offerings that would be needed for broader participation. In addition, this was a market that was still churning from a downturn and one that required an unusually large research commitment. It became very clear that we should continue our niche approach.

ANALYSIS EXAMPLES (continued)

Signals Analysis

This is a particularly good technique for determining how we should react to an event. In this particular case, a competitor had issued two press releases announcing joint ventures in a new area.

The signals analysis, like many intelligence techniques, is aimed at breaking down a question into a lot of smaller parts. It asks how was it done, how strongly was it done, where was it done, who did it, how does it fit with other things we know, is there a logical path, etc.

We were able to determine that the competitor had made (unfortunately for us) a pretty significant move to lock up several of the key players in a new technology. If we wanted to participate, we would be working with a partner quite far down the list. The analysis also identified the key areas where we should be concerned about the competitor's new capabilities, allowing us to set up monitoring and counter-actions in those areas.

Attribute Analysis

The attribute analysis is a derivative of the house-of-quality technique and one that we use very often in the early stages of a program. In this analysis, we place all the attributes that a customer might want an offering to do on one axis of a large spreadsheet, and the features of all of the competitive offerings on the other axis. This table serves very well to identify, for example, who might be strong in certain categories of attributes and who might have leading positions across a wide range of attributes.

In this particular case, we were looking at alternate process technologies for a specific chemistry, and we laid out all that a customer might want the process technology to do versus all the alternate technologies that could be used for this particular chemistry. We use tricks in these charts such as making good news green and bad news red, and bolding significant items, to make it easy to visually interpret the situation.

Air Products was strong in several of the alternate process technologies that could be used for this chemistry, but there were several new process technologies coming into play that would also work. We needed to make a decision as to whether we wanted to build expertise in those new technologies or perhaps watch our position fade away over time.

Six Thinking Hats

Debono's Six Thinking Hats analysis is not traditionally thought of as an intelligence process, but it is similar to many of the other processes that we use and an excellent one for gaining consensus around a decision.

In this case, we were looking at a joint venture opportunity. The potential partner had seven different applications of their technology and we split our due diligence team into sub-teams to investigate those applications.

As we came together to try to make a decision on the overall venture, we found widely varying viewpoints, and we used the Six Thinking Hats approach to consolidate our viewpoints. In five and a half hours, the team delved into each of the six hats for each of the seven applications and for the overall decision. We determined what we knew and did not know, what was good about it, what was bad about it, how we felt about it, what other opportunities might come from it, and so on, and came to a resolution on each one.

At the end of the session, we had approximately 55 posters on the walls, including answers for each application and for the overall investment, and we had agreement on a "yes, but" response. Yes, we wanted to move forward, but there were some significant issues that we needed to work on before the final deal was made.

Most of what we captured on the posters could be used directly in the expenditure authorization request. After all, we knew the good things, the concerns, what needed more work, and what were additional future opportunities – all things that you would want documented. This was a very effective and efficient process for resolving the response of the due diligence team to this opportunity.