It won’t be long before business managers, researchers, analysts, professors and their students pick up their smartphones and, using the nearest wall for a monitor screen, start computing with a distant facility too powerful for any but the wealthiest organizations to maintain by themselves. That’s the promise of cloud computing heard by attendees at the CIMS Sponsors Meeting in October.

“Ask a hundred people what cloud computing is, and you will get 100 different answers,” NetApp chief executive Tom Georges told Barron's magazine in November. Notwithstanding, Mladen A. Vouk, NC State professor and head of computer science, defines cloud computing as “a seamless component-based architecture that can deliver an integrated, orchestrated and rich suite of both loosely and tightly coupled on-demand information technology functions...”

Prof. Vouk foresees an order of magnitude minimum improvement in the cost of computing. This, in turn, will permit raising increasing numbers of people up to performing greater value-added work.

Public Utility in the Clouds

CIMS Industry Fellow Michael Kowolenko sees the cloud as basically a public utility. When combined with the new natural language processing capabilities, it will allow users to plow through the universe of unstructured data efficiently and turn that data into intelligence.

As Prof. Kowolenko wrote in the Fall 2010 Technology Management Report, “We need to develop new tools and services, and significantly reduce overhead and total cost of ownership and services.”

Business Intelligence “in the Clouds”

This was the theme of the Fall 2010 CIMS Sponsors Meeting held in Raleigh this past October. And what a meeting it was! Over 125 people attended presentations ranging from how to be both an “exploitive and exploring organization,” by CIMS Academic Fellow and Brown University engineering professor Angus Kingon, to a whole new business model for higher education, called CONII: Colleges Ontario Network for Industry Innovation, as explained by Trish Dryden, associate vice-president, research and corporate planning, Centennial College of Toronto, Canada.

But without question, the highest level of participation came on the day CIMS researchers described what CIMS is doing ‘in the cloud’ to provide meaning and relevance -- to companies seeking competitive advantage -- from the petabytes of data created every day in cyberspace.

In the Spring 2010 edition of this Technology Management Report, I announced that with the help of the
that can be applied to a wide variety of applications and that many different people can access and use easily.” And that’s what Kowolenko’s Virtual Computing Lab at NC State (http://vc.ncsu.edu) is doing in its partnership with IBM’s jStart Emerging Software Technologies team (www.ibm.com/jstart)

The VCL describes itself as, “an open-source implementation of a secure production-level technology for wide-area access to solutions based on real and virtualized computational, storage, network, and software resources.”

jStart is “a highly specialized group of emerging technology experts within IBM dedicated to leveraging emerging technology to meet real-world IT challenges, providing real returns on technology investments, and helping clients to understand the impact of emerging technologies on their business operations.”

The jStart team identifies four “Big Data” challenges: To harness a tsunami of data in the petabyte range; perform analytics on thousands of transactions a second; correlate structured, semi-structured and unstructured information together; constantly update data analysis and predictive models.

jStart’s collaboration with NC State, announced last August, commenced with the use of IBM’s advanced analytics technology to accelerate the lengthy search processes used by the Office of Technology Transfer in finding potential licensees for university biomedical discoveries. (See “Business Intelligence in the Clouds,” on page 1.)

In one case, the months it took dozens of people to search for potential investors and partners for its vaccine research were cut to one week in which IBM Big Data analytics technology was able to analyze 1.4 million Web pages.

At the same time, CIMS and IBM teamed up with the Drug Discovery Center for Innovation to demonstrate the power of the cloud for drug development. The DDCOI (www.ddcoi.org) is a non-profit center designed to serve as a bridge between industry and academia in translating drug discoveries into effective new medicines. It is headquartered in Research Triangle Park, North Carolina, and funded by the NC Biotechnology Center (www.ncbiotech.org).

For its part in the program, the DDCOI is developing and testing a deep search engine dubbed Business Intelligence Gateway, or “BIG.” It would use the VCL’s 2,600-blade server supercomputer to mine both structured and unstructured data sources for new drug discovery opportunities and competitive intelligence information tailored to user needs and objectives.

BIG would be “a pharmaceutical industry Google without the noise,” DDCOI president and CEO John Didsbury told the CIMS Sponsors meeting.

Didsbury reported that the recently completed beta test of the system successfully answered “real life” queries from two large pharmaceutical companies. New competitive intelligence was obtained, as well as a new drug discovery opportunity.

Next steps are to create a business plan for BIG, refine the software tools used and enter a production phase.

We’re moving into analyzing terabytes and eventually petabytes.

See CHASING, on Page 3
Eventually, BIG may be established as a for-profit DDCOI subsidiary and marketed to prospective pharma business partners, Disbury said.

*Where We Are*

“We’ve now demonstrated that natural language processing algorithms can be applied to business intelligence questions and relevant information extracted from the Internet,” Kowolenko says. “We’re able to separate signal from noise.”

As the program now moves from the proof-of-concept phase to development, “we have to show that we can apply data-driven decision making on a much larger scale,” Kowolenko continues. “Previously, we searched 400 websites and now we need to scan thousands; we’re moving into analyzing terabytes and eventually petabytes.”

All of this should be good news for, among others, the 543 C-level and other business executives in 17 countries who responded to a recent survey conducted for Seattle, Washington-based Avanade by Kelton Research (http://www.avanade.com/BigData). Fifty-six percent of the respondents said they were overwhelmed by the amount of data their company must manage; 62% of the C-level execs complained of being frequently interrupted by irrelevant incoming data; 46% of the companies reported that bad or outdated data had led them to make inaccurate business decisions.

As Rod Smith, IBM vice president of software technology, declared when the CIMS partnership was announced, “The volumes of data on our planet are growing exponentially, which represents huge opportunities for organizations that can unlock the insights hidden within the mountains of information. NC State University sets an example of using smart analysis of big volumes of data to explore and kick start new businesses that push our economy forward.”

—M.F.W.
BUSINESS INTELLIGENCE, from Page 1

IBM Company, CIMS was building a cloud computing environment on NC State’s Virtual Computing Lab (see “Together CIMS, NC State and IBM Seed Smarter Clouds” at http://cims.ncsu.edu/downloads/newsletters/62_CIMSspring10.pdf ). Using advanced software tools from IBM, we would attempt to do “text analytics” in search of answers to common innovation questions. That is, we would gather, filter, annotate, and eventually make sense of the massive amounts of unstructured data that reside on the worldwide web in the form of web pages, wikis, blogs, etc.

Just What Is Text Analytics?

This was a big topic of discussion at the meeting. Current information retrieval techniques are often based on statistical models of frequency analysis performed on indexed data. This is the basis of popular search engines such as Google, Illumin8, and Thompson Innovation. While this approach produces rapid results, the relevancy of the return value to the searcher is often limited. The process sacrifices precision for speed. There is no contextual analysis performed with statistics-based searches. The returns of the search require user time to determine the context of the return.

Text analytics, in contrast, is based on analyzing written language using software algorithms that capture the rules of grammar. With these rules, dictionaries and thesauri, users can generate search criteria that become more precise with regard to their required content. This allows the users to set priorities in evaluating search results.

By evaluating the association of words within a sentence, paragraph, page, or document, it becomes possible to establish a hierarchy of those web pages likely to contain the information the user is seeking. Literally millions of pages are reduced to a “readable” set. Further, visual displays and text highlighting techniques make final analysis of the reduced set of records fast and easy.

This is a fundamentally different approach than statistics-based determinations of relationships. The software is able to “pre-screen” the text for the context the user defines.

CIMS and Users Work Together

Understanding how to generate an objective question with defined terms that convert a user’s ideas to machine actions requires knowledge of the process beyond the simple models of information retrieval currently in use. CIMS faculty members work with users to clearly define the query.

In order for the tool to provide relevant information, we will break down the query into several objective questions. Because the process becomes iterative, complexity can be built in as results are obtained. The more specific the query becomes, the more relevant the returns. For example, the question of “who’s active in polymer coatings?” may not provide as much strategic information as the question of “how much are companies involved with polymer coating spending on R&D?”

The software is capable of recognizing integers and performing mathematical calculations on the data analogous to many of the functions in common spreadsheet programs. The software can deal with both unstructured and structured data. Files generated from ERP systems can be incorporated for data analysis by these tools. All the data generated from these queries can be stored as text files.

Progress to Date

The prototype project was developed with NC State’s Office of Technology Transfer in response to the all-too-common question, “Who would be a good partner to help me develop my invention?” At the October meeting, we not only reported the successful conclusion of that prototype project but we announced that three more research projects had begun with CIMS members: the Drug Discovery Center of Innovation, the Plant Sciences division of BASF, and the Global Supply organization of Eisai.

All three of these projects are being performed under a special engagement...
BUSINESS INTELLIGENCE, from Page 4

model worked out with IBM and NC State's Contracts and Grants Office (see illustration below). Under this special arrangement, CIMS members have free access to the VCL computing resources and IBM software for the duration of the research project. Moreover, they will be able to host their meta data files (MDF) on the VCL until we have properly prepared the people in their organizations to use this information to make more informed business decisions.

CIMS Academic Fellow, Mariann Jelinek, a research team member, calls this process the “informating” of critical, strategic business decisions.

At this time, we constrain the extent of the crawls performed in the proof-of-concept experiments (Phase 2) because our current hardware storage capacity is limited to 5 TB. We generally crawl the web for two weeks, gathering up to 400 websites containing 10 million pages of text. However, in Phase 3 we plan to build much larger MDFs, perhaps 1,000 times as large! Right now work is underway to secure the hardware required to support these truly massive data sets.

**Why this Capability Is So Important**

CIMS believes those companies that harness the meaning and power of the massive amounts of data being generated every day in order to understand:

- the macro trends buffeting their industry
- the new opportunities these trends permit
- the capabilities of present and emerging competitors, and
- the global network of qualified and eager “innovation partners” at their disposal

will have competitive advantage over those that do not.

**How To Engage In a CIMS Research Project**

If you believe your organization would benefit from having such an information advantage, or if you just have questions about any of the topics addressed in this article, please don’t hesitate to email me at Paul_Mugge@ncsu.edu.

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**Engagement Model**

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Perform under a CIMS Sponsored Research Agreement to take advantage of NCSU’s VCL

Ad hoc

Defined

Managed

Leveraged

Optimized

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Under the CIMS industry engagement model, our job is not done until we help companies begin implementing this knowledge.
Entrepreneurs Fuel the Innovation Ecosystem

“The innovation process hinges more on the construction of new combinations of old ideas and new networks that can advance those ideas,” Andrew Hargadon wrote in the Fall 2009 CIMS Technology Management Report (http://cims.ncsu.edu/downloads/newsletters/60_CIMSfall09.pdf).

Hargadon has been researching the innovation process since 1996 when CIMS helped to fund his dissertation on technology brokering. Now holder of the Soderquist Chair in Entrepreneurship and a professor of technology management at the Graduate School of Management at the University of California, Davis, he has come to investigate what he calls “the entrepreneurial side of innovation.” Consequently, TMR began by asking:

What do you mean by “the entrepreneurial side of innovation,” and why is it such an important element of the innovation ecosystem you wrote about in your previous TMR report?

HARGADON: As you know, my work on innovation shows that it’s all about the network. All the innovations that have made a significant impact (seemingly overnight) have essentially been new combinations of old ideas, old technologies, old resources, and people that somebody managed to assemble in a new combination that made that impact.

But the more I studied that, the more I came to realize that the real engine behind that impact was the effort the entrepreneurs made to keep those resources together. It wasn’t so much finding the resources as it was the effort and investment the entrepreneur made in constructing a network that would bring those resources together in just the right way.

What I call the entrepreneurial side of innovation is not having the idea, but going out and actually stitching together the resources that make that idea a reality. There are many good examples—the most obvious and well-known being the iPod.

Apple certainly didn’t invent the MP3 player. Apple was about the 15th on the market when it introduced the iPod in 2001. But what it did so well was to launch the iPod all ready to be integrated with its Tunes music store and Macintosh operating system. Shortly after that, Apple built a set of relationships for its record labels that nobody else had. As a result, the company was able to sell music online, which the other MP3 players were never able to do.

That seamless connection between an iPod, a music store and something to sell in that store—the songs—really created this network. It was the network itself, not the iPod that made Apple so successful in this venture. Today we’re in a world where there is something like 250,000 iPhone apps being written by people other than Apple, but making the Apple product even better.

The key for me in all of that is to ask, what’s the vision and then what’s the skill set that enables individuals and companies to build those networks? There are many different definitions for entrepreneurship but the one that rings most true for me is that entrepreneurs are builders.

Entrepreneurs build networks that didn’t exist before. The pieces almost always existed in other places but they hadn’t come together in just the right way to be successful. The entrepreneur’s main task is seeing how that network can come together, and then building that network.

To me, the entrepreneurial innovator is the individual, the team or the company that is capable not just of having a good idea but of having the kind of idea that others will gather around and connect with, and then being able to build the partnerships that make that idea real.

It strikes me how different that person is from the inventor.

Oh, completely! The inventor is like an artist. There’s a great quote by Winston Churchill about why he loved painting.

See ENTREPRENEURS on Page 7
“Because no matter how badly I paint the tree, it doesn’t complain,” Churchill said.

Invention is in many ways the same. No matter what you do, you’ve done something that nobody else needs to participate in. With entrepreneurship, in contrast, the real effort comes in building a set of relationships around the product or the original idea among investors, co-founders, customers, and suppliers.

When you look at entrepreneurship as a building process, innovation becomes part creativity, coming up with a new combination or a new way of combining things, and then execution, or entrepreneurship: the actual art of piecing those pieces together.

*Inventors, on the other hand, seem to have difficulty going out and selling their inventions, possibly because they really don’t have the skills to build the relationships and the networks.*

Absolutely. This has become my new focus: What are those skills? What makes a person a good innovator? Give ten people the same idea and tell them to make it a reality, and that’s often the point at which you can distinguish between who’s innovative and who’s not.

*What are the skills you’ve identified in your research?*

The first is the ability to build that broad-ranging network. Forget cash. If you’ve been able to build a good network, that’s going to be more valuable than any other capital you’ll need.

Past that is the ability to see what I call “the three-bird solution.” Innovations that are truly successful are the ones that somehow manage to take out three birds with one stone. By this I mean an innovator’s ability to see how the needs of one person can be solved by another’s resources, and in turn their needs are solved by a third person’s resources.

You get this positive Mexican standoff, where each person is able to contribute to somebody else in the network, and often in ways that are not that expensive for them. Think about Apple again. Two guys in a garage can write an iPhone app in a couple weeks. They may not make much money on it, or they may make an enormous amount of money, but either way Apple benefits.

Apple benefits from providing that marketplace, from the infrastructure of the phone, and from the customers. And the customers benefit from the phone and from the availability of the app, so everybody gains.

*What kinds of personality traits have you identified?*

Aggression is one of the interesting ones. Talk to most people who want to be innovative or inventive, and you’ll find they’re not particularly aggressive.
socially. This is a shortcoming.

We tend to think of aggression as bad, but the fact is that innovation entails changing other people’s worlds, other people’s behaviors; getting people to do something they haven’t done before. And that takes a willingness to be aggressive in the sense of urging, “You should do this differently.”

Too often, inventors—and many innovators—simply prefer to set their solution down in front of people and let them come to it. But it just doesn’t work that way.

Anything else?

Coming back to my three birds, that’s really about being able to juggle simultaneously the needs and abilities of five or ten different pieces in the puzzle. It’s that willingness to consider how these pieces might fit together in different ways, and to select which is best way, that I consider a really important element.

Can you give us an example?

A friend of mine did a brilliant job creating a company, MaxPreps.com, which was recently bought by CBS Sports.

My friend is a basketball coach and was aware that most local newspapers no longer have reporters covering local sports. So he created a website for high school sports statistics. Because high school coaches want to make sure their kids get credit for the games and the statistics, they would gladly enter those statistics after each game.

College coaches, in turn, would be able to find out who’s doing well—who’s a quarterback over 6 feet and thrown for more than 200 yards a game this season? And the newspapers wanted the statistics without having a beat reporter.

From that initial set of people, the site started to grow. Soon photographers were able to upload pictures of games to that site, and the pictures would be linked to the games and to the individual players.

So you started to get this feedback loop, where newspapers would pick up photographs of local games, and the photographers would get paid as a result of posting them. Parents would log on and look for photographs. Kids would log on and compare their statistics to other kids. You got this network where everybody got something out of it, and was also willing to put something into it to keep it going. It created a terrific community where the technology—which was not that sophisticated—enabled these transactions.

Coaches could get their kids recognized for great play and maybe even recruited to colleges. The kids could compare their scores, see pictures and download pictures. Newspapers could get those statistics and the photographs. Photographers could sell their photographs. Last but not least, of course, it’s such a wonderful demographic that Nike, Adidas and other advertisers recognized the value as well.

All from one innovator!

He grew it into a real company, but the wonderful thing was that they didn’t have to generate any of the content. They simply built this network to come together, and it created all the value.

They went out and, coach by coach, recruited a league. Then, league by league, they recruited a section. After that, it just kept growing.

But getting that first cofounder, and then that first investor, and then getting that first coach to sign on, or the first league to sign on-- that’s
What are you researching at this moment?

I’m spending a lot of time in the green-tech space, trying to make sense of the innovation happening in green technology. That’s because green technology innovation is very different from innovation in information technology-- the networks are just harder to build. MaxPreps could do it because there was already an Internet.

The challenge for green tech companies, renewable energy companies, is getting into an energy industry that’s 150 years old and heavily regulated. It takes a very different network to construct-- a network that includes the utilities and other large quasi-public bureaucracies. It includes regulators, utility commissions or transportation boards, and it has customers who are looking for the security of a 20- to 40- year commitment on energy assets.

What’s so interesting to me about this space is that it makes building networks in information technology seem like a walk in the park.

Does it take a different kind of person than the innovator who builds an IT network?

I don’t know if it’s a different kind of person, but certainly a different perspective on the road ahead. These things can take ten years as opposed to two years to get off the ground.

You gave the keynote address at NC State’s BioSciences Executive Series last spring. What would you say about being an innovator who can build networks in the biosciences? It strikes me as closer to green tech than it is to IT.

The nice thing about biosciences is that while it can take ten years to get a drug into the market, the returns are so large that your investment is paid off and more. In green tech, that’s not always the case. It may take ten years, but the investment every year is increasing. As a result, the returns to risk capital or venture capital just aren’t there in green tech. I think we’re finding that in a number of the companies that were media darlings and are no longer all that exciting.

Are the life sciences attracting a different kind of innovator because of that?

Yes. The people I see in that space are the faculty, the researchers who really need to be, in many ways, that much better at building networks. Because a lot of the interesting work happens early in identifying the molecules or the drugs or the diagnostics, and then pulling together the people who prove that it works. At which point, you’re acquired by a pharmaceutical company or a major manufacturer that has the existing sales network and all of that already put together.

To wind up, what does all of this say to those academic institutions that want to turn out more entrepreneurial innovators?

We need to teach them much more hands-on skills around seeing, building and maintaining networks. We teach most of our MBA students how to analyze an existing market, how to run an Excel spreadsheet, how to put together a PowerPoint presentation. But when was the last time we asked them to actually organize anything, or create an organization that didn’t exist before, create an event that didn’t exist before--the real hands-on training of stitching together networks?

Thirty years ago you couldn’t build a digital video recorder. Today, you could put one together – you could have your own brand, if you wanted, by going out and finding all of the contract manufacturers who have the components. That’s a skill that’s available to individuals-- why don’t we teach people how to do that?

How to go out and actually do what now is the new product development process?

Don’t some places do that to a degree?

I’ve not seen a business school that really emphasizes those skills.

Thanks, Andy
“A brilliant work of art” is how Professor Robert Cooper portrays contributions to the innovation process at Air Products by Aleksandar G. Slavejkov (slavejag@airproducts.com). “Alex” Slavejkov (SLA-vey-Kov) is Director of Combustion Technology at Air Products. He leads development of new combustion applications for the glass, steel, non-ferrous, and other industries that Air Products serves. Holder of 17 patents and co-author of more than 35 research publications, he was also a member of the Industrial Research Institute’s Process Effectiveness Network, which identified best practices for the so-called Fuzzy Front End of innovation in the late 1990s.

Slavejkov received his Ph.D. in chemical engineering from Rensselaer Polytechnic Institute and his B.S. and M.S. from the University of Belgrade, Yugoslavia. Since joining Air Products in 1990, he has been recognized as one of the company’s most prolific inventors in combustion science. Consequently, Technology Management Report’s editor Michael F. Wolff began the interview by asking:

Which issues or problems are getting most of your attention today?

My primary role is to develop and manage our combustion R&D group. In addition to the normal supervisory role, I also work with the team to make contributions as a combustion expert and an inventor to develop combustion technologies such as burners and combustion systems for furnaces.

We often conduct optimization studies as well. In other words, we help our customers run their furnaces more efficiently by providing them with high-performance technology, most often proprietary oxy-fuel burners, and help them install and run the furnaces to get the maximum benefits.

You characterize yourself as both an inventor and an industrial research manager. That’s not a common combination. How did it come about and how does it work?

There seems to be a distinction in the industry between research managers and inventors, and very often inventors are seen as fit only for technical work. I don’t believe that’s necessarily true.

My position is that a successful manager should manage by example. I tell my team that they do not work for me but with me. I think that is a very important point. While I am their supervisor, I would like them to treat me as a co-worker and respect me for the ideas that I have and the work I have done rather than for my grade level and the position.

What kind of teams do you manage?

The core team is a research team and they focus on industrial applications. We operate several laboratories including Air Products’ new Clean Energy Combustion Lab, which opened in July 2010. In addition, there are combustion people who work directly with our customers in the worldwide commercial technology field. They understand the vital link between technology capabilities and business needs.

I consider them all as a big combustion team and we work closely together.
The commercial team has solid knowledge of the industry and the researchers have in-depth knowledge of the science.

**What exactly do you mean by leading by example?**

What I mean is that I am very interested in technical details and in what’s going on. I try not to micro-manage. Often I joke that I’m always right except when I’m wrong. When researchers on my team come to me asking for an opinion, I give them an opinion but advise them to pursue their own leads because I’ve been wrong before and I could be wrong again.

I try to encourage freedom and let them pursue their own leads because that is how one comes up with a serendipitous discovery. I’ll give you a good example:

We had a young researcher who was designing a new flame stabilizer for our hydrogen production business. She made a design “mistake” and specified a tube that was too short but nevertheless produced an effect that proved to be very important. It led to a different kind of burner—a large-scale vortex burner—that we patented.

I still remember how she came to my office and said that the flame was stable and the device was running fine. I looked at her in disbelief. I said, “No, it wasn’t possible with such a configuration.” I ran to the lab and saw it. It was incredible that she was able to run a much-diluted fuel with cold air and the flame was right there, stable. Had she followed general rules for burner design, often requiring a long tube to achieve a fully developed flow, she would have missed it. That’s serendipity!

I would never have made her “mistake.” But serendipitous discovery was made because this researcher had the freedom to go into the lab, to run the experiment, and to make a “mistake” in designing the device. As long as the researcher is following safety procedures, he or she needs to have the freedom to experiment.

I’ve seen similar situations time and again where you think you’re going in one direction and then you discover something totally new. But the key is to be able to see and recognize the new discovery, and in such moments experience helps. That’s a key to innovation -- being able to see when the new stuff is happening and recognize its potential use at the same time.

**Tell me about your own inventing history. Did you invent as a boy in Serbia?**

Both my father and mother were engineers. My father was a chemical engineer and director of a technology institute in Belgrade. He was very inventive and innovative. He managed to build many factories in old Yugoslavia.

I worked at his institute, in a different division though, for a few years before...
I came to the United States as a Ph.D. student.

My mother was a textile engineer and taught at a specialized textile school of technology.

So you had the influence of parents who were engineers. Did you have technical hobbies?

My father was a very hands-on person. He was working on the house doing everything, and I was there to help. The hands-on stuff really helps. In fact, that’s a secret of mine. When I interview people I inquire about their hands-on skills and I do take heed of those who are hands-on, who can touch things, who don’t mind getting grease on their fingers.

I repaired cars myself. My first car was a junk car; I was repairing the transmission every couple of months or so because it was just a poorly designed, cheap automobile. Now I do lots of construction at home. I repair everything—electrical, plumbing, anything; just name it, I do it. As well as high tech. I installed my home security system and all sorts of things in the house. I’m a very hands-on person.

To shift from technology, you have not limited yourself to inventing and technology but you got interested in the process of innovation. Eventually you helped introduce the Stage Gate® process at Air Products. How did that come about?

After I received my Ph.D. from RPI (my thesis was on boron chemistry), Air Products hired me in its gas applications group. I thought I was going to work on the chemistry of flames and things like that but they told me to develop a new burner. I asked myself how I could develop a new burner when I didn’t know anything about burners!

Nevertheless, I was given the task to develop a new glass burner. At the time, oxy-fuel burners were not very durable in glass furnaces. A glass furnace is a very hot, corrosive environment, operating at about 2,900 degrees Fahrenheit. It’s very difficult to get things to survive in a glass furnace.

They showed me some pictures of oxy-fuel burners that melted when they tried them out. They said, “Off you go; that’s your project. Develop something that will work.”

We did develop one burner that was practically maintenance-free, which really helped with the implementation of oxy-fuel technology in the glass industry. After that I worked on the second generation and invented the Cleanfire® HR high-radiation burner. That was a big step up in the efficiency of furnace operation.

Then I took a break from combustion work and went to do economics in our Corporate Science and Technology Center (CSTC). That’s when I got involved in the innovation process. I led the economic evaluation group, working with the CSTC scientists to evaluate benefits of their projects and streamline their research to maximize the value created for Air Products.

That’s how I got involved with Professor Robert Cooper and his Stage Gate® process. We came up with a Stage Gate process for Air Products that was introduced in CSTC. Later on, many different groups in the company came up with their own Stage Gate processes and all of a sudden we had more than ten such processes within Air Products. Different groups could not communicate because the processes had different numbers of stages, different names of stages and different meanings. It was a total mess. It was very difficult to understand what was happening in different groups and to effectively manage the portfolio from the corporate level.

So I was asked to lead a team to come up with a corporate standard for the Stage Gate. It took a lot of effort and I must tell you that convincing people to change the number of stages and names was much more challenging than I expected. But eventually our corporate standards team prevailed and we introduced a standard process that is still in place and running.

We also developed and introduced metrics that we still use to measure what each project is producing after it’s commercialized. We even developed software to log in all the projects and

**Good tech managers should be technically strong, understand financials and lead by example.**
keep track of the gates and progress and milestones and metrics. Currently, all these data are regularly consolidated and reported to our chief technology officer, and I must tell you it is a real pleasure to see all this working.

Was there resistance to introducing these systems?

Absolutely! At the time I worked on this some days were tough. There was resistance at every step of the way. Change does not come easily, you have to work on it. Even today, there are some folks who are unhappy with all this extra “administration.” However, I believe that the majority of people see the value of having the system in place.

What happened next?

Once the work on the Stage Gate was completed, we realized there were some other challenges with the innovation process that needed to be addressed. Let me try to explain:

Consider that every organization starts with a portfolio of ideas. Some are good, some not. If you apply the Stage Gate as a processing tool—meaning that once you have an idea you put it in Stage Gate and it quickly eliminates the “bad” ideas, then the biggest problem turns out to be the shrinking idea pool. I realized that to increase the outcome and productivity of research, we had to improve the idea generation process. That was my next, post-Stage Gate, focus. I have been working on that for quite a long time.

You were also involved with the IRI’s Process Effectiveness Network during this time.

That’s correct. I participated in a workshop with representatives from several other IRI companies and reported on what happened when Air Products introduced its model. We debated different Stage Gate process designs and how to remove the fuzziness from the so-called Fuzzy Front End. We came up with a New Concept Development (NCD) Model that we published in Research-Technology Management (Koen, P. et al, “Providing Clarity and a Common Language To the ‘Fuzzy Front End’,” March-April 2001, pp.45-55).

Soon after this, I was called back to lead the combustion technology group. That’s when I realized the utility of our NCD model and the importance of triggers.

The slides at the left are from a paper I presented in 2002 to the Commercial Development Management Association (CDMA). They illustrate how a good idea needs to have two conditions satisfied (or “triggers”): an opportunity identified and a technical solution proposed.

This only takes place at the very intersection of the opportunity field (or business segment of interest) and the skills/capability field (in this case combustion). So to increase the probability of having a viable intersection, one needs to work on improving his skills and capabilities.

People often forget to strengthen these triggers. It’s like what a body builder does—going to the gym and building the muscles. When you’re in a scientific area you have to build your resources and capabilities. That’s what we are doing; we are really walking the talk.

A good idea lies at the intersection of an opportunity and a solution. But the probability of finding a viable intersection is proportional to the strength of your capabilities. If you have better capabilities, the intersection is easier to find.

That’s the secret of our portfolio here at Air Products. We try to match our skills and capabilities and continually expand on them so that we can successfully address the needs or opportunities.

Remember that one person’s problem is another person’s opportunity. So we’re looking for problems to solve. In terms of our model, the broader we can make the intersection between our two triggers, the sooner this can happen. With stronger capabilities, you can address more of the needs and thereby have good ideas and good projects to work on.

Like what?

Like CO₂ capture for power plant operations. For example, we are trying to position ourselves to address the need to reduce global warming. The...
Tech Managers Should Check Out…


Crowdsourcing may not be the elixir for creativity that some are hoping for. That’s the upshot of research by Barry Bayus of the Kenan-Flagler Business School at the University of North Carolina (Barry_Bayus@UNC.edu). His empirical study of Dell’s IdeaStorm system reveals that individual creativity is positively related to productivity (current effort), but negatively related to past success.

As a result, Bayus writes, productive individuals are likely to have creative ideas, but are unlikely to repeat their early creative success once their ideas are recognized as being creative. He explains that these findings highlight difficulties in maintaining an adequate supply of creative ideas from the online crowdsourcing platforms that several organizations have developed. He emphasize the need for a greater understanding of these systems.


How does a corporation grow, organically or by acquisition, when it doesn’t know what it doesn’t know? That’s the question posed by Mark Bernstein, CEO of Palo Alto Research Center (PARC), an independent subsidiary of Xerox. Bernstein answers his question with advice derived from PARC’s years of experimenting with different models for business innovation. Acquire platforms, not just patents; draw on outside expertise for breakthrough possibilities; don’t rely only on VCs; utilize the open source ecosystem; build a process for opportunity discovery into your innovation front end.


Booz & Company’s sixth annual study of the world’s 1,000 biggest R&D spenders shows their total R&D spending decreased in 2009 by 3.5% to $503 billion. The study also found that the most successful companies follow one of three fundamental innovation strategies but, regardless of the strategy, the top performers “focus on a particular, narrow set of common and distinct capabilities that enable them to better execute their chosen strategy.” Booz maintains that companies that have achieved such coherence with their overall business strategies “consistently and significantly outperform their rivals on several financial measures.”

Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5; http://www.nap.edu/catalog/12999.html

In the five years since the National Academies released their Rising Above the Gathering Storm report, America’s ability to compete for quality jobs in the global economy has continued to deteriorate. That’s the conclusion of an updated report by members of the committee that wrote the 2005 report. Their new report calls for a sustained effort in education and basic research to keep the U.S. from slipping further.

“Reversing the Extraverted Leadership Advantage: The Role of Employee Proactivity”; Adam M. Grant, Francesca Gino, and David A. Hofmann; Forthcoming in the Academy of Management Journal

In contrast to the conventional wisdom, introverted leaders can be more effective than extraverts in certain circumstances, according to research by Wharton School professor Grant and co-authors Gino of Harvard Business School and Hofmann of the U. of North Carolina Kenan-Flagler Business School. A synopsis of their paper is available at http://www.knowledgeatwharton.com/article/1/2339

---M.F.W.

new lab is also helping our existing customer base with oxy-fuel solutions that improve efficiency while reducing air pollutants.

As you can see, technical inventions, innovation, Stage Gate, NCD model, metrics, and process economics all fit together. Perhaps this explains why I take the position that good technology managers should be technically strong, understand financials, and lead by example.

You told me earlier that you really enjoy bringing products to market, that you get great satisfaction from contributing to the company’s bottom line.

That is correct. Many of the technologies our group has come up with—and I am a co-inventor of many of them—have found their way to the marketplace and are right now running in customer furnaces. I’m talking about worldwide. We have combustion installations all over the place. Wherever Air Products runs a business we are there.

My final question, then, is what next for Alex Slavejkov?

I would like to go deeper in energy and the field of applied combustion and actually tackle the very challenging problem of global warming. Our new combustion lab will give us the opportunity to work on this problem.

The coal we have in the United States is a great source of energy and if combusted with oxygen will produce a stream of relatively pure CO₂, which can then be sequestered. I would like to work on advancing the oxy-coal technology, which is generally considered as a very promising option for CO₂ capture and subsequent reduction of global warming.

I believe that our civilization will have to rely on hydrocarbon fuels for some number of decades before we can move completely to nuclear or solar or something like that. The hydrocarbon combustion is here to stay, at least for now; we will need it to keep us warm. My goal is to make it much more environmentally friendly until we find a better energy source.

Thanks, Alex
Increasingly, companies are recognizing that business model innovation more than R&D and technology innovation will be the primary driver of their competitive advantage. As Mark Johnson, author of Seizing the White Space (Harvard Business Press, 2010), has written, “It’s far harder for an incumbent to fight back against a business model innovation than it is for them to match and raise the stakes on a technology innovation.”

Nevertheless, 82% of 876 senior executives whom Ernst & Young surveyed in 2009 said they needed to rethink their business model. The survey confirmed Ernst’s own observations and other research that suggested many successful companies were encountering such fundamental changes in their markets that they were being forced to reinvent their core businesses.

Consequently, Technology Management Report turned to Tony Singarayar for his advice on business model innovation. Singarayar developed an approach to the process in 1997, and today his strategic consultancy, Analogy Growth Partners LLC (www.analogypartners.com), helps companies grow through business model innovation. TMR began by asking him to explain why this has become so important.

I’ll begin with four points:

1. In today’s world of open innovation and free information flows, technology innovations are not secrets; all major competitors are able to access the information that leads them to very similar innovations at about the same time as everybody else. Technology innovation, although extremely important, is alone not enough because it’s easier than ever before for competitors to imitate you. Those companies that couple good technology innovation with good business model innovation get much stronger play in the market and are able to create and capture a lot more value.

2. For a long time, businesses operating in the emerging markets—China, India, Korea, Malaysia—had different models than companies operating in developed markets. When the best of those emerging market companies suddenly gained access to markets in the developed world, they were able to succeed extremely well because their business models were differentiated and had been polished and tested over time. Companies like Li & Fung and Huawei, for example, have been able to command global dominant positions in many categories.

I find that when developed market companies confront these “different” emerging market business models, they seem unable to respond to them quickly or effectively.

3. People have been making lists of the “best” and “worst” performing...
Companies find it really difficult to change their business models.

companies for years. However, in any business category some “best” companies become “worst” after only a couple of years. We find great performers and poor performers whose products and service offerings are not very different—there’s something else they are doing that is making them win or lose. We call that the business model. It’s the business model that’s making the difference between the best and the worst performing companies.

4. In every industry there seems to be a secret code that dictates competitive actions and reactions. My colleagues and I documented 25 of these codes (we call them competitive fingerprints) and we found they have given birth to different business models that operate very well. However, when the competitive fingerprint changes, many companies are unable to change their once-successful model in response; this results in weak performance.

Consider watch manufacturing, for example. Its gold standard used to be Switzerland, but suddenly you could put a computer chip inside a watch and it was no longer necessary to employ highly skilled people laboring for hours to make a watch. This changed barriers to entry, drove the need for a completely different business model, and many of the Swiss watchmakers failed to adapt.

Companies find it really difficult to change their business models even when it is a matter of life or death.

Business Model Cornerstones

Given these circumstances, what should a company do? It must develop a capability to innovate its business model. To start, think about the six elements that form the cornerstones of any business model:

1. The product or service.
2. A customer for that product or service—and ideally a brand equity that tells your customers things about the product or service even before they know exactly what it is. Tell somebody that Apple’s coming up with a new product, for example, and immediately there’s an expectation about the quality, design and functionality of that product, even before they know exactly what that product is.
3. Outside influencers who like your company and its products enough to urge others to buy your product rather than some competing product.
4. The company’s ability to manufacture its product or service with high quality, low cost and high reliability.
5. The ability to distribute those products broadly through existing or new channels.
6. The profit model, which captures value (revenues and profits) from value created by the foregoing five cornerstones.

Dialing for Performance

Once you have clarified what the cornerstones of your own business model do for your business, you are ready to address the question of how you out-perform the competition. I like to think of this in terms of a dimmer on a light switch: you dial up the dimmer to get the optimum—not necessarily the maximum—illumination for what you need to do.

The more you “dial up” a business model cornerstone, the more you are able to compete differently and better than the competition in that cornerstone. It usually takes more than dialing up just one cornerstone to win.

Unfortunately, what companies are good at turning up and strengthening in business model terms is not necessarily what’s best in a competitive situation.

Mimicking the Competition

We find that in most business categories, the dominant competitors seem to dial up the exact same “dimmers” to the exact same strengths. Because these category leaders are all so good, they are able to turn these dimmers up to a very high performance level; consequently, it’s very difficult for any of them to gain a sustainable advantage over the others.
It’s like Olympic athletes competing against each other for tiny advantages that require enormous effort to sustain and last for a very short time because someone else soon catches up.

Consider retailing, for example. Here, the distribution channel and brand are the primary cornerstones that determine whether you win or not. How do you arrange your shelves? Do people have a nice shopping experience in your store? Are there aspects of the experience that are painful? Is your brand like Target or Wal-Mart, or like Bloomingdale’s or Nordstrom?

These elements and many others combine to become a customer’s “experience with the store.” Every store provides a different shopping experience, but leaders like Bloomingdales and Nordstrom, and Target and Wal-Mart, are competing at the Olympic athlete level inside their stores. As a result, it’s very difficult for them to gain competitive advantage because they’re all champs!

We see this pattern of competing by imitation happening over and over again in many different business categories. That’s why our job as business model innovators is to figure out how to compete differently and more profitably than the competition.

I shall describe our approach to competing differently, with my five “tough questions,” in the next issue of TMR.

Tony Singarayar, Founding Partner, Analogy Partners, LLC; tonys@analogypartners.com

NC State professors Stephen K. Markham and Thomas Hollmann have finished their long-running study of the differences (many surprising) between product and services innovation (CIMS Technology Management Report, Fall 2009, Winter 2009-10 and Fall 2010). Their final report is forthcoming and available from Prof. Markham at stephen_markham@ncsu.edu. Meanwhile, here’s their final summation of how services innovation differs from goods (product) innovation:

- Services developers spend more time on the front end.
- Services use teams more and train their members more.
- Services are more separate, with less connection and support from the rest of the organization.
- Services make less use of formal processes.
- Services use fewer development and technology tools.
- Services check competitors and compare more and sooner.
- Services check financial performance earlier.
- Services check business model and market acceptance sooner.
- Services are more market-oriented.
- Services use less IT communications.
- Services use fewer development partners but more development agreements and deeper relationships.
- Services use more formal rewards and less celebration.
- Services have clearer goals but they are not aligned with rest of the company.
CIMS Makes a Difference at Eisai

“The spending race is over in pharmaceutical R&D, with companies now focused on DOING MORE WITH LESS,” headlined an article in the June 7, 2010 C&EN. In “Research Recalibrated,” (pp.13-18), Lisa M. Jarvis reported on the steps Merck, Pfizer and others are taking to create “a more robust new-product pipeline for less research money.”

CIMS Sponsor Eisai Inc.(www.eisai.com) faces the same environment. A U.S. pharmaceutical subsidiary of Tokyo-based Eisai Co., Ltd., Eisai calls itself “a human health care company seeking innovative solutions in disease prevention, cure and care for the health and well-being of people worldwide.” The company devotes approximately 22% of its worldwide revenue to R&D.

“We recognize that the landscape is really changing for the pharmaceutical environment — from a global perspective, a legislative perspective, from many different perspectives,” says Trudy Burke, Senior Director for Eisai’s Baltimore, Maryland manufacturing facility and the Gliadel® Wafer supply chain.

“We wanted to make sure that we had the capabilities and understanding to not only be successful short-term but moving forward as well,” she explains. “We were moving from having two blockbuster drugs that were facing loss of exclusivity to really looking into the future and being a global supplier. We realized that our traditional management and continuous improvement processes were no longer enough to meet future business needs.”

To help Eisai make the changes deemed necessary to transform its production and supply operations “into a more market-savvy organization,” management turned to CIMS in 2009 and together they formulated the three-phase Innovation Initiative that Burke describes now.

Preparing Leadership

The first phase was designed to prepare the Product Supply organization leaders “to be able to define, plan and lead a set of lasting ‘step function’ improvements to the organization’s cost structure and to the value it delivers to its customers.”

This, in turn, consisted of the three modules illustrated in the diagram, on the next page.

1. The first module involved understanding the compelling need for change. A 26-participant team worked through what was going on in the environment, what was having an impact on Eisai, what the business drivers were, and why we really needed to do something in order to continue being successful and supplying products for patients.

The exercise focused on our functions and helped us to understand why the change was required as well as our dependency on both internal and external organizations and functions. We examined the market signals and came up with the following eight industry drivers that would be critical to our business and our operations moving forward:

- Growing adoption of price restrictions globally.
- Growing economic power and needs of the developing world.
- Declining R&D productivity.
- Emphasis on pay-for-performance measures.
- Emergence of mini-busters rather than block-busters.
- Emergence of biotech and biologics.
- Increasing emphasis on personalized medicine.
- Increasing use of pervasive monitoring.

This exercise helped us to understand what new capabilities we needed versus our more traditional way of looking at an organizational structure. Where did we need to transform ourselves to be best in class? What types of things did it make sense for us to continue in order to maintain a given level of excellence? Where did we need to partner with another enterprise?

And then, was there anything that didn’t make sense for us to do internally and that we should shed or outsource?
Eisai’s new innovation initiative aims to transform its production and supply operations into “a more market-savvy organization, attuned to the macro challenges—and opportunities—facing the pharmaceutical industry.”

**Program flow and outcomes**

<table>
<thead>
<tr>
<th>Macro Trends &amp; Issues</th>
<th>Building Breakthrough Business Models</th>
<th>Creating a Culture of Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand today’s ‘market signals’ (2 hours)</td>
<td>Overview CBM technique (4 hours)</td>
<td>Overview ‘what we know’ (2 hours)</td>
</tr>
<tr>
<td>1. Prioritize resulting ‘industry drivers’</td>
<td>Align change imperatives for Production/Supply (P/S) area (2 hours)</td>
<td>Assessing P/S Org Culture (6 hours)</td>
</tr>
<tr>
<td>2. Map to Eisai operational areas (16 hours)</td>
<td>Decide how Eisai P/S operations will be ‘special’? (7 hours)</td>
<td>‘To be’ Org culture model and Change Management Plan (6 hours)</td>
</tr>
<tr>
<td>3. List ‘strategic inferences’</td>
<td>Develop the Investment Plan (10 hours)</td>
<td>Practices and change processes (4 hours)</td>
</tr>
</tbody>
</table>

- Show enterprise-wide dependencies
- Focus on Production/Supply operations
- Know why change is required
- “Transform…Partner…Maintain…Shed”
- Clear rationale for actions
- High-level business case
- Example for the rest of Eisai
- Current thinking on Org culture components
- Assessing current culture
- How Org culture can be influenced

**Note:** 1. Requires PSLT only, all participants will be kept informed of results

2. The information we learned in this first module helped us to look at our business model and determine what kind of organization we needed in terms of capabilities and key outcomes. We listed potential step function changes or innovative areas that we were going to prioritize and determined which were right for us to pursue. We assessed them on the basis of increasing patient value while at the same time decreasing overall health care costs. We wanted patient value to go up and costs to go down.

3. The final module focused on building a culture of innovation. CIMS facilitators helped us to assess our current culture within departments, sites and certain corporate functions. We were able to identify cultural behaviors that could either hamper or facilitate innovation and learn how we could, as leaders and role models, coach the organization into creating a culture of innovation. Without a supporting culture, none of the innovative ideas we had were going to be successful. The strategy was really dependent on the culture. In addition, Eisai’s mission is one of human health care (hhc) where we give our first thoughts to patients and their families and contribute to increasing their benefits.

**Discovering the Boundary Spanners**

One exercise that made a big impact on us was to diagram our information flow and our formal versus informal networks. This allowed us to identify a few key individuals who were very critical in facilitating information flow.

See EISAI, on Page 20

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We actually identified boundary spanners who performed that function without it being an explicit part of their assigned roles. It was simply part of “who they were” as opposed to the organization making a conscious decision to do it or really understanding the value of boundary spanning.

That was a key discovery. One of the outcomes from it was that we are incorporating formal boundary spanning into all of our leadership objectives. We recognize that boundary spanning, both internal and external to the company, is critical for innovation.

Four Innovation Concepts

We also identified four different innovation concepts that we need to systematize in order to continue to facilitate and foster innovation and innovation management within our organization.

One of those is an Idea Management system, which we are currently piloting for Eisai Inc. at our RTP facility.

The second is Customer Connectivity — putting systems in place to interface with our managed care and distribution chain customers. Having direct contact through existing channels will enable Supply Operations to identify trends and emerging opportunities, and enable us to provide higher satisfaction to our customers. This, in turn, will allow us to make improvements that will increase customer satisfaction consistent with Eisai’s hhc mission.

The third is Patient Connectivity, which involves the traditional complaint management as well as being able to socialize the patient’s needs and concerns with our employees. We will establish systems that will allow us to connect with patients, caregivers and key opinion leaders in order to understand and evaluate the effectiveness of our products and services in meeting the critical needs of our patients.

The fourth is to make boundary spanning a formal part of our daily business operations.

These were all things that we may have done in the past to some extent, but certainly didn’t have systematized. As a result, we are in the process of putting systems in place to really facilitate that information flow.

Deployment

Now we’re moving to the next phase, deployment. In addition to keeping our change opportunities and innovation systems moving forward, we’re addressing the culture and communication aspects at regular meetings and asking each leader to share the information within his/her own organization.

Progress in these areas is checked monthly by a Product Supply Leadership Team. In addition, the team is developing a 3-5-year plan intended to transform Eisai’s production and supply operations into a more market-savvy organization, attuned to the macro-challenges—and opportunities—facing the pharmaceutical industry.

Toward the Cloud

Cloud computing is one of these macro-challenges and opportunities. Eisai has begun working with CIMS to utilize the advanced data analytics capabilities made possible by the cloud for delivering lower-cost drugs to underserved regions of the world.

Louis C. Arp, Eisai’s vice president and general manager for supply operations, explains that, “The objective of the Cloud Computing—Text Analytics Utilization initiative is to accelerate the creation of Eisai institutional knowledge on supply chain current practices for low-income countries. We hope to have an outcome that identifies feasible supply chain options that we can then pursue in more detail before converging on our business strategy.”

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