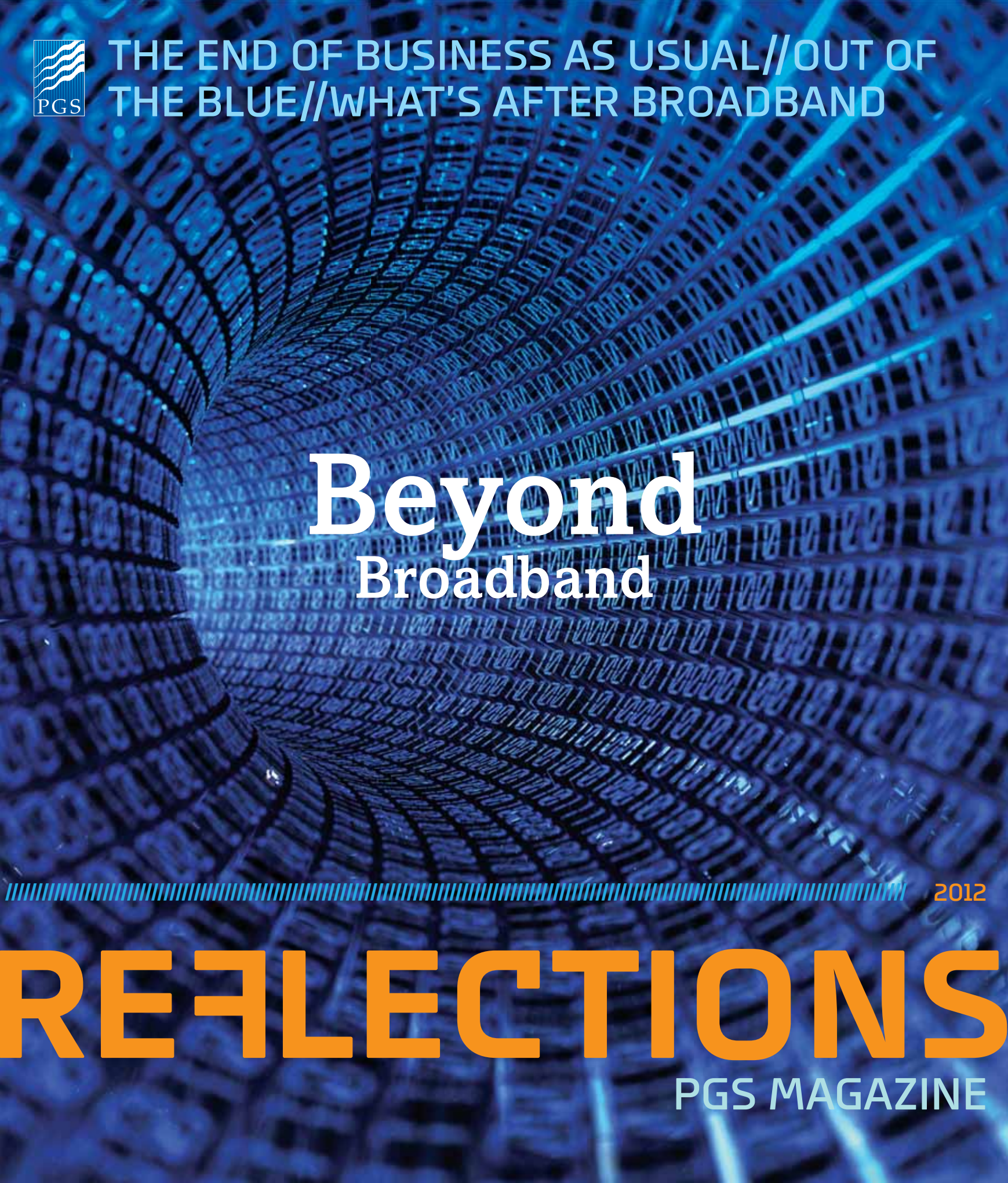
THE END OF BUSINESS AS USUAL//OUT OF THE BLUE//WHAT'S AFTER BROADBAND
Beyond
Broadband
2012
REFLECTIONS
PGS MAGAZINE

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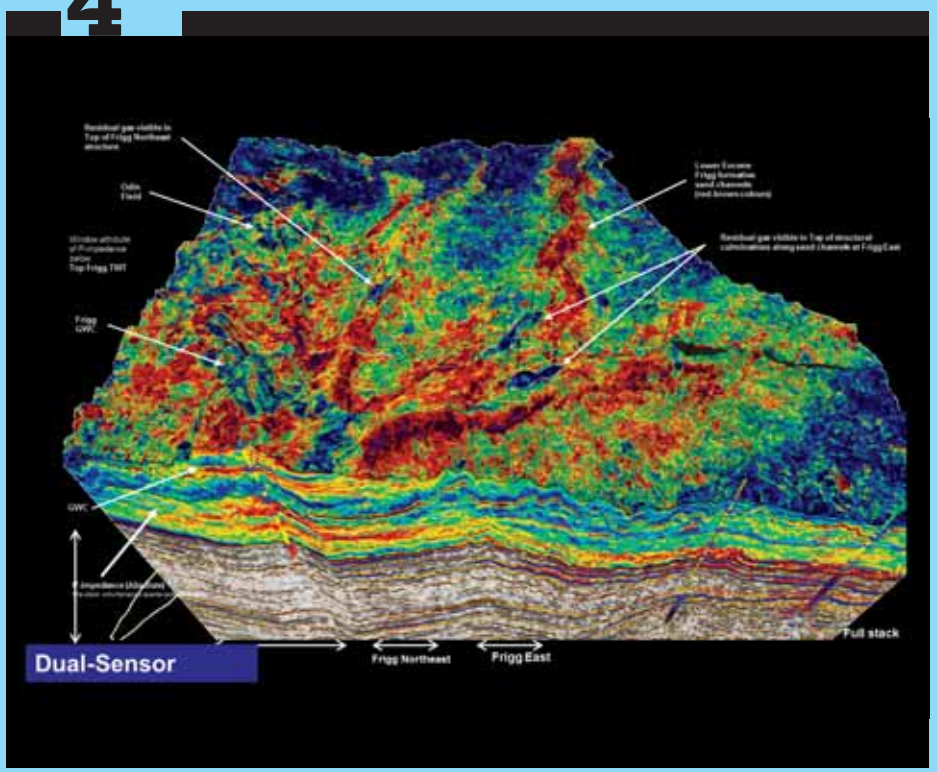
REFLECTIONS / 2012

There is good reason to believe that all new seismic acquisition will be broadband before long. Now this is the baseline, what's next?



Brian Solis believes that social media represents a fundamental change in human interaction. Must we adapt to survive?

This is the beginning

There can be no going back. Our world has been fundamentally changed by broadband technology.

Today's citizens, both in their professional and private life, swim in a different reality than they did just a few years ago. Expanding access to more information is providing new perspectives on everything from politics to prospectivity. In this issue of Reflections we search for sense in the cacophony of modern free-for-all communication, and offer a commentator's assessment on how the oil business is adapting.

In the realm of geophysics, operators big and small are scrambling to get on the broadband wagon. In fact, we believe that all new acquisition will be broadband before too long. So it is a good time to look at what lies beyond mere broadband acquisition.

We lift the lid on some of the cool stuff that waits for explorationists. Finally, a note of caution: cybercrime is on the rise in the oilfield. Access to information isn't always a good thing.

As usual we hope that you enjoy the magazine and look forward to your comments.

Tore Langballe
SVP
Group Communications
tore.langballe@pgs.com

Crises occur when we least expect them and like Murphy's Law, crises can occur where we least expect or want them.

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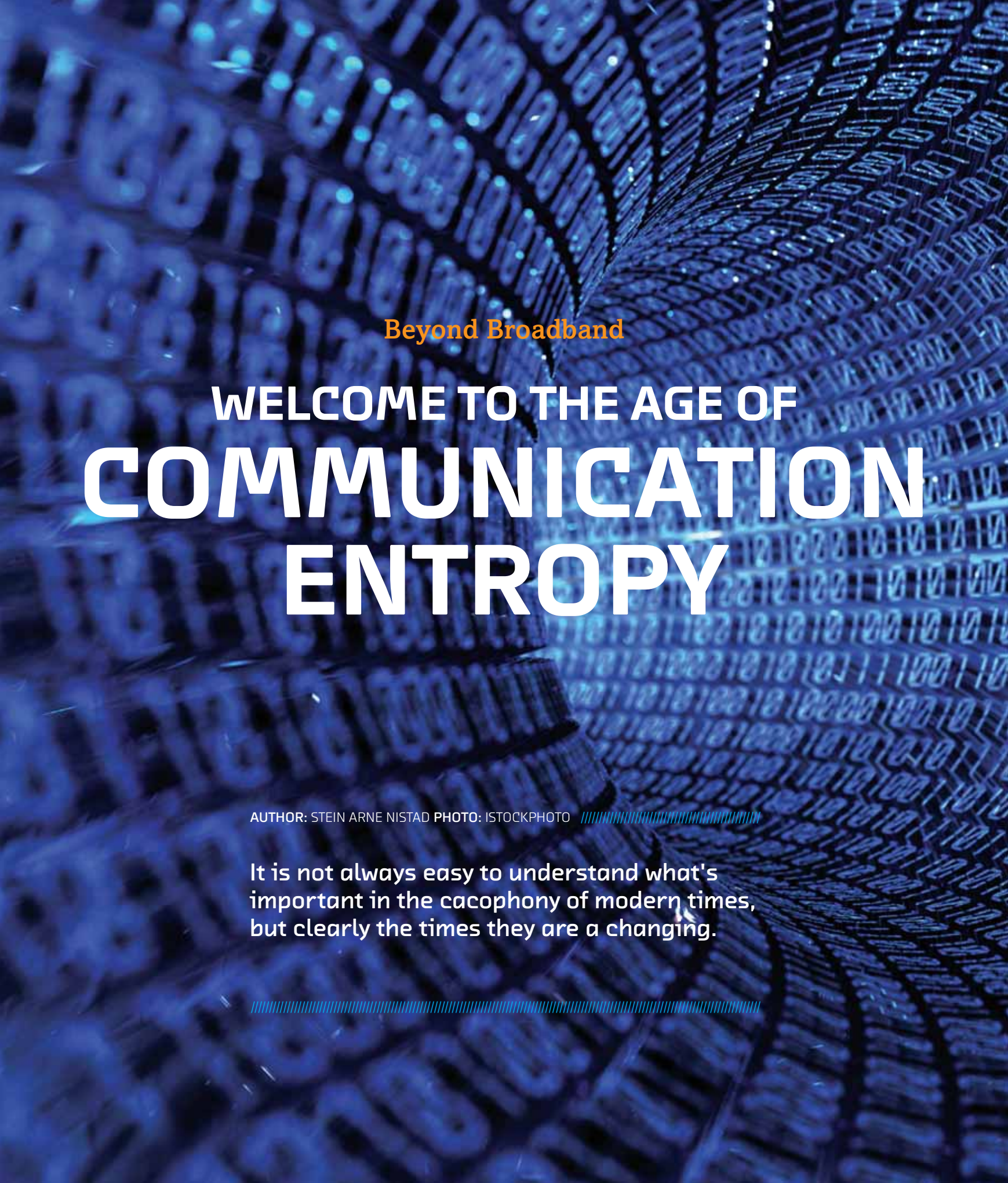


Beyond Broadband

WELCOME TO THE AGE OF COMMUNICATION ENTROPY

AUTHOR: STEIN ARNE NISTAD **PHOTO:** ISTOCKPHOTO

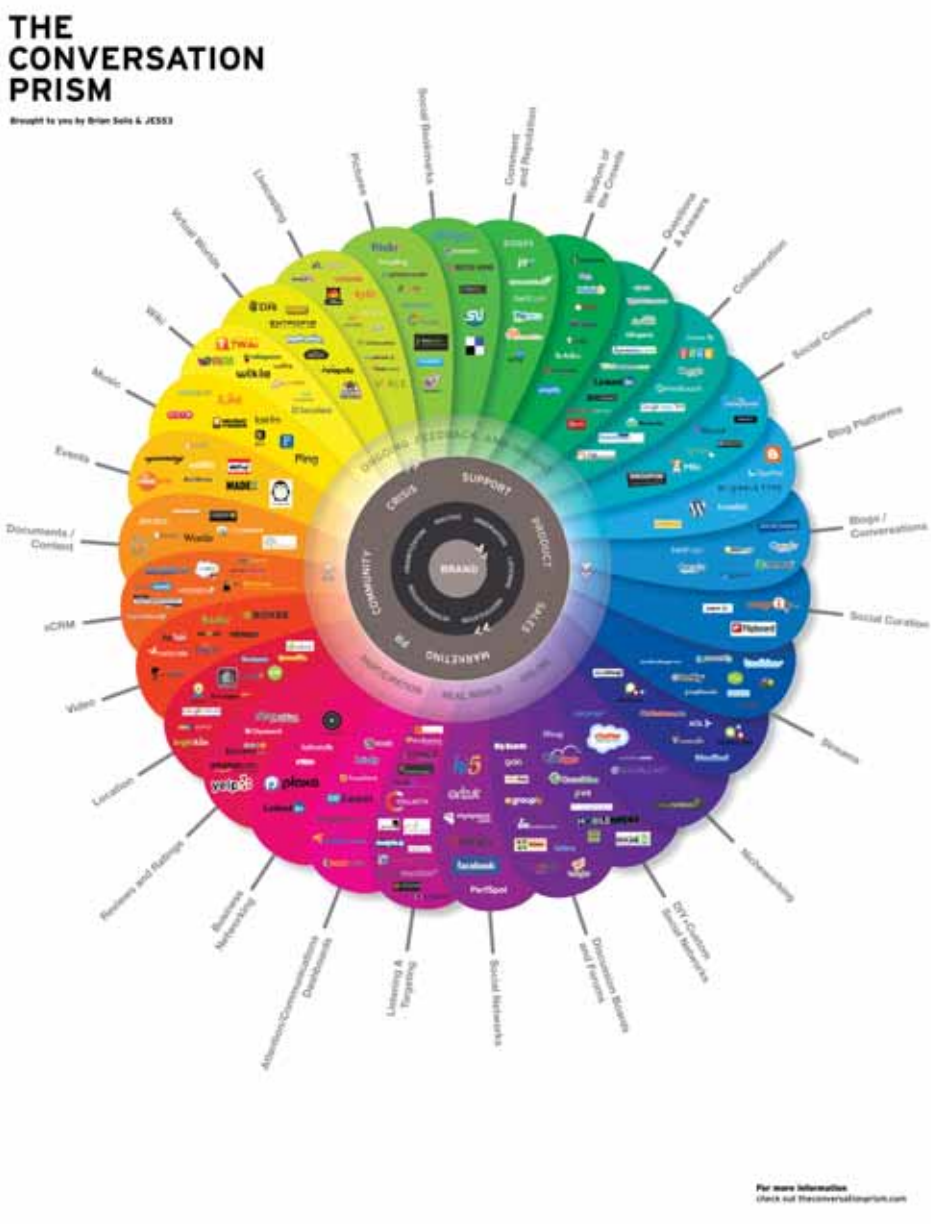
It is not always easy to understand what's important in the cacophony of modern times, but clearly the times they are a changing.

Over the last twenty years we have seen an explosive development in fixed and mobile bandwidth. Communities that previously were remote are now online. We can communicate with each other in real time across regions and continents – not just one-to-one but many-to-one and one-to-many using social media. This is a major shift – but why does it matter?

A bit of simple science may help us to understand what's happening. Entropy is a term that is used in thermodynamics to describe the level of order or chaos in a closed system. In ice, order is high, as the water molecules are neatly aligned in crystals. When the ice melts chaos increases. In steam the level of chaos is higher again.

The movement of each molecule affects those around only if they are close enough, or moving far and fast enough to bounce off one another. In a closed environment this creates increased pressure. This can give a measure of the total effect of the increased activity without needing to know the precise movements of each individual molecule.

What if societies too were characterized by a level of entropy? The analogy is pretty straightforward. The interactions of citizens affect the opinions and preferences of their neighbors. When the rate of participation increases, it raises the level of communication-driven entropy. As this level grows, in terms of active individuals, bandwidth and message complexity, so too does the buzz and agitation. This can lead to euphoria in teenage pop fans or turmoil in a closed society. Monitoring social media activity is a bit like a pressure gauge on an oil well. We need a blowout prevention plan. »



"The Conversation Prism" by Brian Solis gives an overview of the social media universe, from a brand perspective. This multi-channel reality affects individuals as well as companies.

In ancient times there were fewer people around – and little communication between groups. Bandwidth was limited by word of mouth. It could take weeks or even years to pass on a message over large distances. A war could be fought and won – before it was even known that it had started. It was indeed a slow, slow world.

The medium was the message

The development of communication channels and bandwidth has been a long and winding road. We have used runners, horses, carrier pigeons and imaginative installations based on smoke, flags and light signals to communicate. Communication was mostly based on the physical movement of the medium in the form of parchment or paper. The invention of the semaphore lines (1792) and the electronic telegraph (1837) changed this picture. For the first time, messages could be communicated over long distances in real time. It was the content that moved – not the medium or the messenger. The invention of the radio (1895) removed the point-to-point barrier as no wires were required, it could even be used on the move in boats and vehicles. Human kind was in the early stages of exploring an electronically and virtual world.

The mobile ME!

Today the majority of the world's population has access to mobile phones and Internet. Smartphones transform us to mobile communications centers. Almost wherever we are we can download, capture and distribute messages, audio, images and video in real time. We can create live reports from nearly any event. In 2009 photos of the spectacular emergency landing of US Airways Flight 1549 on the Hudson River went global in social media, long before the traditional news media got to the scene. The history of communication entropy

Monitoring social media is a bit like a pressure gauge on an oil well. We need a blowout prevention plan. “

is also the story of challenging existing business models and social structures. Internet guru Cly Shirkey said, “When we change the way we communicate – society changes.” We could add, when society changes – everything changes.

Documenting MY life

Increasingly we document ourselves, our relationships and our networks in a virtual world – reflecting the physical. Our life is documented and shared as we live it. Almost 950 million people, 1/7 of the world population, are active users of Facebook. China has over half a billion Internet users and half of them use social networks. Their favorite is called RenRen. Facebook users typically spend fifteen minutes or more or each day on the site. The average number of “friends” is 121. People share information and thoughts regardless of time zones and geography.

A World of Edutainment

YouTube used to be considered an entertainment channel. Today, it is the second largest search engine, generating 4 billion views per day. Every minute, 60 minutes of new video is uploaded, most of it devoted to training and instruction. In many ways YouTube is the multimedia edition of Wikipedia, created and organized by those who use it. Wikipedia is touted as the world’s largest and most reliable encyclopedia – created by volunteers as a collective project. Twitter outperforms traditional media when it comes to breaking news. It barks out incident reports using 121 characters long before the traditional media know what has happened.

No boundaries

As society becomes more and more digital and virtual, bandwidth has created new opportunities. The availability of information is mind boggling. Some of us may feel that we can no longer see the wood for the trees: that instead of creating a utopia of enlightenment and knowledge, we have entered a digital desert of white noise. Nevertheless, we need to learn to tune in to deal with it and take advantage of the new opportunities unfolding.

The re-wired humans

The bandwidth is here to stay. From now on the most important driving force for change may be the new generation that has grown up with these opportunities. Those born after 1980 do not see the the internet as innovative or exciting, they regard it as basic infrastructure. This new breed of humans think differently and expect openness, transparency and online presence. For them, Facebook and its like are as essential as cell phones and E-mail are to their parents. By 2015 this group will represent the majority of the workforce. This will influence and challenge traditional political systems, markets, and organizational models. We are sticking our heads in the sand if we believe the change only affects their private lives, or consumer business. The wheel has already turned, regardless of what we think about it. It will change us as individuals and our businesses. It will create anxiety and new opportunities. To benefit from the new paradigm requires an active attitude – not passivity. Are you ready? Fasten your seat belts. Welcome to “The Age of Communication Entropy!”

Beyond Broadband

THE END OF BUSINESS AS USUAL

AUTHOR: STEIN ARNE NISTAD **PHOTO:** DARCY PADILLA AND GETTY IMAGES ////////////////////

Brian Solis is an expert on disruptive technology and understanding the processes of change. He argues that recent changes in human information interaction are fundamental and pervasive. It's about new employees, behavior patterns, organizational and business models. His message is simple. Adapt or die!

At breakfast this morning I sat opposite a man from Orlando. He ran a factory producing electrical generators. “Social media is completely irrelevant to our industry! Generators and Facebook – it just doesn't fit!” he told me. I think about him by the fireplace in the lobby of the Queen Anne’s hotel in San Francisco, with my laptop on the table, an anachronism in an interior that is a hundred years old, cocooned in heavy velvet drapes and surrounded by antique furniture. It’s a place where time ticks slowly and sometimes seems to have stopped entirely. But time doesn’t stop. As, Brian Solis, the man I am going to meet, can testify. In his recent book, *The End of Business*

› Changes are evident, powerful even in the most unexpected places.

‹ For the new generation simultaneous multi-platform presence has become the norm.

as Usual, he reveals that, despite his much loved collection of fountain pens, he has put the noble art of handwriting on the shelf and replaced it with finger movements on his smart phone and other tactile gadgets. He claims that the future is electronic, in the boundless flow of online information. They say the pen is mightier than the sword, the Arab Spring showed that social media can topple juntas. The tide of information in modern society is unstoppable. The man from Orlando is doomed to sink if he cannot learn to swim in it.

The guru in the office

Brian Solis is a principal analyst at Altimeter Group, a research based consultancy. Despite their relatively small size, the company is regarded as one of the most authoritative researchers on the modern information landscape. Its directors, Brain Solis and founders Charlene Lee and Jeremiah Owyang, are global keynote speakers and respected authors and consultants in their field. Despite the hype, what I meet in the San Mateo conference suite is a rather nice and very accommodating, open-minded man.

Why should the man from Orlando bother?

Why should our generator manufacturer care? Brian Solis answers with a question. "What is his business all about and where is it trying to go?" Obviously the business purpose is to create something. But in the end it's all about people with different roles and how business objectives align with customer expectations and behavior. We all want to do our job as efficiently as possible and to fill our role. We are acting on information and are making decisions. Over the past twenty years, the Internet has become an important channel, together with traditional means, like fax, telephone, papers and meetings to gain information and make better and faster decisions. We have become more mobile and we use different channels to interact. Social media can obviously be considered as a new – or a bunch of new channels. But that's only a part of it. What is really new is that social media makes it easier to obtain information. The threshold has been reduced. More importantly, it puts the individual at the center. This means that the social media information flows to you from your network. We choose who we want to listen to and get information from. This changes fundamentally how we collect information, and use it in our decision making. We are getting more engaged and transparent.

No business goes free

You might think that this does not affect b2b business producing industrial products like raw oil, robotic arms, airplanes and generators. Solis disagrees, "But it does! When people change the way they interact with information or how they seek information, how they make decisions also changes. This absolutely affects the business. Information and communication are equally important for such businesses – even if the end product is a physical b2b product. The discussion about the importance of social media is very similar to the one we had twenty years ago about the Internet. Why should we have a website when we've brochures, pamphlets and white papers? Now we ask – why should we spend time on social media when we've got a Website?"

A brand new generation of employees

Solis connects the dots for us. The challenge for the majority of business is that they are not in sync with and don't understand the new generation of employees and customers. The younger segments of the population are enforcing the changes in behavior and the rest of us are adapting. Solis is referring to the Millennials or Generation-Y born in the period from the late 70s to the early 2000s. The oldest of them are now in their thirties and building their careers. Today most people are digital – in the sense that we use computers and online services. The Millennials take it much further. They are truly online, getting most of the information, impulses and decision making by using social media and other virtual networks. They act differently and ignore traditional channels. It is estimated that by 2015 more than half of the active workforce in the US will belong to this group. Solis calls them Generation-C to represent *connectedness*.

The connected customer

The connected customer is accustomed to using social media. Its received ideas and information largely provide their foundation for decision making. This is something

In many companies the social media information policy is: use common sense. The problem with common sense is that it is very uncommon.

that we ignore at our peril. It is simply an inevitable consequence of development. At the same time there are still people with traditional behavior patterns. Therefore the traditional channels are not uninteresting or irrelevant. But one should be aware that the development will continue. Five or ten years from now we will not even think that change has happened and we all are transformed to connected customers. However, those who claim that *the connected customer* does not exist or have no influence today are fooling themselves.

The very uncommon, common sense

If Solis is right, it raises a lot of questions. What happens when we stop searching because information is flowing to us? What happens when our social networks are the primary source of information? How is it possible to succeed in a competitive world if everything is common knowledge? And what happens when the employee begins to share business secrets in social media? Solis answers, "It's a common mistake to equate transparency and a kind of total transparency culture. In many companies the social media information policy is: use common sense. The problem with common sense is that it is very uncommon. In social media employees must understand that it's about the company's values, policies and business models. But there will be more openness and transparency. This can be seen as a threat but also as a strategic opportunity to create an advantage."

Thought leadership

"Strategic transparency is about Thought Leadership," explains Solis. Many businesses expose their knowledge to generate competition. Solis points to examples where companies promote their own expertise to get a commercial advantage. He refers to a semiconductor business with a highly educated, research-based staff. They have always espoused thought leadership through presence at conferences, and publications on their own and other relevant websites. And they still do. In addition they have developed a strategy to position themselves in the new channels. They did an analysis of what people Googled in their disciplines and found that the key words were not as important as full sentences and complete questions. Based on this, they established a blog where they simply gave qualified answers to frequently asked questions. As a result they became known in the market as a competence center within their field. This attracted attention both from potential customers, and potential employees including competitors. Brian Solis also offers examples where leading companies have created open innovation processes such as Starbucks, Sephora, and also SAP. They asked the community for ideas to solve very specific problems. This type of behavior changes traditional thinking about transparency and business secrets. "For knowledge-driven businesses, exposing their competence and knowledge by admitting employees to participate in social networks – is a far better strategy than being invisible or closed," says Solis

Your sons and your daughter are beyond your command

A common problem for industry executives is that they are either unable, not competent or unwilling to understand what actually is happening. Many of them are not using social media themselves nor net-based

BRIAN SOLIS

Brian Solis is an American industry analyst and principal at Altimeter Group. He entered the public relations field in 1991, working for Dodge and Mansfield and later the Benjamin Group, in Silicon Valley.

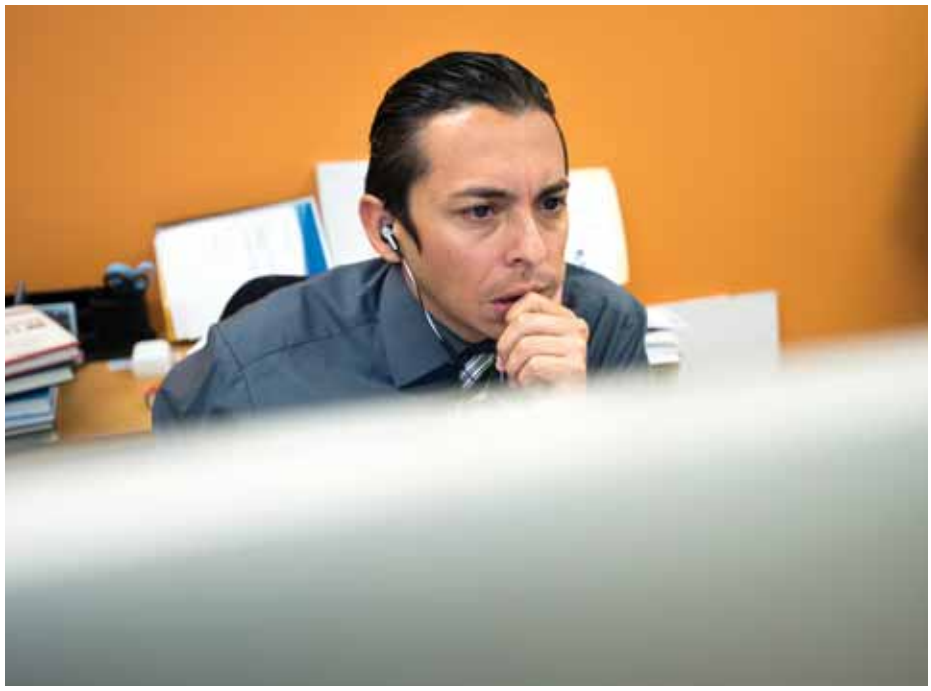
In the 1990s, Solis began to engage with message boards, communities and early blogs. He founded FutureWorks in 1999, focusing on new media marketing, branding, and business strategy. In March 2011, Solis joined Altimeter Group which specializes in new media strategies and frameworks to connect companies and customers, employees, and other stakeholders.

Brian Solis has led interactive and social programs for a number of Fortune 500 companies including Oracle, Cisco and Microsoft, notable celebrities such as Oprah Winfrey, Ashton Kutcher, Billy Corgan, and Katie Couric, and various Web 2.0 startups.

Publications:

- ***The End of Business As Usual:*** Rewire the Way You Work to Succeed in the Consumer Revolution (2011).
- ***Engage:*** The Complete Guide for Brands and Businesses to Build, Cultivate, and Measure Success in the New Web (2010).

Source: Wikipedia



‹ Solis scans the landscape for change and opportunities in the new information age.

solutions. They may be working in fairly traditional organizations based on traditional and stable business models. For people who may not even read their own e-mail, social media is both alien and threatening. But at some point they will face a moment of truth. Sooner or later they will understand that what is happening affects and changes the business. Employees change, community, framework and business models change. Hopefully the realization of the moment of truth will not come to late...

No company is too big to go bankrupt!

"If we look at the Fortune 500 companies today, there are almost none that existed when the stock exchange was established," Solis continues. "Companies are transformed, changed, acquired and go bankrupt. Still the fact is, that most of us got where we are today by being good at what we do. Therefore we stick to the business models we know." We know exactly what works, how the marketplace reacts and how we should react to produce results and growth. And it could work well for years to come. But like a frog that is being heated in a pan of water, the change is incremental. What happens when it's too late to jump – when the majority of our workforce and customers are operating on a completely different model to ours? This will create an entirely new paradigm. Solis refers to a new business model from the consumer industry, Tomes Shoes. The brilliant business model is simple. For every pair of shoes a customer buys – another pair is given away to a child who needs them. The combination of social responsibility challenges the traditional business model. "My point is," says Solis "that the new models will be new, different and based on something we even might not be able to imagine before they pop up."

Change of conditions!

"For the oil and energy industry the changes are much deeper and more major," claims Solis. "Social and political changes in society can alter the entire system. We have already seen examples of this. Obama hit a nerve with his social media driven 2008 campaign The Arab Spring is a powerful example of how fast things can change in this medium. This is just the beginning," says Solis. The world becomes more transparent and individuals can increasingly influence and threaten existing truths, myths and systems. Decisions that used to stay behind closed doors will increasingly be exposed. In many ways this is a democratic process taking place simultaneously over the whole world. Individuals and groups are getting a voice that cannot be neglected or censured. "Over time it will change rules, regulations and even political systems. So it's all about being engaged to understand how to adapt and develop organizational and business models. Adapt or die," says Solis.

The pen of the past

The interview is over, and because I know of his devotion to the art of writing, I hand over a gift from Spencer Stationary. I have bought Solis a beautiful old-fashioned book with handmade paper with torn edges. It is a book with blank pages and a soul. I hand it over. "You have to write in this book," I say. "You cannot let your pens suffer unused!" Solis is excited about the book, and answers, "After I wrote my book I have tried to pick up writing by hand again. The problem is that the tip of a fountain pen adapts to the handwriting of the writer. I had lost the habit. I had changed too much. The tip was adapted to a former me, one that no longer exists. The change happened gradually – but at some point the tip of the pen was no longer adapted to me. It's the same with all change. Businesses cannot afford to sit on the fence waiting – and let things just happen. Suddenly the business model will not be adapted to the market and the customers." When the tip of the pen no longer works. That's the end of business as usual!

Beyond Broadband

OUT OF THE BLUE

Crisis communication in a transparent world

AUTHOR: STEIN ARNE NISTAD **PHOTOS:** AP IMAGES

The speed and transparency of digital media challenge traditional crisis management and communication models. The message might easily be as uncontrollable as a blowout, claims Gerald Baron.

Baron has spent 30 years analyzing crisis communication. His case study, "Unending Flow" is a post mortem on the information flow during the Deepwater Horizon incident.

My interview with Gerald Baron is on Skype, a virtual space shared by individuals thousands of miles apart. Again I am reminded that although time zones are still a challenge, today we communicate virtually anywhere, anytime. Facebook and Google abide grudgingly by local legislation, but there are no boundaries – and few controls in the digital channels. Cyberspace is like a giant digital organism – like an ant colony, where swarm intelligence focuses the group on survival and threats. When Deepwater Horizon exploded, sank and created one of history's worst oil disasters, the swarm engaged! The companies at the center of the maelstrom were faced with a dual challenge – how to stop the spill and how to handle the communication in a transparent, digital world.

When the crisis strikes
Preparedness when disaster struck was very good, says Gerald Baron. Both BP and the U.S. Coast Guard used a common system called PIER. Baron was involved in the development and deployment of the system. PIER allows anyone dealing with crisis communication to interact through a common platform regardless of geographic location. The PIER model also contains methodological requirements and assumptions, like establishing a dedicated crisis communication website and managing social media in the early stages of an incident. The U.S. Coast Guard has a strategic focus on social media. When the crisis occurred, they immediately flew in a team of trained and experienced staff members from Washington. After a few hours, the communication squad was established and teams from the Coast Guard and BP were able to communicate using PIER.

The spokesman just died…
In such crises all media channels work together and have to be handled simultaneously, explains Baron. Traditional channels remain important. However, this crisis showed that digital media played a far more important role than it used to. This resulted in a large number dialogs and created a new type of transparency and flow of information. In the old days, a spokesperson would periodically give public statements about all aspects of the incident. In today's transparent world, multiple dialogs render this virtually impossible. It's also not appropriate. A host of people have information they can share. Both the press and the social networks are aware of this. In the Gulf, BP and the Coast Guard were the first to be involved. Even though they created a shared communications center, they couldn't manage the information flow in the old fashioned way, through a spokesman and press releases.

A transparent crisis!
The bottom line, according to Gerald Baron, is that the world has become more transparent. Information is there to be shared. The important thing is to focus on facts – not rumors and speculations. In the digital world, the speed is overwhelming. An issue can scale very fast locally, nationally and globally. This gives activists and influencers new tools and possibilities. Including the option to publish information that is biased or false. One key experience however, is if it's large enough a virtual group will tend to correct or neglect false information. They want accurate and reliable information. This is why Wikipedia works. The quality level of information in Wikipedia is surprisingly high, even though it is created collectively. It works because enough people have a genuine interest in reliable and true information. Thus saboteurs are neutralized and misinformation is corrected.

You can't take it back!
One challenge with digital communication is that once it has spread, information cannot be taken back. Gerald Baron gives an example. A few weeks ago, a highly critical European research report was published on genetically modified food. News based

GERALD BARON

Gerald Baron is the founder (2000) and CEO of PIER Systems, the provider of a crisis information management product designed to streamline communications during major disasters.

PIER Systems is used by major oil and energy companies such as BP, Shell and Marathon Oil Corporation; and U.S. government organizations such as the U.S. Coast Guard, USDA, American Red Cross; and many businesses.

In 1999 Baron was inspired to build PIER after completing a project for Equilon Enterprises (a joint venture between Texaco and Shell). Equilon was managing the Olympic pipeline which burst pouring vast amounts of gasoline into Whatcom Creek in Washington state. The gas created a massive forest fire and killed 3 people.

Crisis communication record:
Hurricane Katrina (2005)
Californian wildfires (2008)
Hurricane Ike (2008)
Deepwater Horizon (2010)

He is the author of "Now Is Too Late2: Survival in an Era of Instant News." He blogs at **crisisblogger.com** and **emergencymgmt.com.**

Photo: Gabriel Rodriguez

A case can develop and scale massively and fast. You have to engage and try to kill the story with facts – that is your only chance to stop it before it spreads. "

on the report spread swiftly in both traditional and digital media. It grabbed a lot of headlines and attention. In retrospect, it turned out that the report was not reliable. The results were, to a high degree, not based on scientific methods. However, the damage was already done. The story apparently came from a reliable source, and both media and normal people accepted it. Hence it was almost impossible to deny or correct the information. Generally speaking, it is extremely important to monitor what is happening in the digital media that can affect your business, says Baron. Speed is the key. A case can develop and scale massively and fast. It is absolutely necessary to act aggressively. You have to engage and try to kill the story with facts – that is your only chance to stop it before it spreads.

Journalists all over the place!

Today anyone with an internet connection or a smartphone is a potential journalist or reporter, says Baron. Very large digital and social networks communicate messages, pictures and even video from and to people everywhere on a 24/7 basis. There's always someone in the right place at the right time, who is interested in spreading information. This is especially true if the information is about something that cannot withstand scrutiny – or is of public interest. He points to an example from Macondo. The authorities demanded that subsea video cameras should be mounted on the seabed, close to the well. Thus, the flow of oil could be observed live on the internet. In the early stages BP tried to stop the spill by mounting a cap on the well. At first the flow was reduced, but the cap failed, so the flow of oil raised again. This was observed by an individual over the internet. This person immediately reported it to the media – which started to question the communication staff at BP. The transparency meant the general public was able to observe and report what was happening, even before the people at BP knew! My advice to my clients, says Gerald Baron is that if a product, routine or other conditions cannot withstand public attention – it should be changed. Sooner or later the truth is going to get out – and a communication and brand problem may occur. In the food industry, they have defined a new quality goal and term, called "socially acceptable food". The product itself and the process of producing it should be transparent and withstand scrutiny in social and traditional media by the general public. The same goes for the oil and gas industry. At some point people may require socially acceptable energy.

New opportunities

Digital communication and social media also provide new opportunities. No other medium is so well suited to communicate with a specific audience. The oil industry should take advantage of this opportunity, says Baron. It requires a proactive engagement and strategy. It's really too late to start communicating when a crisis or incident occurs. The dialog with stakeholders must be established under normal operation and circumstances. The oil industry needs to adopt social media to create that dialogue with its audiences. In return they'll get engagement, valuable information and if they can build trust, then they'll get a kind of loyalty. This might be extremely valuable when a crisis occurs. BP learned this the "hard way". In my opinion, Baron continues, BP was not sufficiently experienced in handling social media and digital communication. That's why they didn't do it very well in the early stages of the incident. They had a steep learning curve,

DEEPWATER HORIZON

Ultra-deepwater oil drilling rig

Deepwater Horizon was an ultra-deepwater, dynamically positioned, semi-submersible offshore oil drilling rig owned by Transocean, and leased to BP from 2001 until September 2013.

On 20 April 2010, while drilling at the Macondo Prospect in the Gulf of Mexico, an explosion on the rig caused by a blowout killed 11 crewmen and ignited a fireball visible from 56 km away. The resulting fire could not be extinguished and, on 22 April 2010, Deepwater Horizon sank, leaving the well gushing at the seabed and causing the largest offshore oil spill in U.S. history. The total cost of the incident to BP has been estimated at $38Bn.

> In major crises.., it is easy to underestimate the political impact and the political motives. “

but they picked up the necessary skills fast, says Baron.

Political reinforcement of crisis!
In major crises like the one in the Gulf, it is easy to underestimate the political impact and the political motives, says Baron. Initially, communication came from the Coast Guard and BP – politicians pointed to the oil company and actually reinforced the crisis. However, at one point, the situation grew to such proportions and was so politically sensitive that the White House and the president had to engage and take responsibility. They took over and handled communications directly. This in turn led to a sudden change in the communication approach. Increasingly the information was angled to reduce the political effect of the predicament and target political goals. The flow in social media changed from dialogue to a more traditional publication approach, says Baron. At some point, BP realized that it could not continue like that. Therefore they established parallel, dialog-based channels in digital media. It was a necessary and prudent step according to Baron. In the early stages of the crisis, BP appeared quite inexperienced and passive in social media, but they ended up more open and assertive. They made it through, says Baron. He refers to a comment from March, 2011 in the Financial Times, “BP got many things disastrously wrong in the Gulf of Mexico last year, but one thing it managed well was its online response.”

About lipstick and pigs
I’ve heard people argue that Deepwater Horizon was a crisis communications disaster. I totally disagree, says Baron. The crisis was at such a level, that no matter how it was handled it would inflict great harm to any company. The accident itself was the crisis – not the communication. Of course, they made mistakes and BP could certainly have done better – but in the end this was of

FTSE 100 SOCIAL MEDIA INDEX

RANK	COMPANY	SECTOR
1	Carnival	Travel & Leisure
2	Burberry Group	Retail
3	BP	Oil & Gas
4	Marks & Spencer	Retail
5	ARM Holdings	Technology, Media, Telecom
6	Royal Dutch Shell	Oil & Gas
7	Reckitt Benckiser	Consumer Goods
8	Aviva	Insurance
9	Unilever	Consumer Goods
10	InterContinental Hotels Group*	Travel & Leisure

BP was recently ranked 3rd overall in a survey of social media performance among FTSE 100 companies for blogging, Facebook, Twitter and YouTube. Seven oil and gas sector companies were included: BP, Shell, Tullow Oil, Essner Energy, AMEC, Petrofac and Cairn Energy.

It used to be best practice not to comment on business related issues in the media before you were asked to. Today, the opposite is a better approach.

marginal significance says Baron. Whatever plans and precautions you have in place, any player who gets into a situation like this is going to incur huge problems. Sometimes it is about putting lipstick on a pig. In this case, all the lipstick in the world could not help. The pig was simply too big to handle. However, in my opinion one lesson learnt is that BP did not communicate aggressively enough at the beginning of the crisis, continues Baron. The hypothesis was that there was no point in propaganda before the spill was stopped. Although they were in a difficult situation, BP should still have pushed forward with a true and accurate picture of the situation. Some of the rumors, untruths and speculations that spread might have been avoided, or reduced, by a more proactive attitude – not least in the digital channels, maintains Baron.

New rules

Baron believes there are some important communication lessons we can learn from the incident at Macondo. The first is about monitoring the digital information world. We need to see the warning signs, before untruths or biased messages start to spread. Secondly, social media should be included and valued in our regular communication, not just when disaster strikes. We need to understand how these channels work and gain knowledge and experience from initiating and sustaining dialog with audiences relevant for our business. This will create a new form of loyalty and openness that can be invaluable when an emergency arises. Moreover, such groups could be exploited as sources of experiences and ideas for problem solving. This might help to change the situation and by that avoid negative publicity in digital and traditional media.

Get a grip!

I also strongly recommend, expounds Baron, that companies are aggressive in maintaining and communicating truths and facts. It used to be best practice not to comment on business related issues in the media before you were asked to. Today, the opposite is a better approach, especially in digital channels. If something is false or inadequately communicated, you must comment, diligently and energetically, to correct and promote the true facts. The key words are "correct" and "true". Untruths and half-truths will be revealed. The information and your reputation must be trustworthy. Finally, there is the management of destructive forces. There are people and organizations who, for various reasons, want to hurt your business. I can't see any reason to let them spread their message. Companies need to go on the offensive to meet that kind of initiative, says Baron, use facts to build a correct and nuanced picture.

The swarm never sleeps

Thank you for sharing, Mr. Baron. I'm sure our readers will appreciate your views and opinions. I press the disconnect button and he's gone. But I can see that he is still on-line on Skype. It's around midnight in Europe and time to call it a day. I just have to check Twitter, Facebook and a few other channels first, to check what's going on in my networks and the rest of the world. But the swarm, the global pulsating digital brain, never sleeps. At some point it might focus its attention on me… or you.

Stein Arne Nistad the author of *The age of You! A rough guide to social networks and the connected society.*

THE END OF BUSINESS AS USUAL

WHAT ON EARTH?

Since the dawn of time, humanity has struggled to understand the world and has not always liked the answers. New realities can be pretty shocking. Broadband is one of those.

For most of the world the term refers to data transfer and how limitless access has changed human interaction patterns. For geophysicists, it has another meaning. But before we get too carried away by how access to technology is changing our view of the world, let's get a bit of perspective. The end of business as usual? Try a few of these for size!

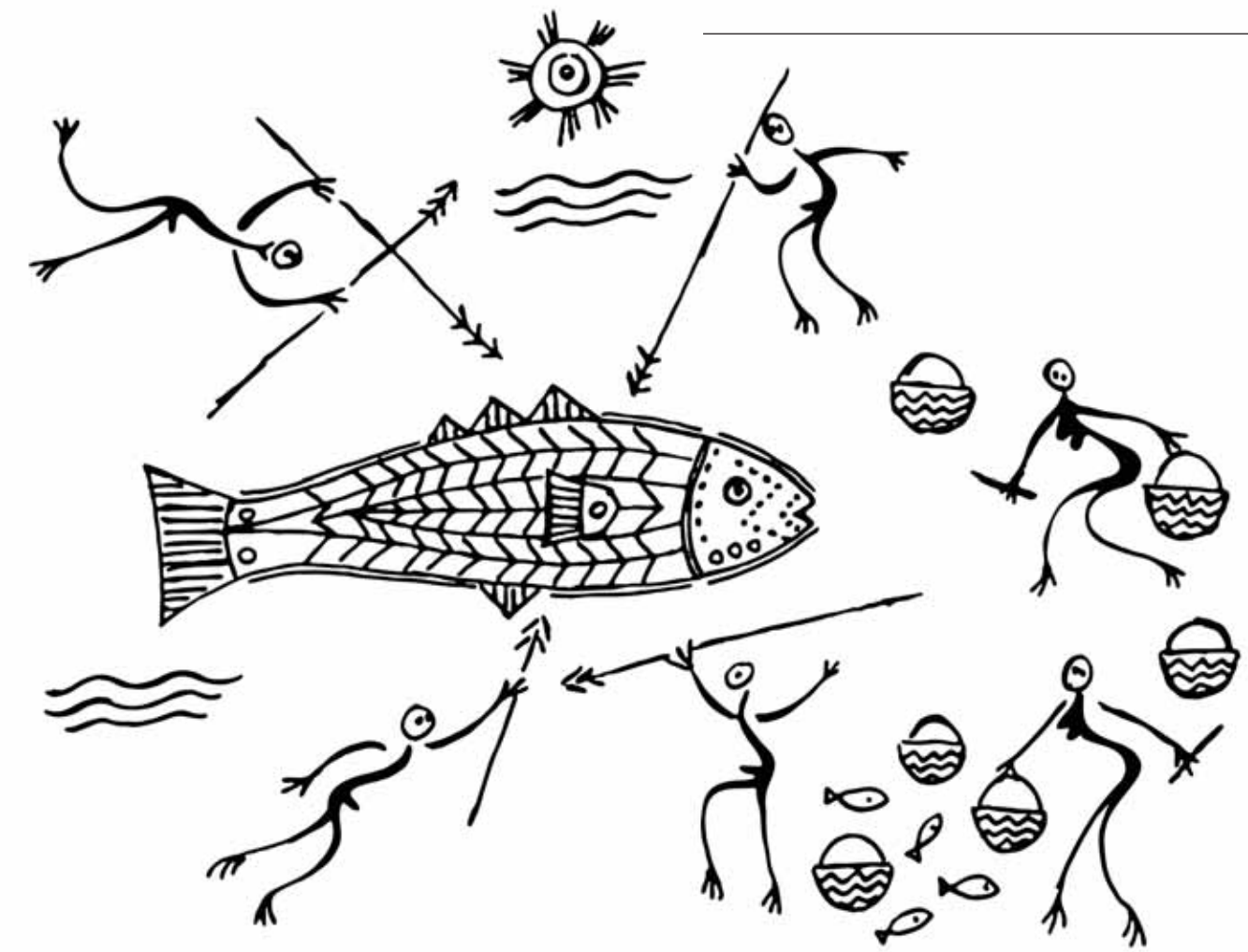


PHOTO: ISTOCKPHOTO

OVER THE HORIZON

From around 600 BC the Greeks hypothesized that the Earth was not flat but spherical. Aristotle added new observational and physical evidence when he observed that the shadow cast by the Earth during a lunar eclipse was round, and the visible stars in the night sky varied in different hemispheres. Over several centuries, the idea spread becoming the dominant paradigm in the Middle East, Asia and eventually Europe. Around 1000 AD Abu Rayhan Al-Biruni used trigonometry to accurately calculate the Earth's circumference. Eventually, around 1520 Ferdinand Magellan tested the theory out in practice. Then European mathematicians Copernicus, Keppler and Galileo began to question the Earth's relationship to the sun. PHOTO: ISTOCKPHOTO

BUSINESS AS USUAL?

Status quo Here we go!

TIME AFTER TIME

Few discussions in geology can occur without reference to geological time. Long before geologists had methods to measure the age of rocks, people pondered over petrified remains of bones, shells and leaves found in layers in the earth. As a result, geological time takes two forms, relative age relationships for subdivisions of the strata of the Earth which are recognized by the existence of fossils, and absolute time measured in millions of years, obtained by radioactive dating or some similar method. The system of relative relationships began to evolve in Asia and the Middle East in the 11th and 12th centuries and in Europe in the 1700s. The timescale most commonly used today has existed with a few refinements since the 1930s. PHOTO: USGS

BUSINESS AS USUAL?

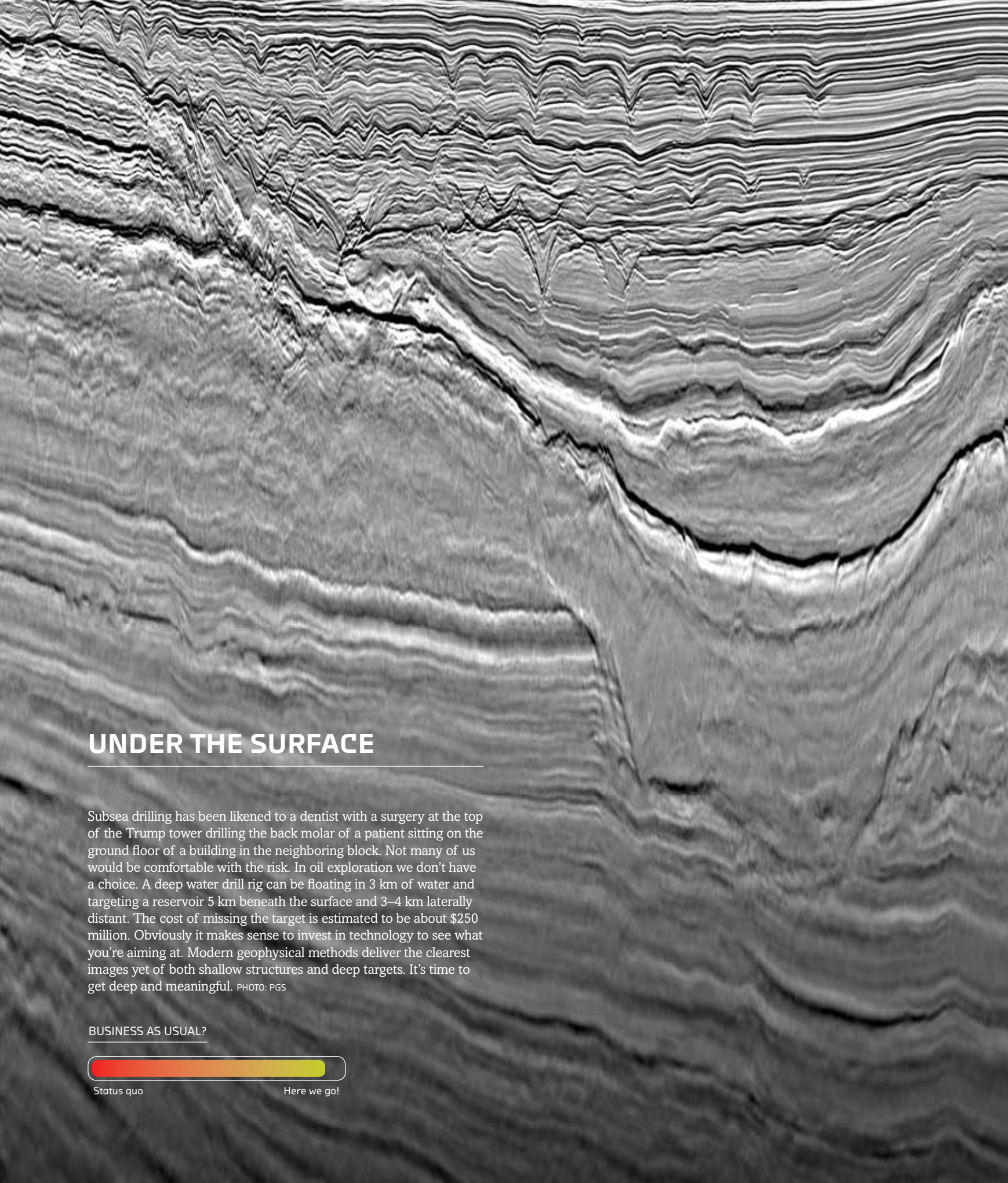
Status quo Here we go!

ON THE MOVE

Magellan had noticed that the coastlines of Africa and South America fitted together like a puzzle, but it was not until 1912 that Alfred Wegener proposed his theory of continental drift. Though fossil finds supported the idea, Wegener couldn't explain why it happened. Convection currents in the liquid mantle were not enough. Further evidence appeared in the 1950s from examinations of the Earth's magnetic field. These indicated that either the North Pole moved over time, or the continental plates did. In the 1960s geophysical studies revealed new information about seafloor spreading, balanced by plate subduction at the continental margins. The final pieces of the puzzle fell into place and the theory of plate tectonics slotted into the lexicon of accepted truths. PHOTO: ISTOCKPHOTO

BUSINESS AS USUAL?

Status quo — Here we go!



UNDER THE SURFACE

Subsea drilling has been likened to a dentist with a surgery at the top of the Trump tower drilling the back molar of a patient sitting on the ground floor of a building in the neighboring block. Not many of us would be comfortable with the risk. In oil exploration we don't have a choice. A deep water drill rig can be floating in 3 km of water and targeting a reservoir 5 km beneath the surface and 3–4 km laterally distant. The cost of missing the target is estimated to be about $250 million. Obviously it makes sense to invest in technology to see what you're aiming at. Modern geophysical methods deliver the clearest images yet of both shallow structures and deep targets. It's time to get deep and meaningful. PHOTO: PGS

BUSINESS AS USUAL?

Status quo — Here we go!

What comes next

AFTER BROADBAND

AUTHOR: CYRILLE REISER, RESERVOIR CHARACTERISATION DIRECTOR, PGS **IMAGES:** PGS

Lately, the marine seismic industry has seen a big shift in application of broadband seismic data acquisition techniques. Common to all methods is an approach to increase the frequency bandwidth of acquired data in comparison to data. The goal should be to extract more from the earth than mere frequencies.

Narrow band on the run

The most obvious benefits of broadband techniques relate to the increase in resolution on offer from the wider bandwidth, in addition to improved penetration due to signals richer in lower frequencies. Currently, around 30% of all tenders for new data acquisition specify broadband, and this number is increasing continually. The arguments for broadband are so compelling that there is good reason to believe that all new acquisition will be broadband before too long. The GeoStreamer image from offshore Namibia on the previous page clearly illustrates the improved resolution available from broadband techniques and more particularly from ghost free (source and receiver ghosts) seismic data. It also amply demonstrates the improvement in interpretability.

Aside from pure imaging, this technology has other applications, which though less publicized have significant potential. Broadband data has a huge impact on the outcome of geo-scientific analysis in the E&P environment. The benefits are significant, as the case studies presented in this article highlight.

Bandwidth helps where it Hertz most

Deriving physical rock properties from seismic data offers great value to geoscientists. After all, it is rocks that we drill, not acoustic signals. The most common technique to derive rock or elastic properties from seismic data is generically known as Seismic Inversion. A fundamental fallibility of all inversion methods is that a particular seismic data set can lead to a number of conversion results. With narrow band seismic data there is a lack of information, so the geoscientists tend to constrain the number of possible solutions to reach the most reliable. Normally, they do this by inputting known or "a priori" information into the model, usually nearby well data or other geological values. As a consequence, the uncertainty of the results away from these constrains increases. Using dual-sensor seismic data, with its greater frequency content, substantially reduces the amount and potential bias of a priori data input. It thereby makes the inversion solution less dependent on what we already believe, and increases its usefulness in areas where a priori information may be scarce or uncertain.

The following case studies demonstrate how the use of broadband seismic fundamentally helps delineation of prospects, describes the internal structure of reservoirs, quantifies key reservoir properties such as porosity, and increases the probability of separating lithology-fluid facies.

Stretching ambitions: Elastic properties

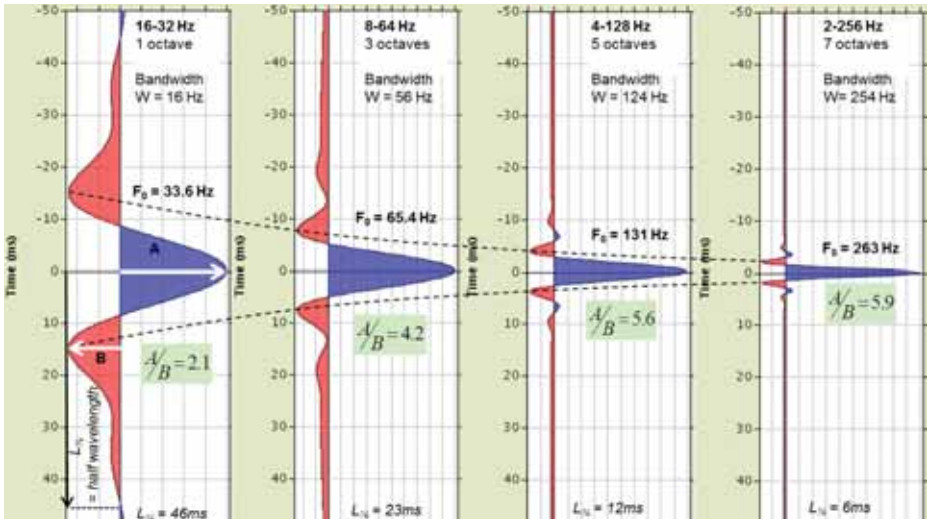
CASE STUDY 1 – North Sea

Dual-sensor acquisition and processing was recently performed over a 3D area in the North Viking Graben in the vicinity of the Heimdal and Frigg fields ***(Figure 2)***.

The results of a pre-stack relative seismic inversion workflow conducted on the Heimdal area are presented in ***Figure 3***. The pre-stack relative inversion was initially performed without a low frequency model derived from the combination of the seismic velocity and the well information which is traditionally performed in the industry. Instead, first the seismic velocity information used for the flatness of the PSTM gathers (the RNMO velocity field) has been converted to interval velocity using the Dix equation. Then, this interval velocity was multiplied by an average Tertiary density of 2,35 g.cm3 to provide an approximate transform of relative acoustic impedance to "absolute" impedance that produces a low frequency model derived solely from the seismic data.

This seismically-derived, low frequency model was then added to the relative elastic attributes extracted from the seismic to transform to "absolute" attributes. Using this workflow an "absolute" seismic inversion result has been estimated without using well information as calibration points for the velocity model. Using this approach the resulting "absolute" impedance volume is derived solely from seismic information.

1. Seismic wavelet at various bandwidths



A broader bandwidth gives a much shorter wavelet with small side lobes

Figure 3 illustrates the result of this "absolute" acoustic impedance. This is compared at the well location to the same attribute measured from the well log data which has been filtered to seismic bandwidth. The trace of the acoustic impedance from the seismic inversion closely matches the (filtered) acoustic impedance log at the well location.

This analysis demonstrates that, with good processing, the broadband seismic delivered by dual-sensor, towed streamer systems can be used directly to derive elastic attributes that are remarkably close to the calibrated ground truth. This approach works, thanks to the very rich coverage of the low end of the seismic frequency bandwidth, which minimizes the low frequency gap and the need for extra information. Even the minimal residual gap at the ultra-low end can be adequately filled by using the velocity information contained in the broadband seismic (which is also more accurate and more reliable).

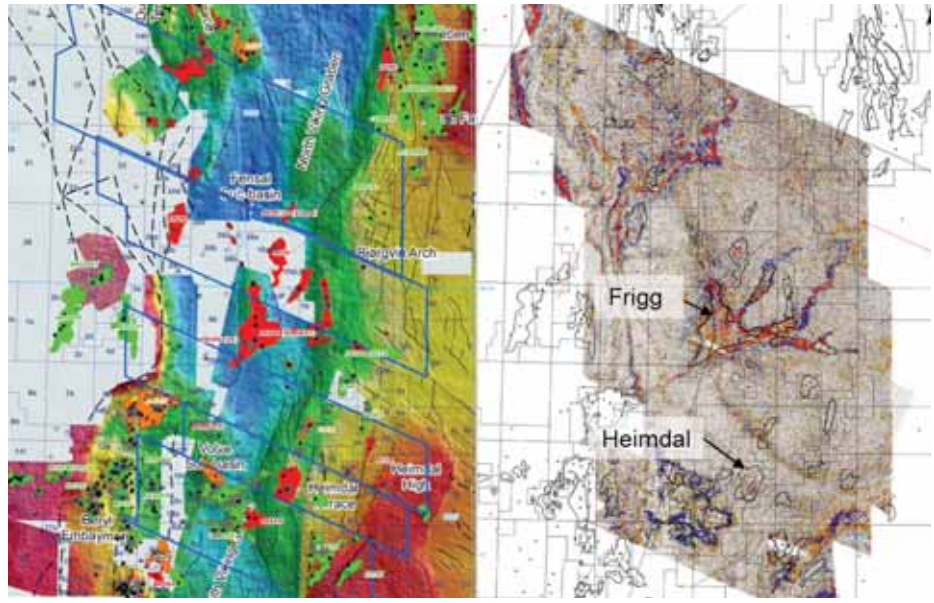
This example demonstrates the potential to use pre-stack inversion of broadband seismic data to evaluate the acoustic/elastic impedance response away from well control with a relatively high degree of confidence, as there is no reliance on a priori information from sparsely-spaced well data, which could bias the inversion analysis. This approach using dual-sensor data can be expected to yield useful results even when no well information is available in an area.

Case Study 2 – Australia

The next case study from the Browse Basin in Australia illustrates the benefits of using relative inversion derived from broadband seismic. This time the focus is on better imaging of the fluid contact.

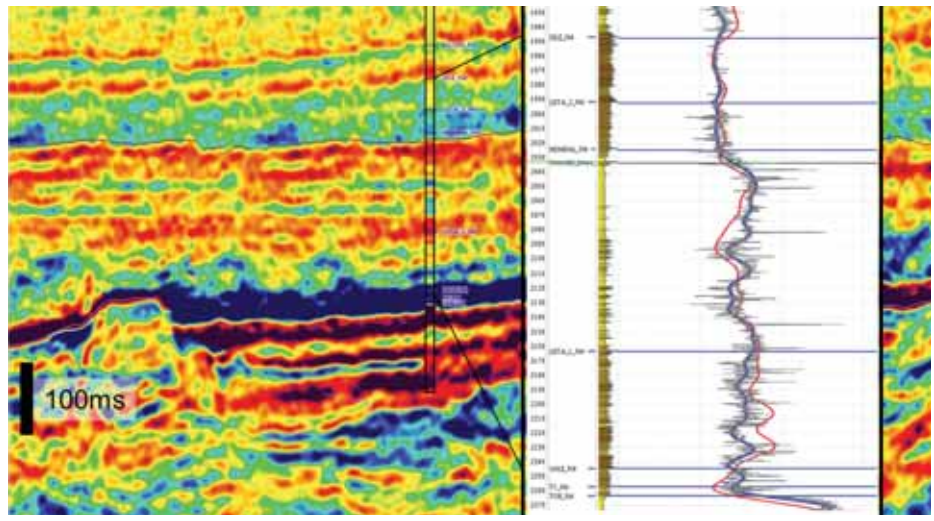
The seismic line is located in a known gas

2. North Viking Graben imaged with dual sensor seismic



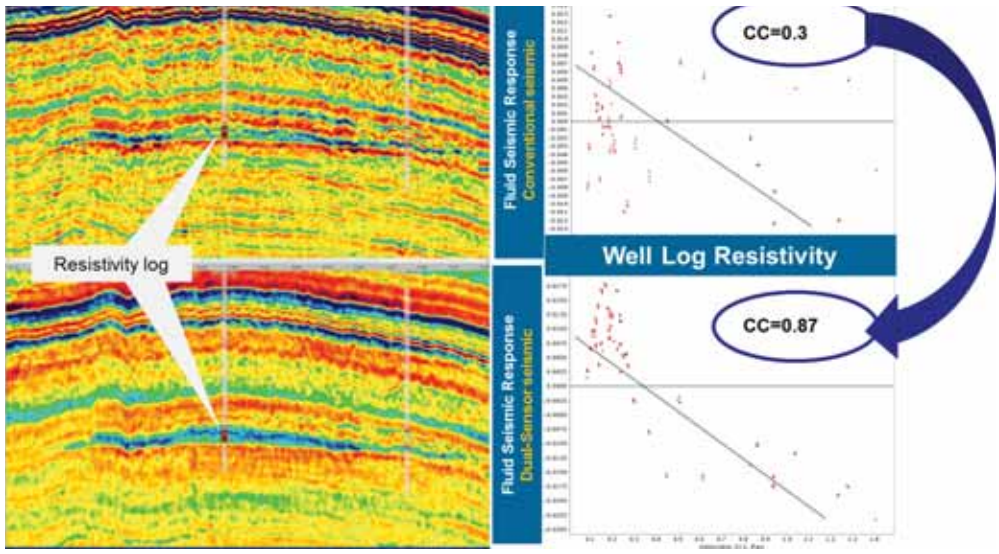
Map and timeslice views of the North Viking Graben using dual sensor seismic

3. Acoustic impedance and well log



Inversion for acoustic impedance from dual sensor seismic alone gives an excellent match to well log data.

4. Fluid angle response



Dual sensor data reveals greater resolution of gas sands in an AVA rotation section and higher correlation coefficient (CC).

province of the North West Shelf of Australia. The stratigraphic sequence comprises Permo-Triassic sediments overlain by Jurassic to Cenozoic syn- and post-rift successions (Longley et al., 2003). In the same acquisition program 2D seismic data was acquired along this line location with modern conventional streamer configuration and with dual-sensor streamer technology.

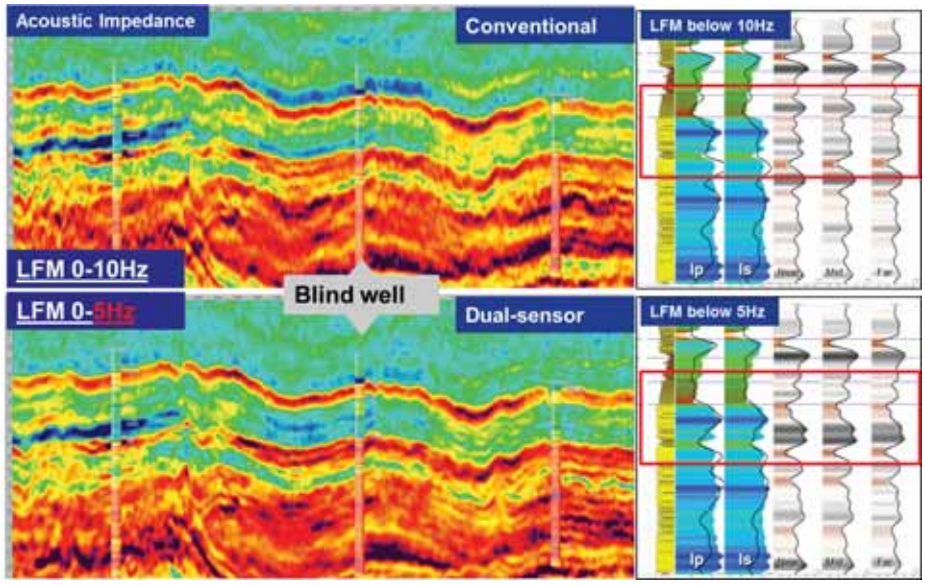
The results of a relative pre-stack inversion workflow performed on these two datasets are presented in ***Figures 4*** and ***5***. The workflow used in this case follows the method described by Thompson, 2011. This workflow is equivalent to the EEI (Extended Elastic Impedance) methodology developed by Whitcombe (2002). In this approach, the rotation is performed in the angle stacks domain. This is a statistically independent space, with higher signal-to-noise ratio and the rotation angle can be related directly to rock physics analysis.

In this case, the rotation angle is performed in the inverted space (relative pre-stack inversion of the near and far stacks). The rotation between the angle stacks was performed to maximize the gas response as this is the main hydrocarbon fluid present in this data.

The Fluid Angle results for conventional and dual-sensor datasets are shown in ***Figure 4***. Compared to the conventional seismic data ***(top)*** the AVA rotation section for the dual-sensor streamer seismic data ***(bottom)*** shows clearer definition of geological units with improved resolution of the geometry and extent of the gas sands interval and a sharper gas-water contact.

For a semi-quantitative assessment of the improvement, the AVA stack rotation response at the optimized fluid angle of -320 was extracted along the borehole and compared to the resistivity log. The cross-plots ***(right side)*** show a marked improvement of correlation (0.87 as opposed to 0.3), as measured by the correlation coefficient (CC) between the rotated angle stack response using dual-sensor streamer

5. Acoustic Impedance and well data



Dual-sensor data gives improved estimates of elastic attributes at the blind well, despite using substantially less information from the well compared to conventional data.

Dual-sensor, towed streamer systems can be used directly to derive elastic attributes that are remarkably close to the calibrated ground truth.

compared to the conventional seismic. This indicates numerically that the broadband seismic data estimates gross fluid volume substantially more accurately than conventional seismic data.

A question of character: Case Study 1 – North Sea

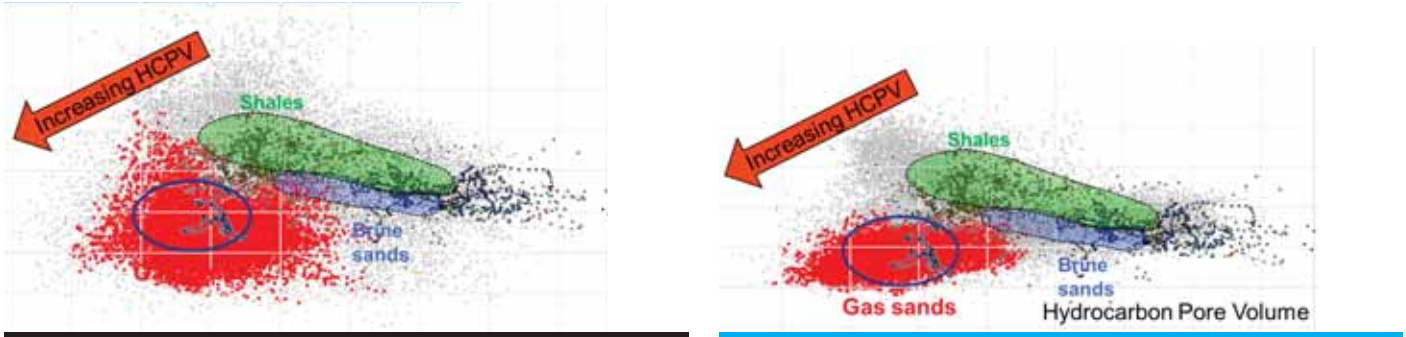
This study, based on a 3D seismic dataset over the Heimdal field in the North Sea, examines further the advantage for quantitative reservoir characterization from the broadband nature of dual-sensor data.

The objective of this study was to investigate the impact on elastic properties prediction away from the well control, and the importance of a low frequency model below seismic bandwidth. Two cases were analyzed and compared. In both, the low frequency model was built using well log information and seismic NMO velocity information to fill the gap in frequency spectrum below seismic bandwidth. Pre-stack simultaneous inversion was performed with the same parameters for both datasets. The only difference between the two studies is the amount of low frequency model information that needed to be "injected" into the inversion process. The first case represents a typical scenario with conventional seismic bandwidth. With a realistic seismic bandwidth at the reservoir level of 10-30Hz, the inversion has to rely on a low frequency model up to 10Hz to fill the frequency gap below seismic bandwidth, based on information from sparse well locations.

In the second case dual-sensor streamer broadband seismic data provided an additional octave of low frequencies and therefore a narrower low frequency model was required, from 0 to 5Hz (many dual-sensor datasets show useful signal down to as low as 3 Hz). This frequency gain of an octave on the low side is equivalent to a gain in the high frequency from 25Hz to 50Hz.

Figure 5 illustrates the results over the Heimdal field area of the pre-stack inversion

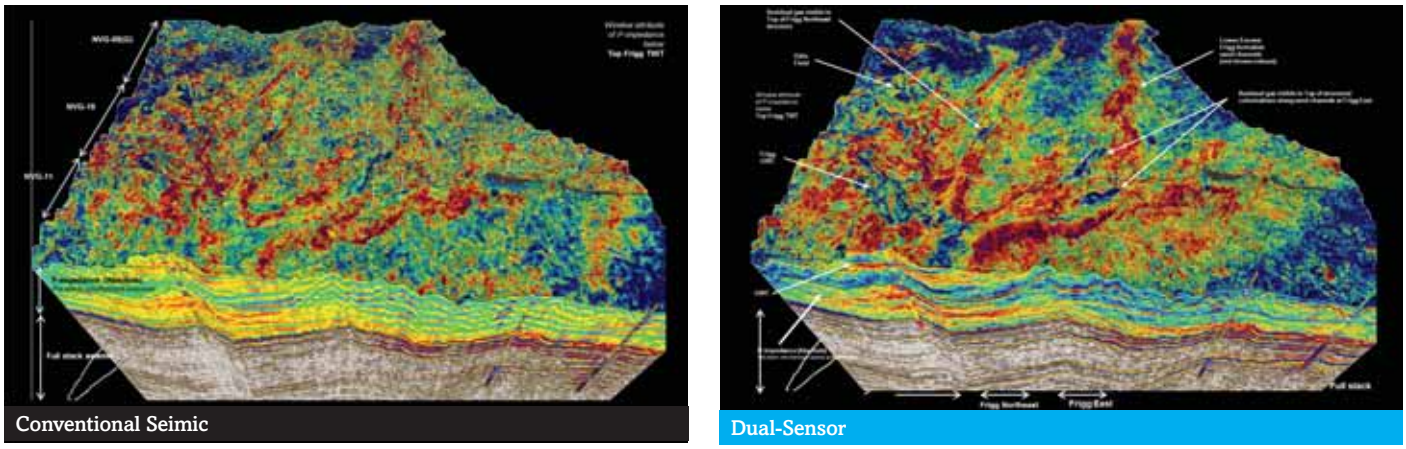
6. Cross plot of acoustic impedance versus Vp/Vs ratio



Conventional Seimic | Dual-Sensor

Cross plot of acoustic impedance versus Vp/Vs ratio using dual sensor data gives a much better match to well data.

7. Acoustic impedance inversion



Conventional Seimic | Dual-Sensor

Acoustic impedance inversion from dual sensor data gives substantially improved delineation of geological features compared to conventional data.

using the two seismic datasets. In this example, the low frequency model and inversion were performed using the two outer wells as input control points and the results evaluated against the central 'blind' well. The outer two control wells are more than 20 km apart. By looking at the match between the inversion results at the 'blind' well and the actual well values, the match of the pre-stack inversion can be evaluated in section view and in a well tie view ***(right side)***.
It can be seen that the elastic attributes estimated at the blind well are improved with the inversion results from the dual-

Dual-sensor data can be expected to yield useful results even when no well information is available in an area.

sensor broadband data, relying more on seismic input and using only 0-5Hz of low frequency model. The conventional seismic, supplemented with 0-10Hz of low frequency information derived from well data shows a poorer match to the blind well in section and log view. The conventional data shows a discernible degradation in vertical resolution of the seismic data or inversion result. The dual-sensor data does not.

This case study demonstrates that the ability to predict the reservoir properties away from calibration wells is improved by the extended low frequency bandwidth offered by the dual-sensor streamer. This closer match with ground truth should increase confidence in the results of this type of pre-stack inversion of broadband seismic data away from well control, and offer added value for well placement.

Careful processing and pre-conditioning is important, especially of the pre-stack seismic data. The cases underscore the pressing need for accuracy of these data, particularly in terms of signal to noise ratio, amplitude linearity, flatness of the gathers, multiple suppression and preservation of frequency content across the offsets.

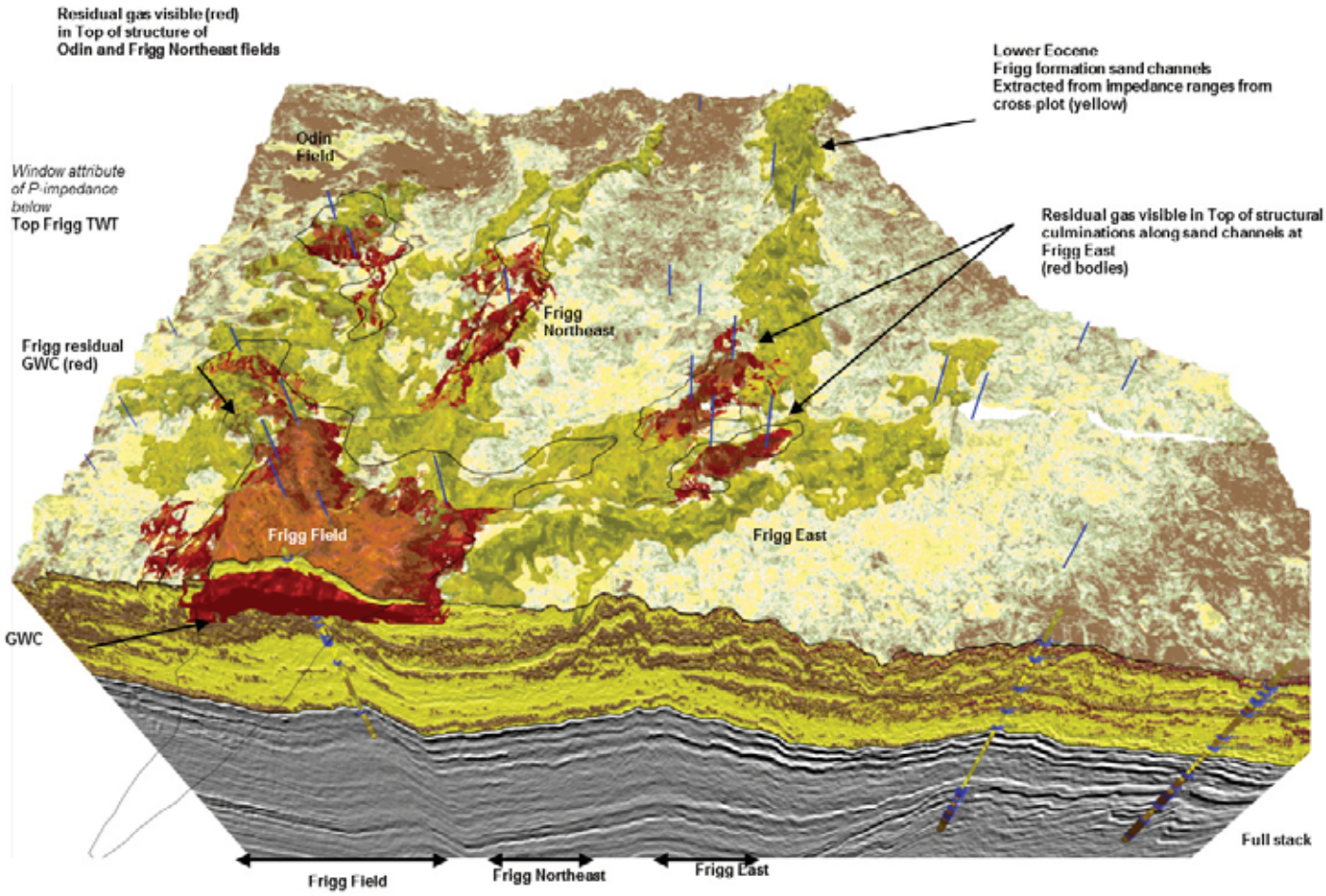
Born to run: lithology-fluid prediction

Case Study 1 – Australia

To further examine this aspect of increased reliability in the elastic attributes away from the well location, the next logical step is a more quantitative assessment of the benefits of increased bandwidth at the well location. This is illustrated by using cross-plots generated from a 2D example from the North West Shelf of Australia, where pre-stack seismic inversion was performed on collocated conventional streamer and dual-sensor datasets. Both inversions were carried out using exactly the same parameters, with the same low frequency model and inversion parameters. The wavelet estimation naturally had to be different, since there is significantly broader frequency content in the dual-sensor data compared to the conventional dataset. Therefore, the only difference between the two datasets is simply due to the type of streamer acquisition.

The dual-sensor seismic inversion results

8. Lithology fluid classification highlighting residual gas



Lithology fluid classification derived from dual-sensor data, clearly highlighting residual gas and other accumulations in the area.

exhibit a clearer definition of the individual geological layers and the fluid contact. More importantly, the cross-plot analysis between the two is significantly different, as illustrated in ***Figure 6***. On this cross-plot of acoustic impedance versus Vp/Vs ratio the distribution of grey and red points extracted from the seismic inversion of the dual-sensor streamer data shows tighter clustering and a visually better match to the distribution of elastic properties extracted from the well. This is not the case with the conventional seismic dataset shown along side. Cross-plot comparison clearly demonstrates the better stability and lower noise in the pre-stack domain of the elastic reservoir properties, especially in the Vp/Vs-ratio using the dual-sensor streamer acquisition. In addition, the slope of the tighter cluster is consistent with variations in porosity and hydrocarbon pore volume (HCPV).

Case Study 2 – North Sea

This North Sea case study from the Frigg field of the North Viking Graben ***(see Figure 7)*** illustrates the estimation of lithology and fluid in 3D, using the pre-stack seismic data comparing legacy/conventional and dual-sensor streamer datasets.

The Frigg gas field was discovered in 1971 and production was terminated after 27 years. The field comprises a clastic reservoir of early Eocene age, deposited in a deep marine environment and exhibits characteristic prograding submarine fan geometries. The gas was discovered at a depth of around 2,000m and a clear flat-spot signature is evident on the seismic. Production ceased and decommissioning of the field started in 2004, however residual gas is still present and can be analyzed and mapped.

On these datasets a full quantitative interpretation has been performed including the wavelet extraction, low frequency model generation and pre-stack simultaneous inversion. ***Figure 7*** illustrates the inversion results by comparing the acoustic impedance from the conventional seismic and recently acquired dual-sensor data.

Before examining the lithology-facies clas-

This case study demonstrates that the ability to predict the reservoir properties away from calibration wells is improved by the extended low frequency bandwidth offered by the dual-sensor streamer.

sification itself, it is instructive to review the results of the acoustic impedance inversion. The contrasts between the results for the two co-located datasets eloquently summarize the benefits of broadband seismic in terms of interpretability improvement and better delineation of the geological features.

- Improved interpretability: the various stratigraphic units, for instance the prograding fore-sets are better delineated on the dual-sensor data

- Better delineation of the main geological features by separating the sands and shales responses using the inversion results. As the dual-sensor seismic data are richer on the low frequency side of the frequency spectrum, the side lobe imprint is significantly reduced improving the resolution of the inversion results. This provides a clearer discrimination of geological layers and less residual imprint of cyclical 'seismic' layering

- Significant improvement on the delineation of the channelized features: higher signal-to-noise ratio impedance with the broadband seismic makes the impedance volume ideal for structural and stratigraphic interpretation and the overall understanding of the geological depositional system.

The improvement in results from dual-sensor pre-stack analysis was encouraging, suggesting that a better understanding of the lithology and fluid distribution in this dataset could be achieved by lithology-fluid classification. Elastic attributes have been classified stochastically based on a rock physics analysis performed for the area. The lithology fluid classification ***(Figure 8)*** highlights all the main geological features and field architecture and differentiates channel sands, hydrocarbon sands, and the shale layers forming the reservoir seal. By overlaying the various field outlines on the 3D lithology fluid classification, the residual gas in the Frigg, Frigg East, Odin and various other hydrocarbon accumulations can be seen clearly, located on the structural culminations of discrete localized channel fairways. Greater bandwidth is making the quest to predict rock and fluid properties in the Earth achievable. Now, the seismic industry is moving towards the next generation of seismic: full wavefield methods. Can multiples and primaries be combined to extract even greater information from the subsurface?

WHY GO FOR A SWIM?

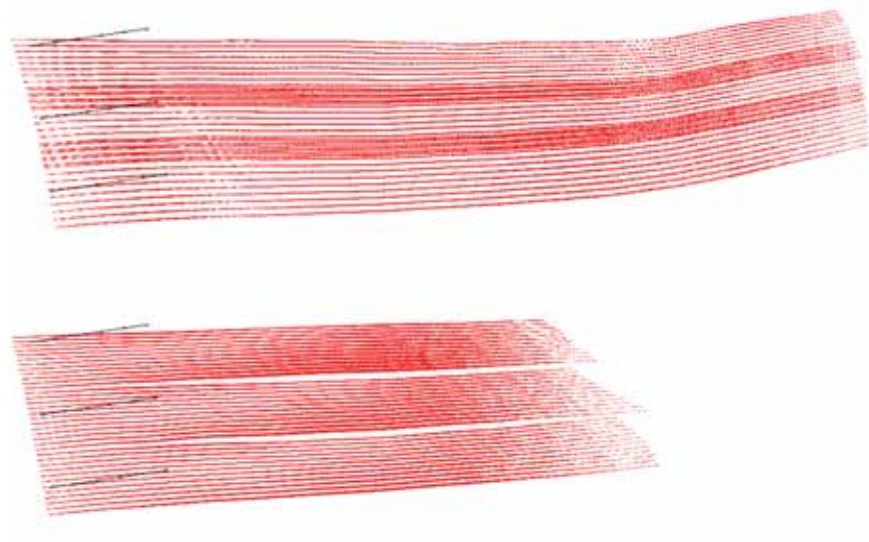
Fundamental breakthrough in imaging using dual sensor recording.

Sound is propagated from a seismic source downwards into the earth. The first time the signals are reflected and scattered upwards from acoustic interfaces within the earth, they are referred to as "primary reflections".

Seismic signals that have made the journey from the surface to any geological target and then back to the surface in any kind of indirect manner are referred to as "multiples". Naturally, multiples involve more complex journeys from the surface to one particular acoustic interface, then upwards some distance, then maybe downwards from another acoustic interface and then maybe upwards again, and so on.

At some stage the multiples make it to the surface where they are recorded by the seismic streamer. In traditional data processing, removing the effects of multiples has been an important part of the processor's art, and in some areas sometimes the most important and time consuming step. Fundamentally, though, multiples are bona fide elements of the recorded wavefield, and our attempts to attenuate them in processing

Target illumination from 10 shots, 3 sail lines



Ten successive shots are fired for three adjacent vessel sail lines. Bottom: primary reflections illuminate the target with a small "gap" between each sail line. Top: there are no gaps because of the improved (and overlapping) illumination from surface multiples.

really only reflect our inability to use them properly as useful signal.

Taking the downs with the ups

All this is set to change. Since dual-sensor data recording such as GeoStreamer enables us to separate "upgoing" (scattered up directly from the earth) and "downgoing" wavefields (reflected back down again from the sea surface/air boundary).

The downgoing reflections act as "secondary sources" much further away from the vessel than the actual source array being towed. When combined together, these two wavefield measurements make it possible to create images of the earth that exploit the greater lateral "illumination" from the surface multiples. Historically this was impossible and inconceivable.

In separated wavefield imaging ("SWIM") both the up-going and down-going seismic wavefields are used in an algorithm that treats surface multiples as a form of signal.

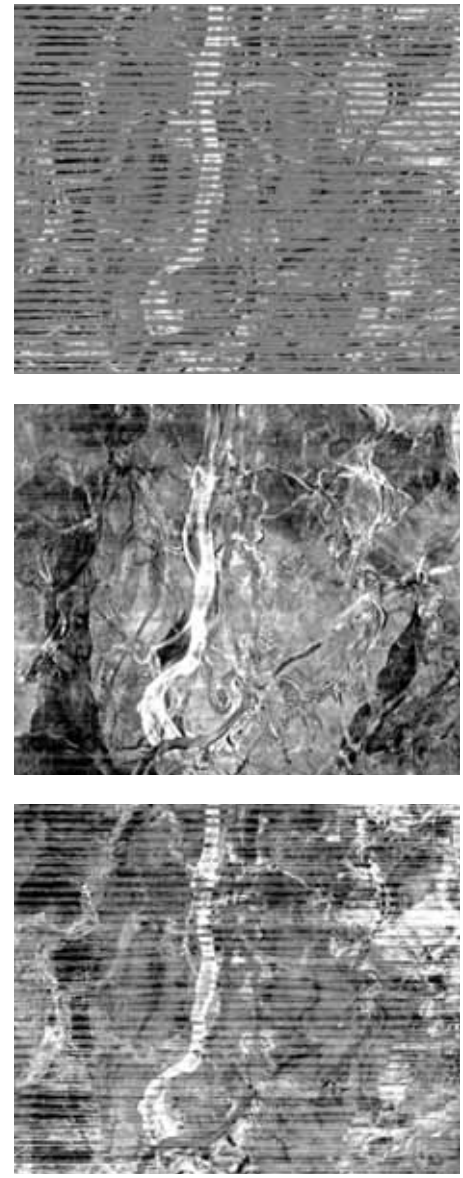
Complementary seismic images can be derived in three ways: from primary reflections only, from surface multiples only, or from both surface multiples and primary reflections. The spatial location of geological interfaces will be identical. Because the effects of ghost interference have been removed, all possible images use an uncompromised broad bandwidth range of signal frequencies. What is most significant is that because surface multiples can illuminate target interfaces over a larger spatial extent, SWIM can provide images of more geology for each source location than the traditional approach that uses primary reflections only (refer to ***Figure 10***).

Multiple benefits

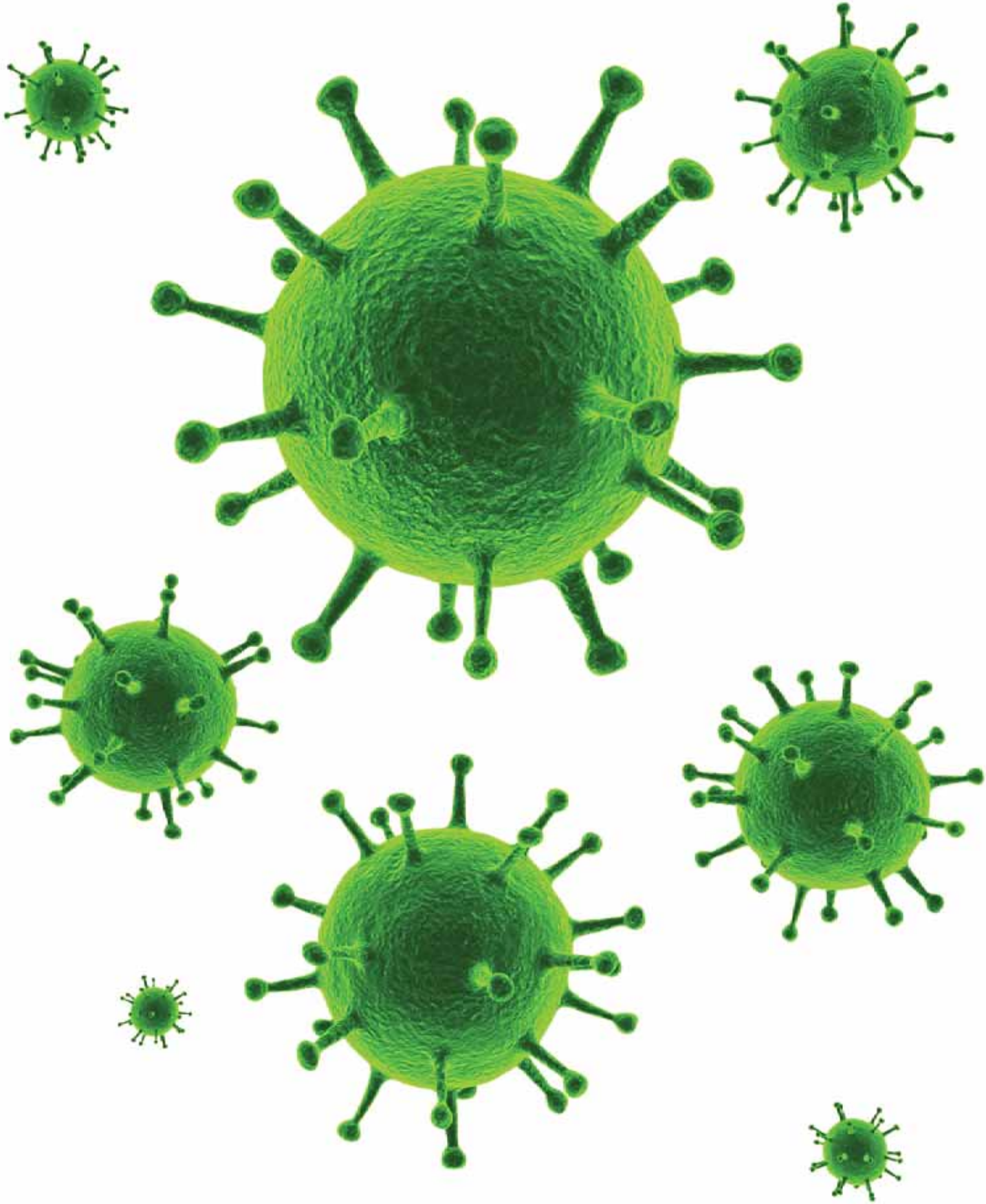
Figure 11 shows real data. SWIM is applied to a 3D survey where traditional acquisition artifacts (the "acquisition footprint") degrade shallow seismic image quality. The center panel shows how the improved illumination from surface multiples can be exploited to improve the seismic imaging of shallow geological targets. This could offer great acquisition efficiencies, as SWIM essentially eliminates the acquisition footprint effects that often preclude the use of large streamer spreads for shallow targets. And since the area under the acquisition spread is illuminated over a wider swath than with primary reflections alone, it holds promise for reducing the number of vessel passes over the survey area for the same subsurface coverage. This would be a step change in efficiency improvement.

Research is still ongoing, but one thing is certain – SWIM is a breakthrough. Combining dual sensor seismic data and multiple reflection "noise" into broad bandwidth signal offers an enticing glimpse of what the future and what comes after broadband.

Time slices – 3 versions



Top: SWIM with primary reflections only.
Middle: SWIM with surface multiples only.
Bottom: Kirchhoff migration using primaries only.



CYBERTHREATS TO THE OILFIELD

Computer crime is a growing threat to our industry. Each member of our community has a responsibility for security.

AUTHOR: ERLING MOEN SYNNES, VP GLOBAL IT, PGS **ILLUSTRATION:** PGS

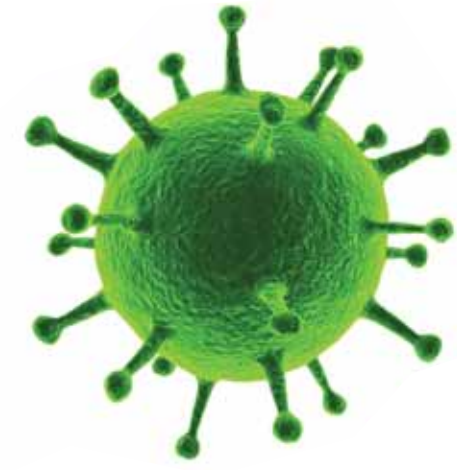
In 2011, the Night Dragon virus hit oil and gas companies in Asia, central and Eastern Europe and the USA, and stole proprietary information from six US and European energy companies.

August 2012, Saudi Aramco shut down its systems to protect production facilities, following an illegal data intrusion. Hackers today are backed by organized crime, well-funded activists, or even national interest groups. Their illegal penetrations last longer and the infections are more resilient. Experts say anti-virus has lost the fight. How can we defend our operations and your data from this threat?

The International Monetary Fund, the French Ministry of Finance, and global security company Lockheed Martin Corp. were all hacked last year. In September 2012, Microsoft claimed malware was being installed in new PCs by the factory manufacturing them in China.

It is estimated that about $221 billion a year is lost to cybercrime. Visibility, wealth and public interest make the oil industry a significant target. It is tempting to think that only the biggest companies are vulnerable but the truth is that value chains are interlinked and attackers will take advantage of any weakness. Each year the PGS firewall

A little paranoia is an essential part of self-preservation, as we scan the landscape for potential aggressors and threats. “



stops a barrage of between 20 to 50 million attempted cyber intrusions. We take the problem very seriously.

Masked marauders

In the past, hackers were often speculative, acting alone and wanted to show off what they could achieve. That picture has changed. According to David Emm Senior Regional Researcher, at Kaspery a Global Research & Analysis firm, we are starting to see an increase in targeted attacks. Critical systems, like those in oil production, are vulnerable to attack, he says. The scenario of activist driven disruption is a concern.

Cyber security company Watchcom warns that modern hacks are largely perpetrated by organized criminals. They leave fewer traces and if you are not watchful, then you may not even notice you’ve been hit.

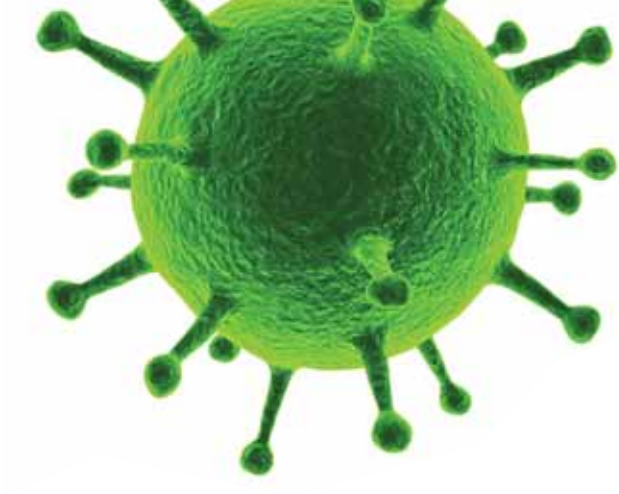
Though virus protection has been my responsibility for many years I, like many business leaders, became aware of the new scale of potential disruption when Stuxnet was detected in June 2010. This highly sophisticated piece of malware targeted nuclear production facilities in Iran. It was designed to affect systems that weren’t connected to the Internet and it spread through the company's internal network.

This new threat isn’t classed as a virus. It is a worm. Programmed to cause disruption and damage, Stuxnet hunted for a specific piece of software, then issued new instructions to the machinery it controlled, crippling production. Imagine what havoc a similar attack could have on the oilfield.

Speaking at the World Petroleum Congress in Doha, in 2011, Ludolf Luehmann, IT manager at Royal Dutch Shell PLC confirmed the fears of many when he said, “Attacks now span longer periods of time. Hackers collect more information than before to create more complex and resilient infections.” The nightmare scenario for an oil company would be if somebody gets into an area that can control opening and closing of valves, or release valves!

Protection strategies

As we scan the landscape for potential aggressors and threats, it is tempting to be spooked by the doomsday scenarios. But it is important to keep a sense of propor-



Humans are used to viruses and infections... we need to make data protection as instinctive as personal hygiene. “

tion. Experts may say that anti-virus is like a cycle helmet in a traffic accident but the everyday day threat is still the biggest. Helmets save lives. Effective firewalls, anti-spam, a regularly upgraded operating system and installing the latest release of common applications (such as Java and Adobe) are effective protection against most threats.

This is a fairly natural process, after all humans are used to viruses and infections. Our ancestors survived because they learned to avoid infection, or built immune systems that could cope. So we need to make data protection as instinctive as personal hygiene and vaccination programs.

Penetration testing examines the highest risk areas within existing and new applications. It tests how far an attacker could get if we became a target. This allows us to reduce vulnerabilities and plan counter measures, before we code an application. Existing systems are also reviewed. We repeat this regularly and use a variety of auditors to try to ensure that we don't become complacent. These security audits are the health checks and CAT scans of the data world. They help us identify the really nasty bugs.

Standing together

Cybercrime is a safety risk that we cannot eliminate, but we can prepare well and fight smart. The risk is increasing and the mutations are endless, we are told. Each member of our community has a responsibility for the security of their own organization and also, when they visit, for their customers and suppliers. If they can't hit you they may try to hit us. Viruses are contagious. Right now, the next kid on the block is trying to find a loophole in our systems. The only answer is constant vigilance.

GLOSSARY

AVA – Amplitude variation with angle. The amplitude of a seismic reflection is related to its angle of incidence at the reflecting interface, and varies characteristically with lithology at the interface, particularly in the presence of reservoir fluids. The diversity of angles acquired during a seismic survey, due to the wide range of source receiver offsets employed, offers AVA as a powerful tool for assessing reservoir properties.

AVA stack rotation – AVA stack rotations are a powerful attribute that can be used to highlight potential hydrocarbon anomlies when little or no well data is available.

Bandwidth – The range of frequencies from lowest to highest. In computing often misused to refer to the rate of data transfer.

Blind well – Well information not used in an inversion calculation, but used as a benchmark to test the accuracy of a seismic inversion result.

Blowout – The uncontrolled release of oil and/or gas from a well after pressure control systems have failed.

Broadband seismic – Seismic signals which contain a range of frequencies significantly higher than conventional data both at high and low frequencies.

Correlation coefficient – A measure that determines the degree to which two variable are associated.

Cross-plot analysis – Used in well analysis to calculate a result based on two or more forms of data.

Dix equation – Used to calculate the interval velocity within a series of flat, parallel layers.

Dual-sensor streamer – marine seismic recording system that records both pressure variation and particle velocity.

Elastic properties – The mechanical properties of rocks. Elasticity is the ability of a material to return to its former shape following deformation, such as during the propagation of an acoustic wave.

Extended Elastic Impedance "Elastic impedance is the product of the density of a medium and its shear wave velocity. Extended elastic impedance is based on the gradient impedance/acoustic impedance crossplot."

Fluid contact – The site in a reservoir where there is gas-oil or oil-water contact.

Gathers – A display of seismic traces that share an acquisition parameter.

Impedance – The product of velocity times density – symbolized by Z. Absolute impedance describes the impedance of the rocks themselves.

Interval velocity – The velocity, typically P-wave velocity, of a specific layer or layers of rock.

Kirchhoff migration – A method of seismic migration that uses the integral form of the wave equation.

Lithology-fluid facies – Sedimentary unit which is different from adjacent units in its seismic characteristics, specifically with relation to its implied fluid content.

Low frequency model – Inversion techniques require information from low frequency signals which are generally absent in conventional seismic recordings, so an estimated a priori model of low frequency content needs to be injected into the calculations. Since dual sensor recording captures more low frequencies naturally, dependance on the model is reduced.

Multiples – Seismic signals that have been reflected more than once.

Primaries – Acoustic signals reflected directly upwards from interfaces within the Earth, without secondary bounces off other sub-surface interfaces

PSTM – Pre-stack time migration.

Quantitative interpretation – Application of rock physics derived from seismic data to predict reservoir parameters, such as lithologies and pore fluids.

Recorded wavefield – The raw signals recorded during a seismic survey.

Relative seismic inversion – An inversion scheme which aims to calculate relative rather than absolute acoustic impedance in a geological section. It is simpler to do, and less dependent on a low frequency model or a priori information.

Resistivity log – A log of the resistivity of a rock formation. As hydrocarbons do not conduct electricity while all formation waters do, this is used as a hydrocarbon indicator.

RNMO – Residual normal move-out correction – the basic step in velocity field refinement.

Rock properties – The physical characteristics of rocks.

Seismic Inversion – A mathematical process which uses seismic data to generate a model that is consistent with the data. Usually requires a high signal-to-noise ratio and a large bandwidth particularly at the bottom of the frequency scale.

Stacking – Adding seismic traces together from different records to reduce noise and improve data quality.

Time slice – A horizontal display of 3D seismic data, representing points with a shared arrival time.

Wavelet – A short wave-like oscillation with an amplitude that starts out at zero, increases, and then decreases back to zero.

Well log – The measurement versus depth or time, or both, of one or more physical quantities in or around a well, or the display these measurements with depth in one axis.

Petroleum Geo-Services is a focused geophysical company providing a broad range of seismic and reservoir services, including acquisition, processing, interpretation, and field evaluation. The company also possesses the world's most extensive Multi-Client data library. PGS operates on a worldwide basis with headquarters at Lysaker, Norway. For more information on Petroleum Geo-Services visit www.pgs.com

REFLECTIONS / 2012
PGS MAGAZINE

This issue:

In this issue of Reflections we search for sense in the cacophony of modern free-for-all communication and offer a commentator's assessment on how the oil business is adapting. In the realm of geophysics, operators big and small are scrambling to get on the broadband wagon. We look at what lies beyond mere broadband acquisition and some of the cool stuff that waits for explorationists.

REFLECTIONS

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