A New Golden Age Of Industrial Technology

Remarks of Rodney T. Cox
Chairman and CEO, Borealis Exploration Limited
and the Borealis Family of Companies
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Thank you for the introduction.

It's an honour and a great personal pleasure to be here today. Thank you, IBM, for giving me this opportunity to speak on the future of science.

Thomas J. Watson Jr. paid my way through Columbia University for my Ph.D. I was a scholarship student and I have life-long gratitude to Thomas J. Watson Jr. and IBM for giving me the opportunity to get a really superior education and to be associated with great people with great minds who have broadened my limited horizons.

The future of science is simply magnificent. The future is well beyond my dreams of over 50 years ago.

Basic science as applied to the industrial world is about to enter a new golden age.

This may not come as a surprise to you, but it will to most people. To the press, the pundits, the Wall Street analysts, the academic technology experts, and to many others, the future of science is almost exclusively in "high tech," meaning mostly electronics and computers and biotech.

The Borealis Family of Companies have made scientific advances that will transform the basic science that underlies some of our oldest, biggest, and most important industries of which electronics is only a small part.

We are applying the techniques and knowledge of the 21st Century to the basic scientific, technical, and engineering discoveries of the last two centuries.

How would the great inventions of the past be done if their inventors had the tools and the basic understanding of atomic particle structure we have today?

Our Borealis Family has answered that question for electric motors, electrical power generation, cooling, and refrigeration. These re-invented basic technologies will enable a new golden age of industrial innovation, vastly improved industrial processes and consumer products.

We call it the Borealis Industrial Revolution, and we believe that it will drive worldwide economic growth and open new fields of scientific research for generations to come. This is not a paper revolution. We are building what we invent. We are building today.

Let me talk a little about history.

Many of the major scientific advances of the late 19th and early 20th centuries are the basis of our current economies. Our modern economies are built upon those scientific and technical advances mostly from around 1885 to 1903.

That means that most of the world's most important present-day industrial technologies and products are still based on scientific and technical advances of a century or more ago – when we knew much less about physics, chemistry, and engineering than we know today.

Electric motors were basically developed from 1888 to 1890, and the level of understanding of electric motors has not been fundamentally improved since 1915.

Thermal management, including almost all means for producing air conditioning, refrigeration, and cooling of all kinds is based on the Rankine Cycle, patented by Willis Carrier in 1902.

Our means of generating electrical power – surely as fundamental and important a technology as we have – was invented by Nicola Tesla and George Westinghouse in the period 1888-1895.

Man first flew compliments of the Wright brothers in 1903.

These industrial advances of a century ago were not funded by DARPA or the U.S. Army. By and large, they were not made in universities. They were done by ambitious men with a vision of how the world ought to be, and the energy to go out and get to work.

And since we're here, let's not forget IBM. IBM began as CTR, the Computing Tabulating and Recording Company, and it was built on the back of the products that capture and use data, with the key inventions dating from 1885 to 1896.

CTR, which became IBM in 1924, was put together by a noted businessman, Charles Flint, in 1911. All significant companies handling data in 1911 were combined. It would be called a 'roll up' today.

In 1914 Thomas J. Watson Sr. was hired as general manager by Charles Flint. Thomas J. Watson Sr. was hired as professional management, and he took over in a year as President.

IBM, from the beginning, was based upon market dominance through market position and extensive patent protection. The basis of IBM's business was strong R&D, which produced proprietary and patentable new products, which led to long-term market domination and high-margin profitability. That is the same strategy we at the Borealis Family are following today.

When somebody like Thomas J. Watson Jr. had the money to put somebody like me through school, and do it in style, I was real interested in how he made so much money that it was trivial to him to pay for my schooling. I was impressed and am still impressed by the IBM business strategy of Tom Jr. and Tom Sr.

Of all the basic industries set up around 100 years ago, only the electronics industry, which is basic data management, has continued to grow and develop intellectually and scientifically. Of all these most basic industries – electric motors, refrigeration, and power production – electronics is the only one that has continued to this day to receive intensive R&D funding, and also funding for real engineering development. Because it has been properly funded, the electronics sector has achieved constant progress. Electronic products have become better, less expensive, and more effective with everybody trying to get and keep a proprietary edge and with the unexpected result of many people ending up going open source.

In the rest of the world's basic industries, real innovation and basic advances have ground to a halt. They have become moribund, completely commodity-based industries with no real scientific advances and therefore no proprietary advantages are even possible. Most basic industries do not own their technologies. Their profits, if any, are maintained only by hiring better salesmen and better accountants than the next company.

Never forget that the drive toward commoditisation is relentless in all industries. This tends to drive profits to zero without effective differentiation in the market place.

Electric motors were done by 1915. Airplanes were done by 1946. The planes flying today are very good 1946 science. Jet turbine engines today are better and bigger than they were in 1946, but they are still fundamentally the same engine.

Electric motor production really has not changed much in 100 years. There has been relatively little spent on R&D, and the little there is, has gone on incremental and cosmetic improvements. None of the giants of the electric motor industry are spending real money on developing new types of motors. They're spending all their money on making the ones they've got a little prettier, a little quieter. In fact in some cases they've even given up on that, and just sold off their motor divisions to allow someone else to have a go, or even tried and failed like General Electric to get rid of their electric motor business.

Even IBM has decided that its Thomas Watson labs are going to look to immediate profits from research and immediate profits are from programming and not from physical sciences.

Almost everybody has agreed that the physical sciences and the attendant business that goes with the current physical sciences are settled and known.

As some people have said, the electronics business will no longer be proprietary. There are, as known fact, no major new advances that will make anything in electronics a long-term sustainable proprietary business.

We at the Borealis Family of Companies are going after proprietary market positions in the basic sciences, including electronics. Our issued and pending patents cover revolutionary new technologies that re-invent entire basic industries and will dominate these basic industries for generations. IBM knows all about this game plan. I was taught this game plan by the best.

Most new technologies get their start by solving problems nobody else can solve, and for which solutions are very valuable and customers will pay big dollars for product.

We are providing solutions to real current serious problems and beginning with the most urgent and most valuable applications, in defense and aerospace. Just as IBM, for example, with its data-processing technology for the Social Security System in 1935, hit a cornucopia of infinitely renewable resources with government work, now we are going after full value customers who desperately need our products and who have the money to pay.

The first computers were also developed for military purposes, with very high value contracts driving the IBM research efforts. IBM ended up with commercial products and a super lease base that brought in tens of billions with huge profit margins, but IBM's first real huge money was driven by government work.

Our view of what happened in electronics is that the computer, in incremental engineering steps, drove all the individual parts smaller and smaller as the computer chip was developed and got faster and faster. The computer basically became a commodity with many people able to produce the commodity in one form or another.

IBM's lease base almost brought down IBM, as many individual players were able to build and sell competitive products for much less than IBM was willing to sell or lease similar products. IBM tried to stop the development of new and better products to protect its existing lease base. It failed in this effort, but not until after making huge profits.

Interspersed with the lease base issue, IBM created, or made possible, other giants of the computing and electronics world. IBM used its enormous wealth and depth to get Intel seriously up and running. IBM made Microsoft.

IBM basically made the computer industry happen. IBM drove physical science so engineering shops like Intel, with IBM funding, could continually move actual product out the door that was faster, lighter, smaller and cheaper.

Along the way nobody that we know of seriously thought to step back and see if this 'new science' that worked so well in the chip business had any applicability to the old industrial sciences.

With the success of the Manhattan Project and the Cold War need for continuing advances in rocketry, electronics, computing, and other sciences, the U.S. Government has run science for the past 60 years. The government's technology needs, defined by DARPA, NASA, ONR, DOD, DOE and other government agencies, has driven the priorities of scientists and engineers for decades. Basic research in fields not immediately essential to defence needs has been misguided or neglected and much of the defence research has been at best misguided.

Now, out of the R&D budgets in the U.S. of well over $200 billion yearly almost none goes to basic industrial research. Mostly it's tax code defined research.

For researchers the goal now is to get the next 'grant' – nobody is rewarded for getting the research done. Government officials decide who gets the 'grants'. Nobody takes any chances, and we get correct, proper, incremental research from correct, proper, acceptable people.

This has left a gaping hole in much of scientific research, in many technologies, and in most basic industries. But for well over a decade now the Borealis Family have been working hard in these huge and ignored fields, and we have made some stunning discoveries and inventions.

For example, we have discovered how to make electric motors far more powerful, as well as smaller and lighter. Our Chorus® motor can produce more than four times the startup torque of a conventional motor of the same rated horsepower in real apples-to-apples comparisons. For applications where fast startup or high overload is important, a 20-horsepower Chorus motor will outperform an 80-horsepower standard three phase motor. This new capability has large implications. Among other things, it will make electric cars and trucks feasible and economical.

We are way ahead of most of the emerging nanotechnology industry, with implications for all electronics and computers. We are today building Cool Chips™ devices with conformal electrodes across a square centimetre, and with a gap of less than 10 nanometres. Our scientists are making discoveries about the behaviour of electrons at the atomic particle level that will enable the construction of even smaller devices, and enable entirely new technologies to develop.

Our first such technology is the Cool Chip. These devices will transform thermal management. They are small, lightweight, silent, solid-state, and far more efficient than the century-old compressor technology they will replace. They permit active cooling in very small areas with very precise control and very high efficiency.

The same devices, with some modification, can be used as Power Chips™, to generate electrical power. Think of replacing a huge steam-turbine generating plant with a small panel of Power Chips that will be far more efficient, can be designed right into buildings to provide distributed power, and can provide portable power.

Within Borealis, we are in the midst of another frenzy of invention, which easily matches that of the 1880's to the early 1900's.

We continue to completely cover our inventions and discoveries with patents and to try real hard to make sure we will dominate the future of power generation, thermal management, electric motors, aerospace and computers for starters. We have our research teams and patent teams going after most everything else that is not tied down. In this, we are seeking to emulate IBM's domination of information technology from 1890 to the 1980s.

All basic industries are now in the process of being turned on their heads by our scientific advances and inventions.

We know that the biggest player in new technology and the biggest customer is the government, for military uses. Commercial markets are fine – but one does not see such a deep-pocketed player as the DOD every day in the commercial markets.

The U.S. Government has tried to ensure that everybody behaves themselves and does research on those particular areas favoured by policy makers, and nowhere else. It so dominates both the funding and the priorities for scientific research that it is almost impossible for any researcher to conduct research that is not funded and approved by the U.S. Government. And, if a researcher takes any government money, then both the government and government contractors – including your competitors – can use the results of your research, free. Whether it was the point or not, the net result is that everybody's IP gets contaminated, so that having taken Government money for research, you have to give your science to the U.S. Government so that all government contractors can use it and use it for free.

Nor are the areas of research favoured by government bodies always the best ones. The battle for grants is a political as well as a presentational battle. The value of a particular program comes a distant third.

We have taken no government money. When we asked early on we were told we were unacceptable as research partners.

We have proven our science. Why should we give up the store, when we have already spent tens of millions of our own money, and own our technology outright. At the end of it all, we will be able to sell to the government on commercial terms – for whatever our products are worth. And we won't surrender our IP.

This government policy has had a bad effect on basic scientific research. By requiring researchers to give their biggest customer – the government – the results of their work free, or in the best case cost plus 7% contracts, the government has discouraged scientists from working on projects that are not government-sponsored, government-funded, and government-approved. The Borealis Family was saved from this fate because we were privately funded.

We have spent around $180 million under my watch.

Most all of our patents are, we hope, broad ranging, fundamentally new patents, not incremental or marginal advances. If they are challenged in court, we expect many of them will be designated Pioneer Patents for their originality and broad reach, and accorded the wider protection that entails.

Our reliance on patents to own our science is our defensive strategy. But we do not license patents. We license technology, and the license is defined by the relevant patents, future patents yet to be filed, in-house know-how, and the market sectors for the use of the technology. This way, as a new technology develops, licensees benefit from our own continual R&D, and we don't see our revenues run dry as the first patent expires.

Where is science going? Let me suggest a few directions.

On electric motors, the government has spent as near as we can figure around $20 billion on efforts to eliminate electromagnetic harmonics in motors, which as you know degrade their power and performance. When we set out to invent a better motor, we started at the beginning, and rethought why harmonics appeared and how they behaved. We discovered, after much research and trial-and-error, including blowing up a lot of motor electronics, that you cannot eliminate the harmonics in motors. But you can *capture* or *harness* them, and make them part of the main wave drive form, and that is what we have learned how to do.

Our Chorus Meshcon™ motor combines these harmonics into a harmonic chorus that increases, rather than degrades, the fundamental torque of a motor. As a result, we can make a motor with dramatically greater capabilities than a conventional motor. We can get 400% more starting torque out of an AC induction motor without increasing the size of the electronics. We have seriously increased the engineering envelope for motors.

Chorus Meshcon enables electric motors to do things they never could do, and so Chorus Meshcon motors will simply replace other technologies, such as hydraulics and pneumatics, in many applications. And they will enable Chorus Meshcon motors to be used with Power Chips for new applications, such as replacing internal-combustion engines to drive cars.

Chorus will make electric motors a fast-growth industry where right now there is no future and all the smart players are trying to sell off their motor divisions.

The same revolution will happen in power production, where Power Chips are the future. No moving parts, high efficiencies, no vibration, long life. By retrofitting an existing large generating station with Power Chips to capture heat now wasted, for example, a power company can generate at least 20% more power with no additional fuel cost or added emissions.

Over the next couple of decades, as Power Chips replace large central generating stations with distributed power, the cost of electric power will plunge - but hopefully not before we have extracted proprietary profits from this technology for many years. Eventually, however, Power Chips, perhaps combined with widespread solar power (using Photon Power™ chips to capture solar energy), will drive the price of power down to almost nothing. The future of energy is not – as many expect – shortages and rising prices, but plentiful power anywhere and almost free.

Ask the telecoms about falling prices. In our case we're going to be able to control this fall and benefit as our competitors realize the futility of their products and positions. We own and control the game and we plan to remain in the driver's seat owning and controlling the game as we drive to maximize our revenue and profits from our proprietary products while eliminating the world's energy shortages and making power available to everyone worldwide.

Or take a scientific problem directly affecting IBM: Thermal management for computer chips. You may be happy to hear that this will not be a problem. Our Cool Chips, nearing completion now, should be able to provide the necessary active cooling at the levels you'll require. We are filling military orders first.

Cool Chips are going to keep processors and other chips as cool as you want. Moore's Law will continue to operate: You're only experiencing a temporary delay.

And much smaller, more powerful chips are still possible. We believe it's entirely possible to stack 100 layers in a micron of thickness with transistors as single electrons – we can even cool it. That will give one a little more computing power on a chip than at present.

So, we think that the future of science isn't limited to electronics and biotech. Many wonderful discoveries remain in basic, fundamental physics, chemistry, and other sciences, including electronics and biotech. The future is clear. The entire basic scientific world is up for grabs. We have gotten almost we have sought to date.

Fundamentally, the world is coming into a world with almost free unlimited power, almost free unlimited cooling, and almost free unlimited computing power. The world already has almost free unlimited telecom, using a model for the future where nobody was home minding the intellectual property store.

Today, the Borealis Family of Companies clearly have more projects of very high calibre on our plates than we can now manage. We currently have a Present Discounted Expected Value threshold of $10 billion for any new fields we enter.

We are trying to be very selective as to what we do and will probably have to raise our threshold to probably $25 billion for undertaking new projects. There are just too many wonderful scientific advances chasing our limited resources.

It should be noted that many of your industrial-consulting customers are in for a shock. In the next couple of years they will discover that the industrial sciences they have built their businesses upon, have been totally superseded. The Borealis Industrial Revolution generates products that are proprietary to the Borealis Family of Companies. We build ourselves and are starting selling directly to customers proprietary products that change the engineering envelope. We are being forced to build a much bigger business than we initially intended, as you cannot license what the industrial players cannot understand. Most industrial players in American know no science, and would not license in any event as science is supposed to be free. Our success and our patented proprietary positions on top of their industrial empires will come as a serious shock.

IBM today has a market value about 1200 times greater than the market value of the Borealis Family of Companies. The market value of the Borealis Family of Companies has increased about 2000 times since we took over Borealis Exploration Limited in 1978. We expect the market value of all of our Family of Companies to grow between 1,000 to 10,000 times in the next five years.

This is a responsible rate of return given our use of the original IBM model. The IBM lesson is strong R&D, developing proprietary and patentable new products, which will lead to long-term market domination and high-margin profitability. That was IBM's strategy, and it is good enough for us. I can assure everybody that I have and continue to personally benefit from this strategy. Education is the best road for advancement in America, and I thank IBM again for using some of their vast proprietary profits to give me a really first class education.

Our scientific advances haven't been achieved in a vacuum. Breakthroughs in the sciences related to electronics, many driven by IBM itself, have made these advances possible.

Of course, scientific advances are only the first step. Moving Borealis' technologies into the real world will require great engineers, great marketers and great business people. IBM, as a much larger and more mature company, has developed the best labs in the world and clearly does the best programming in the world.

Your fine work here in the Northwest on software modeling tools, Linux technology, database technology, and high-performance file systems continues to ensure that IBM engineers are providing some of the tools that will make our scientific advances a reality.

If I may single out one name – I'd like to congratulate Paul McKenney here today, a fine engineer, on successfully defending his Ph.D. dissertation.

To Paul, and all of you who value quality and original thinking – if what you are working on will not change the world fundamentally for the better, then change what you're working on.

I thank Thomas J. Watson, Junior and Senior, for showing us the way.

The future is great. The world is just opening up.

We have the present, we know the future and the future is ours.

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