Solid-State Cooling Technology

Remarks of
Rodney T. Cox
Chairman and CEO
Cool Chips plc and the
Borealis Family of Companies
to the
Micro-Nano Breakthrough Conference 2004
Microproducts Breakthrough Institute
Pacific Northwest National Laboratory
U.S. Department of Energy
Portland, Oregon
July 29, 2004

Thank you for inviting me to speak to this conference on Accelerating Discovery to Commercialization.

This is a very hot topic with many facets.

Cool Chips plc is at this moment working very hard to successfully turn research into saleable products for the markets.

I will try to describe for you the complete drive to commercialisation process as we see it. We have a very personal view of the world. We are probably alone today in our views and outlook. Do look at the published remarks on the www.borealis.gi web site that I made last month to IBM about where our products are going.

First let me tell you a bit about who we are.

Cool Chips plc is a Gibraltar public company traded in the U.S. under the symbol COLCF. It went public over two years ago. COLCF is controlled by Borealis Exploration Limited, which is its majority shareholder and is also public trading under the symbol BOREF.

When you set up shop make sure you have a clear idea about who you are, where you want to go and what kind of a company you want to be.

Borealis Exploration Limited came out of a family of companies founded by the late William F. Buckley, Senior. Borealis, also a public company, has been public for about 35 years. Our grandfather company went public in 1927.

Borealis is now a holding company with many varied interests, from iron ore to running extensive privately funded research operations. We are a virtual company with offices and staff world wide.

This was step one. We had our vehicle.

Our market value of Borealis has grown from about $90,000 to $245 million in about 25 years which includes all the family of companies. This is not a bad compounded rate of return but still less than 40% compounded per year.

We have had many false starts through the years. We started scientific research earnestly in 1992.

In 1998 we redomiciled out of Canada to Gibraltar. If you are going to do major business your domicile is crucial. We gave up $17 million in Canadian Government tax credits and other give-ups to leave Canada. This was a super investment.

We left an environment where we had to prove to the regulators that our science was correct, when the regulators have no particular expertise in quantum physics and nano-technology issues. In Gibraltar, we are required to tell the truth, and account for it afterwards. That is the same system that operates in the United States, by the way. You get to make your own announcements about what you've done, and if you tell lies, you can be held to account for them.

You must be domiciled where the truth is what counts, not what the regulators think about it, because at the cutting edge of scientific research, the regulators cannot ever be expert in what you're doing.

Next you need to get your company public. A public company is a good vehicle for raising money and for pricing of equity.

Today, we can get public companies up and trading for less than $5,000. Getting a public company today is not the problem it once was. Our cost of about $5,000 sure beats the $1 million to $10 million that most people quote. You get a lousy share market for your money - but there is a market quote and your money should be spent in research and not on the costs of floating public companies.

The next issue is how to choose your projects.

Picking a research project is easy. We use the "Present Discounted Expected Value" method for evaluating research projects for the purposes of investment.

This is a common business approach but it's not very familiar to engineers and software developers. Let me explain. What we do is estimate the probability of success at any given stage of a project and apply that to the expected gains if we succeed.

Say we have a project that, if it succeeds, might be worth $10 billion but we have to invest $50,000 to see if it has any value to reach the next decision point. And let's say that when we start, we only have a 0.1% chance of getting there. To get the expected value of the project, we say –

I have a one-tenth of one percent chance of gaining 10 billion dollars. That's an expected gain of ten million dollars. I have a ninety-nine point nine percent chance of losing 50 thousand dollars. Take the loss from the gain and the project has an expected value of $9,950,000.

If the project is still a go and has not been disproved, the next decision point might be a $250,000 investment with a 10% chance of being successful. Then our gain is expected to be a little less than a billion dollars, US$999,750,000, for $250,000 invested.

At some point you might find out that the product or technology is worthless.

We did this exercise on the perfect microphone. It turns out that nobody wants a perfect microphone. There was no value at the end of the work and as soon as we figured that out, we walked. We have walked from a lot of projects.

We are just finishing a project called Chorus® Meshcon™, which is a radical improvement on the well over century-old electric motor technology. We have invested about $10 million, first re-thinking the basics of motor science, and then, developing and perfecting the technology. The science is now 100% certain, and with the first sale we will have a $10 billion company. If we are any good at management, we will have a company worth over $100 billion with this science in very short order.

We think we are safe and secure and try real hard not to let bad projects get out of hand. We are ruthless in cutting off bad projects when they do not perform and expected value goes negative.

This method allows you to judge one investment risk against another provided you can get a reasonable estimate of the percentage risk and a reasonable estimate of the value of the market youa re after. You also need to spread your risks and take many such decisions if you can. And you need to ensure that you won't be wiped out be a few early setbacks.

Our research projects that we now have up and running all have a minimum $10 billion market value should they come to fruition. They could do even better, if we get the management right.

Large corporations do not use this decision making process, of course. In fact they don't make decisions at all. Decisions are made by individuals or groups of individuals, usually a committee. They have personal goals such as keeping their jobs and gaining promotion, and they are often frightened of being tagged as the guy who made that expensive mistake. As a result of this, corporations generally avoid taking risks because nobody wants to be blamed if things turn out badly.

This is short sighted. Corporations should concentrate on making sure the risk analysis is good, and then take collective responsibility for the decision. Instead of blaming individuals for taking decisions based on good risk analysis, corporations should examine their strategy for making sure risks are appropriate to the size and resources of the corporation.

At Borealis, we pay great attention to making sure that our projects have very high expected values, but with costs we can afford within our corporation if we come a cropper. We do not blame people for having bad ideas. We just make sure we apply the best-quality risk analysis to every proposal that we can, and we constantly re-evaluate at each stage of the project.

So you now have a company and you have selected projects with high expected values. How do you fund your projects?

Ideally, you should have deep personal pockets and than shake down your friends and acquaintances. That is how we did it. I made my money on the share market and by marrying well. If you are a public company you can get at least some positions filled on a work-for-stock basis. Cutting down on employment cost when you have no revenues is a sensible strategy.

Do not get suckered into government money, unless you want to be a low-margin government contractor for your life, just living from contract to contract. The Government rules say that if they give you money, they get a free license on your invention for any public or defence projects. In nanotechnology the initial big-ticket orders are generally going to be from the Government.

It must be a very boring life making 6% or 7% profit on your costs, and having to have those costs audited all the time, and not by you.

Government money generally picks low-dollar, safe, incremental projects that the government wants researched. The two counter examples are hydrogen and fusion research. If you are lucky as a government research house you get a good job –maybe some market value, and the constant realisation that your master calls the shots and you do what your master says and if your master cuts you off you are gonzoed.

There is an enormous amount of capital around looking for homes. We just get money from our extended family, as the real money does not like or understand our science, our business model or our attitudes. We have been unable to raise any of this standard money looking to invest for any of our projects.

We have had a few offers of VC money, but they all want to get their money out before the product gets to market. The typical move is to pump the stock (of which the VC was allowed to buy scads off-market at low prices) and then sell out before the technology is proven good or bad. That way the VC doesn't have to understand anything about science, it is all about promotion. This model is great for everybody except the small shareholders who get burned and the researchers who thought it was all about science. We are here for the long term not the fast turn.

The Government has offered us all the money we need to get our products to their markets many times in recent years after turning us down flat over a decade ago. In hindsight we were lucky. Because we were never considered serious enough to get Government funding when we needed it most, we are not doomed to live out our lives as cost-plus contractors. We were forced to do it the hard way, and now we own our own technologies 100% and can charge accordingly.

So, you have a company, projects, and your friends have put all their money into your business. You will now need to have some way of showing the world what you're doing, and getting your work scientifically verified.

On scientific verification, everybody else goes for peer review papers. We go for patents and we build what we invent and patent and then build again and again till we get it right. We have never had a paper accepted by a journal, though we have tried. The peer reviewers think we are joking. We are not. Sooner or later we will get proper peer review articles.

Forget peer review. You need to get results -- you need to show results in your labs -- you need for third parties to come and see the results. Then you must build what you have invented, and endure the long, hard slog of improving and developing your inventions into a finished, saleable product.

This is why, if you have a really big project, a worthwhile technology that's going to change the game for everybody, business isn't going to trust you on the basis of articles in peer reviewed journals. They still want to see what you have with their own eyes. They need to touch it and smell it and if possible take one back home and play around with it there.

Patents represent property. They show you intend to defend your property. And they allow you to tell people what you're doing and why it works in a way that prevents them from stealing it. You need patents far more than you need glory. Then you must build.

This is what we have done with Cool Chips™: We have gone for patents, not papers. Cool Chips, in case you have not heard of them, are (we believe) a revolutionary technology that will transform many industries and markets. They are very small devices that pump heat to produce cooling or refrigeration, and they will do so more efficiently than any existing technology. Rather than liquid refrigerants, electrons are the working fluid.

Ten years ago we started to work on new cooling technologies. We invented the concept of cooling using a gap. We discovered later that there was a peer review paper on the subject, but it showed conclusively that thermionic cooling could not work. We first worked with thermionics, and spent several years building the first thermionic devices to show cooling in 1995.

In 1996 we realized that another science -- quantum thermotunnelling -- might achieve the objective more efficiently, although it still works on the principle of the 'gap', or more elegantly stated conformal surfaces. At the time, and for years thereafter, nobody believed it possible to get good cooling from tunnelling across a gap, and nobody believed it possible that we could build such a technology at the nanometer-sized scales of conformal surfaces necessary.

But we have persevered, and we now are on the brink of achieving working production prototype Cool Chips that will be orders of magnitude smaller, lighter, more versatile, more useful, less expensive, and better for the environment than any technology used today. We have identified more than 2,000 specific applications for Cool Chips, from cooling refrigerators and freezers, to computer chips, to cars and airplanes, to medical equipment and cargo containers. This will be a major new technology for the 21st Century. We are now confident enough to be taking orders for production prototype Cool Chips with delivery on a best efforts basis.

With the science now certain, and the technology almost completed, we are now focusing on packaging the chips for various applications and on building manufacturing capacity.

We have built a small fab and we have built two characterization laboratories. Our facilities are first class and we are building and testing product as we speak. These facilities were not cheap. Remember that there is loads of government money around for equipment. The current nanotech boom is really a boom for the equipment manufacturers, not for producers of nanotech products. Except for a few niche products, nobody yet has any significant nanotech products. For now, nobody but us has large billion-dollar markets for their products. So what is happening is that some small players are getting government grants to buy equipment, and then selling their equipment for hard cash so they can get some real research work done.

We have bought millions of dollars of used equipment. Great equipment, no long lead times and the prices are right.

Remember, public laboratories that have the equipment and expertise to test nanotech prototypes are also available. We now have another project where we are having two major outside labs see if they get the same results we have gotten from what we have built. The products from this work should also be worth billions. Outside labs are not that expensive and many of them are dramatically underutilised and dying for fun projects in which to participate.

When you have results, know you can build your products and have the facilities arranged in one way or another and know roughly how your products can be used it is time to look for customers. And you are going to be shocked at the numbers of applications people come up with if you have picked decent products and have not fooled yourself about what the market wants.

When we first started with Cool Chips, we were thinking about microprocessors, about refrigeration, and about air-conditioning. We didn't know much about the thermal management problems in maintaining cellular telephone networks, or keeping an airplane cool on the tarmac in summer, or in surgical devices, or drill bits, or any number of areas. It seems as if every industry in the world has a thermal management problem right now. We are not out selling; the customers are coming to us, asking us if Cool Chips can solve problems we never imagined. The customers are hammering us for product.

So who are your customers?

Most corporations are not amused by our business model. We have a proprietary product, solid patent protection, and the production capacity to do $40 million to $120 million a day in revenues, at proprietary prices. We know plenty of large corporations whose basic strategy is to lock smaller companies into a satellite relationship as a supplier, and then tie them down to commodity goods pricing. Cost-plus again. The larger company is then looking to get proprietary pricing for its products.

So, as with funding, picking your customers and your relationships with the customers is crucial.

There is one customer for nano-technology that far and away outshines all other customers. That is the U.S. government.

The U.S. Government sends out lists of problems it wants solved. The U.S. government tries to make sure it gets anybody and everybody of any possible value into the grant system so they have direct free access to all science generated.

Since we haven't taken any government money, we tried but none was offered in the old days, we expect to get paid market value for our products.

Our strategy is to have the products available for those government projects that simply must have our products. We think we can succeed. We think we know how to do the deals. We think we know how to get paid and we expect to technologically outrun all the government projects that may be trying to catch us.

Cool Chips represent an active cooling solution. They take temperatures down below the ambient temperature. Our technology is needed badly and needed now by the government and the industrial base.

Most new cooling technologies are really heat sinks or heat pipes: they don't produce any active cooling and won't take temperatures below ambient. We know some of these systems are very clever, and we admire the smart and elegant way problems have been solved. But there are many of these passive solutions.

The big customers, and nobody is bigger than government, can afford to pick and choose between heat sinks. To have the status of "most favoured heat sink" is a fine thing, but to be the only active cooling solution that can give the results the government needs is even better. Favour is less important than being able to get paid a true market value for a must-have product.

So in selling to the government, have products that the government must have, that meet their specifications and then sell and deliver your product only against wired funds. Boeing completes every single airplane sale over international waters, against wired funds. Boeing has a lot to teach us all about how to do business.

Be patient to get the deals done right.

One of our ex-shareholders made a major advance in a spectacular military field in the early 1960's. He had unlimited government sales and the government decided to pay in 270 to 540 days. He lost his business because he could not get paid in a timely manner from his customer who was taking delivery on huge orders almost daily. The government wanted to deal with a major player and he was made toast on the back of bad cash flows that the government deliberately arranged. A local company, which the government wanted to have the science, got his company, his patents and his IP.

Almost all nanotech products, if they are of any value, have high-value military applications today. If your product isn't good enough for the military, then it's probably not good enough to capture consumer markets either. Of course you can bypass defence sales if you want to, and go straight to mass production. You will be looking at a heavy capital investment for commodity pricing. It's not easy to break into the markets on that basis.

Government funding, along with the stultifying grant proposals, low expectations, and resume-padding paperwork has crippled scientific innovation in the U.S. There are more scientists working right now than there were *combined* in the world up until 1900. The quantity of work is high, and all the journal submissions are formatted properly, but the breakthroughs that drive our modern world were never designed or invented by a government-funded bureaucracy.

Consider major inventions of the 19th century, *none* of which were developed by a government bureaucracy:

Bessemer steel process. Still dominant.
Internal combustion engine. Still dominant.
Vapor-cycle refrigeration using compressors. Still dominant
Three phase electric motors. Still dominant.

And the 20th century? The automobile on a production line, ball-point pen, and conventional power generation were all invented and developed privately.

There have been advances in medicine (largely funded by drug companies, though the government seeks credit). And of course, don't forget the semiconductor revolution, which has been almost entirely privately funded. Intel, IBM and others have not suffered for it though in many cases they got proprietary pricing for supplying the government with goods and services. And then we have the Internet, which may have been invented by a couple of ARPA employees, but they were not carrying out the instructions of the all-knowing bureaucracy. Indeed, by some accounts they were specifically told *not* to do it. Google certainly is wonderful, no government there. Software inventions have also been generally free of the government-funded millstone.

The really cool inventions didn't happen because some committee approved them. Radar, computers, and the jet engine were all private developments at which the government, in time of war, threw money. Lacking post-war oversight and proper paperwork, these inventions became extremely important. Nothing like them has emerged in peacetime, with all the right people sitting on all the right oversight boards and making all the right decisions. So don't be downhearted. If nanotech, as we expect, becomes very important, it will not be because the National Nanotechnology Coordination Office made it so.

So there is a difference between taking government funds for research, and seeking to sell your products that come from your research to the government after they are done.

Nanotechnology allows everybody to look at the old problems and get new solutions.

We are re-inventing everything from thermal management to power production to electric motors.

We have wide-ranging basic scientific projects that are anywhere from weeks out to decades out. The DOE list of projects looks very much like ours. Scientifically we are clearly ahead of the DOE in at least 60% of the projects they address. Because of our small management team and low level of funding, and because we are building for the military markets, we just have not gone out into the commercial market place yet with our technologies. Power Chips for example will totally transform the world's energy markets.

We expect, for example, to take on the energy markets using profits from Cool Chips. The energy markets are large but we cannot get the kinds of pricing we can get for Cool Chips so we must stay where we have the production capacity to meet the initital high value demand for product.

Given our wide ranging patent base of basic science and our drive to make and sell product ourselves and our willingness to use our revenue and profits to further grow the business, we would hope in the next decade to have our market values driven at least 1,000 to 10,000 to one from where they now stand.

The path is clear; the opportunities are truly awesome as we all make this world a better place for everybody.

If you have the goods, and are not contaminated, we are very interested in talking to you and helping to drive your product to commercialisation.