

Quicklook Analysis of DHT's Retractabit™ Technology
Prepared by MarketEdge

Technology Description

The Retractabit™ is a mechanical device for the drilling industry, which is comprised of the oil and gas, the geotechnical, and the mining sectors. The mining sector version of the device enables changing of the diamond core bit down the hole without having to first withdraw all the drill rods and send them back down again. It works in conjunction with a wireline, which is similar to a coat hanger wire on a spool.

For the proposed oil and gas application, the technology would consist of:

- ❑ A complete assembly which travels up and down
- ❑ A fishing head
- ❑ The cutting heads would 'cone' out of the assembly in three parts, much like the operation of a clutch pencil mechanism.

When a bit change is required, the Retractabit™ tool is lowered inside the drill string on the wireline until it locates into the down hole assembly. It is then withdrawn on the wireline with the retractable bit collapsed onto the tool. Upon reaching the surface, the bit segments are replaced as required. To insert the bit, segments are assembled onto the Retractabit™ tool and lowered through the drill rods on the wireline.

Potential Benefits

Because the bit can be replaced without the need to withdraw the drill string, non-drilling or lost time is greatly reduced, leading to higher profitability. Shift cost reductions and/or productivity increases of up to 25% or more could be expected. These benefits are greatest in environments where time is most important. One such application is offshore drilling, where the cost of rig hire may be up to \$250,000 per day. Another time critical application is where the company has only a limited period of time to explore and prove a lease, before it is returned to the government.

The technology can achieve increased penetration rates by using the most effective bit at all times in differing ground conditions, and because it is a freer cutting bit. Penetration rate is a key metric for drilling.

Reduction in rod trips leads to greater safety. In the mineral drilling industry 70% of drilling accidents occur while 'running pipe', i.e. withdrawing and reinserting the drill rods. As the Retractabit™ can eliminate 80-90% of trips, an argument can be made that companies need to use the technology to fulfill a duty of care to their employees.

Other benefits recognized for the mining version that might translate to the oil and gas market are:

- ❑ Reduced bit wear
- ❑ Reduced rod pulling and lowering reduces wear on rigs.
- ❑ Lower incidence of dropped rods, leading to higher productivity.

Potential Commercial Markets

It appears that DHT's Retractabit™ technology can be adapted to three main subsurface drilling markets:

- ❑ Core holes for exploring and delineating mineral deposits
- ❑ Geotechnical holes
- ❑ Oil and gas well drilling

This evaluation is specifically focused on the United States (US) oil and gas drilling market. Three specific uses were considered: coring, conventional drilling, and casing type drilling.

Almost all of the US is in a mature to very mature stage of development for oil and gas deposits. Oil production peaked in the early 1970s. Well drilling is directly tied to oil and gas commodity prices and

somewhat related to the cost of labor, supplies and equipment related to this industry. Drilling peaked during the price boom of the late '70s-early '80s and has been in decline since then.

Not only has the overall rate decreased, but also the relative percentage of exploratory to development wells. In the '70s, 20% or more of the drilling was for exploration wells. By 1999 that percentage had decreased to 10%. Also during the last 10 years gas has increased in relative value vs. oil in the US, so gas well drilling now dominates the market. Over 70% of the wells drilled in 1999 were for gas.

One US area that is in a lot less mature stage of development is the Gulf of Mexico (GOM) offshore. This is especially true for the deeper water areas of 1000 feet and greater water depth. Here the need to evaluate leases before they revert back to the government and the limited availability of deepwater rigs are more dominant controls on drilling. Exploratory drilling is expected to increase over the next several years as deepwater rigs, now in construction, become available.

Our experts felt that a new drill bit technology would have to have very obvious benefits. Being able to significantly shorten the time to change bits was seen as a potential advantage of this type. There was also strong agreement that a new bit technology would need to demonstrate durability and reliability at least as good as current methods.

Indications of market size varied a great deal for the three specific uses examined:

- ❑ *Coring*: While no specific numbers were available, our experts agreed that this has and will be a very limited market for a retractable bit.
- ❑ *Conventional Drilling*: Even though there has been a substantial decline in US drilling over the last 15 years, there were still over 18,000 wells drilled in 1999. Indications are that this type of annual rate should continue for the foreseeable future. Also, offshore GOM drilling is expected to increase and/or remain high for the next several years.
- ❑ *Casing Drilling*: This is a newly developing market. It is particularly suited for development wells in know areas. Development drilling dominates the US numbers and many of these wells are in and around large known accumulations of oil and gas. TESCO, a market leader in the use of this new drilling approach, seemed to indicate that possibly up to 20% (3,600 wells in 1999) of the drilling market might be targeted for this approach.

Market Interest

DHT reports that 40 attempts have been made in the last 100 years to build a retractable bit. Recent attempts to create retractable bits have been reported in Russia and Canada. The following industry experts all expressed interest in a retractable bit.

Dr. Leon Holloway of the Texas A&M Ocean Drilling Program has contracted with DHT for the development of a 7 1/4" coring bit for deepwater geotechnical drilling.

Dr. Leon Robinson is the retired Head of Research and Development for Exxon Corporation, with 39 years of R&D experience. Dr. Robinson said that, in the oil & gas business, it was very difficult to gain consensus on customer needs and difficult for a new technology to break into the market but that two segments of the market have potential. Casing type drilling operators would be very interested in a retractable system that could easily and reliably convert between drilling and coring. This would also be of interest to offshore operators, especially for deepwater, exploratory wells. Daily rig rates are \$200-250,000 day rates to drill these type holes and the bit would be very attractive if it can demonstrate a time savings in the Texas A&M Ocean Drilling Program.

Mr. Marvin Gearhart, CEO of RBT International, said significant savings in round trip time would strongly encourage the acceptance of this type of technology. Mr. Gearhart also felt strongly that the entry path would have to be via proving it on land at all reasonable depths before it would be considered offshore. While the cost savings would be greatly magnified offshore, so are the risks. Mr. Gearhart does not think operators will be prepared to use multimillion-dollar offshore wells as proving grounds.

Mr. Jeff Kushner, a drilling engineer with Suncor's Heavy Oil Group in Canada, believes the best fit might be for hard rock coring. Mr. Kushner thought the best setting, for a conventional drilling application, would be in a known development field, with soft rock and where there was a good control of

drilling risks. He estimated that this might represent up to 40% of the Canadian drilling market. In 1999 there were about 10,500 wells drilled in Canada and there were, on average, 246 rigs active during the year. This compares to about 18,200 wells drilled and 625 average rigs active in the U.S. in 1999. Mr. Kushner also mentioned that a possible application is the casing-drilling sector, in which TESCO is active.

Mr. Tommy Warren holds a senior position in research and development with TESCO and is actively seeking retractable bit technology for their casing drilling business. They are currently using a retractable under reamer with a conventional bit and are seeking performance improvements that could be achieved with the Retractabit™. TESCO would be able to commit R&D dollars to bring the technology to prototype stage, given suitable partnering arrangements. He believes the market for casing drilling would be no more than 20% of total drilling. That would be 3,600 wells or less of the 18,180 drilled in the U.S. in 1999. Mr. Warren did not believe there would be a significant market for oil and gas coring.

Mr. Matthew Egan is currently with the Australian drilling operator Drillcorp. Drillcorp is the market leader in diamond drilling in Western Australia, with greater than half of the market. Drillcorp and two other Australian drill operators are using the Retractabit™ technology now and report enormous success in 600m deep holes. They are now moving into 1000m and deeper holes where greater economic benefits can be achieved. For onshore drilling in oil and gas, Mr. Egan believes the future of the Retractabit™ is tied to the adoption of a technique known as 'slimhole' drilling. This would remove the problems associated with the internal and external dimensions of the drill pipe versus the size of the retractable bit and its expansion ratio. (While slimhole drilling has been tried in North America, it has not become widespread to date).

Each of these experts expressed interest in the retractable bit for their various drilling markets. However the bit would have to demonstrate quality and reliability, equivalent to the current technology with some obvious added benefit such as cost savings. They suggested several measures or performance the retractable bit would have to meet:

- It meets or exceeds current penetration rates.
- The latching mechanism is rugged.
- It does not create a lopsided hole or go under gauge.
- The bit has comparable durability to current drilling systems.
- Various bit diameters would need to be available for different industry application requirements.

Development Status of the Technology

There are three main customers for the Retractabit™ technology: core hole drilling in the mining industry, geotechnical drilling, and oil and gas drilling:

- A commercial model of the Retractabit™ currently exists for the core hole drilling segment of the mining industry.
- Under the auspices of the University of Texas A&M Ocean Drilling Program a prototype has been developed for the small niche, geotechnical drilling segment of the market.
- The oil and gas version of the device is currently at working drawing stage. Some components have been demonstrated drilling on a bench top assembly.

All offshore development drilling is directional which requires a mud motor to help create the desired angle. This complication would need to be addressed by the Retractabit™ technology to compete in this offshore development drilling market.

DHT might be able to fairly easily modify their Texas A&M prototype for use with a casing drilling company like TESCO. This prototype requires approximately \$500,000 to move through development stage. A marriage with a company like TESCO can move the technology along and help to establish markets that DHT want to build.

Patent Status of the Technology

At this stage DHT has applied for a US patent and an international Patent. DHT has filed for multiple patents on innovations relating to Retractabit™ technology manufacture.

The US patent is currently in a pending status while the US examiner is reviewing the claim. There have been a number of objections raised by the examiner including "...lacks novelty in light of prior US patent No 3,603,413..." along with some other minor objections. DHT patent attorneys have responded to the objections with amendments and explanations. DHT anticipates that all objections will be overcome.

The international patent is also at a pending stage. At present DHT is waiting on the outcome of an International Search Report (ISR) initiated by the Australian Patent Office. DHT will be required to choose the countries in the pact (PCT) that it requires patent protection for on or before 29 April 2001. No decision on which countries will be selected has been made at this point.

The first patents have been issued and are:

- US Patent application serial Number: 09/253,743
Filing Date: 22 February 1999
Name: Retractable Drill Bit System
In the name of: DHT Technologies Limited (assigned from Gavin Thomas McLeod)
- International Application No PCT/AU99/00878
Filing Date: 13 October 1999
Name: Retractable Drill Bit System
In the name of: DHT Technologies Limited (assigned from Gavin Thomas McLeod)

Other patenting activity of additional concern is:

- US Patent application serial Number: 4,384,627
Filing Date: 24 May 1983
In the name of: Ramirez-Jaureugi
This patent upon review appears not to present infringement issues.

Reports of Russian patents in the 1960's are not verifiable. In any event, it can safely be assumed the technologies are now in the public domain. Also, reports of attempted patenting activity by Aquatica for technology funded by the Department of Defense are not substantiated. No significant infringement issues appear to be presented upon review of the oil and gas professional journals.

Competing Technologies and Competitors

There are a number of competing technologies and competitors in the market place, which have enjoyed a long history of success for conventional oil and gas drilling. None of these are retractable systems. These fall under two main bits types, roller cone and PEC or drag bits with stationary ends. For casing type drilling, retractable under reamers with pilot bits are currently in use.

Roller cone bit technology has dominated the market for many years. They normally have 3 cone ends that are free to rotate independently with intermeshing cutting pieces. The heads with bearings, are attached to a solid base. Various sizes are available from the 20" range in cross section to around 4 inches.

PEC or drag bits have stationary ends of various types. They offer conventional coring ends that are fixed with diamond insert pieces or bit end types that are used for conventional drilling. With this apparatus, grinding of the rock occurs instead of chipping. This technology has become more in vogue recently. These type bits offer longer life relative to other technologies currently popular in the industry.

For a well that will be produced, casing will be run over the commercial zones in order to penetrate different zones to selectively open them for production. With conventional drilling the well is drilled to bottom, then the entire drill pipe is removed, the hole is conditioned, then casing is put down the hole and cemented into place. With casing type drilling the last sections are drilled with casing and the driller puts the casing in place while drilling occurs. Because the casing will remain in the well, bit systems for this approach need to be retractable

Most closely related to the Retractabit™ technology under consideration and used in conjunction with the casing drilling, is an under reamer that has a pilot bit at the end, presenting a smaller outside diameter than the casing. The under reamers are retractable arms, much like a bowstring, that push out under the drilling pressure. The pilot bit starts the drilling and the under reamer follows closely behind. Under reamers are known to be not always reliable. The competitive advantage of the Retractabit™ technology would be in terms of dependability, reliability and length of assembly. The entire under reamer assembly is approximately 30 feet long. The Retractabit™ assembly is considerably shorter by a magnitude of four or five times.

It is reported that the Russians have similar technology. No exact details have been discovered. This technology has been in existence since the '60's. It seems to be inferior mechanically and in terms of it's milling and metal strength.

Barriers to Market Entry

A general reluctance to try new products seems to permeate the oil and gas exploration and development markets. Without conclusive data, drilling or exploration services companies are unwilling to take risks on an unproven technology. One of the co-inventors, Gavin McCloud, stated that 40 different retractable bit designs have been tried, but none offered acceptable results. Any new product will have to be proven in actual drilling operations before eliciting acceptance in the oil and gas market

Even with a test program planned this year with the Texas A&M Ocean Drilling Program, adequate funding by the industry has not been forthcoming. Major funding for the Program is coming from the National Science Foundation with a small amount being provided by the membership fees from companies involved with the Texas A&M research consortia. It is estimated that it would cost up to \$500,000 to complete the fabrication of a prototype bit and to perform drilling tests on the University's drilling vessel as proposed in this phase of the program. Since no oil companies, as yet, are willing to take the risk, the Program is currently on hold due to administrative delays at the NSF in Washington, DC.

Rental costs of drilling vessels for deepwater GOM exploration can average \$200,000 to \$250,000 per day. As a result companies are reluctant to risk these precious resources on an unproven technology. There is little crossover data accepted between the mining industry and the oil and gas industry. The technologies commonly in use in these two industries vary enough that acceptance of cross over data is unlikely in the short term. DHT will have to demonstrate the potential time savings, improved safety, and improved performance for an overall reduction in oil and gas drilling costs before the Retractabit™ is likely to be accepted by the industry. Also, Leon Holloway identified as a significant barrier for conventional offshore drilling, a new size drilling pipe that likely would have to be manufactured at an estimated cost of \$2-3,000,000.

Opportunity to demonstrate the benefits of the Retractabit™ will be limited for the oil and gas well coring sector. Coring is not done frequently and when used, often is only used for 30 to 60 feet of a well. This is usually not enough penetration to wear out a bit, thus not requiring bit trips.

In addition, the inventors have stated that one reason for wanting to lease the bits to customers is that the bit assembly is complicated, requiring assembly by factory trained technicians. This marketing strategy will need to be avoided or the rig operators might quickly label the bit "too complicated" before it has a chance to prove its worth.

Recommendations

A retractable bit has great potential for the oil and gas market, if the proposed benefits and savings are realized in testing. A latent, unsatisfied demand is found in general in many different sectors of the oil and gas industry. Two market segments in particular have been identified, conventional oil and gas drilling in the US offshore areas and casing drilling. Combined with the likelihood for increased drilling activity in the near term, due to the current high world oil prices, it is recommended that efforts should be doubled to find funding to speed the development of the bit for oil and gas. The current difficulty in funding for the Texas A&M testing could delay the introduction of the bit from one to two years.

For the offshore conventional drilling option, a dual path approach to gaining industry acceptance is recommended. First, the test plan for the Ocean Drilling Program at Texas A&M should be continued as the major source of independent performance data for the Retractabit system. Pursuit of a major industry partner should be continued as the secondary option for industry acceptance.

For the casing drilling option, efforts should be made to develop a partnership relation with one of the drilling service companies that are currently involved with this type of drilling, like Baker Hughes or TESCO. Mr. Warren, of TESCO indicated they would be prepared to financially support a workable retractable technology for their casing drilling operations.

The following are some additional recommendations:

- Explore the possibility of utilizing the old Amoco testing facilities at Catoosa, Oklahoma, (now run by the Gas Research Institute). There, a company can basically rent a rig to drill test hole to tryout new drilling technology.
- Make contacts with the Drilling Engineering Association (DEA). DEA is a loose consortium of operators that support various drilling related technology to get through the development stage.
- Consider utilizing a US employee and/or consultant to champion some of these efforts. Oil and gas is a very hands-on business with complex relationships between operators, drilling contractors, and various types of service providers.

Commercial Potential Rating

Factor	Weight	Score
Market Potential	25%	1.7
Market Maturity	15%	1.9
Technology Development	40%	1.3
Competitors/Patents	20%	2.6
Total		1.8

Interview Summaries

Technology Inventor/Owners:

Gavin McLeod
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Retractabit Inventor
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Mr. McLeod described the "latent desire" the industry has for a retractable drill bit using as an example the 40 previous attempts by others to make a retractable bit. He is confident that this one will work and has helped create a patent web around the technology with patents worldwide covering mining, down hole assembly, diamond bit assembly, and so on. DHT plans to own the patents and sell licenses to manufacture and distribute. They have also discussed collecting royalties or gaining premium \$ from selected necessary components.

The OCEAN DRILLING Program at Texas A&M University, is working to develop a coring bit for use on their exploration vessel. The bit would create a 7¼ inch diameter hole and create a 3 inch to 4 inch diameter core. A&M is funding the prototype stage for 12 months with a grant from the National Science Foundation in Washington D.C. The bit will be based on a version of the bit currently used in mining operations but will incorporate improvements and changes for the oil and gas application. A&M plans only to use the bits on their vessel and will retain no rights nor will they try and commercialize.

Mr. McLeod estimates that it will be 2 years before a marketable product is available for use in the oil and gas industry. He is not familiar with drilling in the oil and gas industry but indicated that the greatest benefits of the retractable bit can best be demonstrated during coring operations.

No working full-scale model exists at this time, and will have to be built and tested in order to get industry buy-in. The company will have to overcome barriers of modifications to the current drilling processes, some complexity in operating the bit, and the lack of operational data to gain market acceptance. Cost is estimated as comparable to conventional drill bits.

A Complementary Technology was also described as a possible introductory market. TESCO is drilling with the casing using a retractable reamer. Diamond or roller cones are placed on the end of the casing. They want to put Retractabit™ onto this simple design. TESCO contacted DHT last year and expresses interest but no follow up has been made.

Drew Cary, CEO
DHT Technologies Limited
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<mailto:dcary@dht.com.au>

Mr. Cary is CEO of DHT (Down Hole Technologies), which was formed to commercialize the retractable bit technology.

DHT's business plan is to rent the tool for the following reasons:

- They plan to continually update the tool, so it avoids the customer being left with a superseded technology.
- The tool is quite complicated, so it is better to offer it as a service.
- It allows better control of the IP, as it becomes obvious if pirate versions start to appear.
- It is financially beneficial, given that the rental would be about \$A10,000 per month. With 2,000 hours of drilling, or about 12 months, this gives a significant return on the manufacturing cost.

Mr. Cary believes the cost of a total assembly for the oil and gas market would be \$A20-30,000. The cost of the bottom assembly only would be approximately \$A2,500.

The existing mineral technology consists of:

- The wireline which is like coat hanger wire on a spool
- An assembly on the drillstring, consisting of a housing on which the bit will land and lock.
- A tool that travels down with the bit then comes back up leaving the bit in place.

For the oil and gas application, Mr. Cary would see the technology as:

- A complete assembly which travels up and down
- A fishing head
- The cutting heads would 'cone' out of the assembly in three parts.

Mr. Cary would see the application as drilling the lower part of a hole, where the most bit changes take place, or for coring. Therefore a combined production hole and coring is a good prospect, for example where a core is taken as the bit drills through into the oil/gas reservoir. However coring is a fading technology, given the advent of electronic tools for measuring while drilling.

Mr. Cary also discussed safety, which the distributors plan to use as a selling approach. Since 70% of drilling accidents occur while running pipe, and Retractabit can save 80-90% of trips, they will argue that companies not using the technology are not fulfilling their duty of care to their employees.

While most mining drilling is cored, there are many hurdles to cross to translate the experience to the oil and gas business. Hence they would foresee a different distributor for the O&G market from the mineral market. They would also see local manufacture in each market, so as to allow minor localizations.

Offshore drilling would be better suited to the technology, because of the high cost of rig time.

Oil & Gas R&D Representatives:

Dr. Leon Robinson
Retired R&D Head for Exxon
713-465-6041
docleon@att.net

With 39 years of R&D experience, Dr. Robinson said that, in the oil & gas business, it was very difficult to gain consensus on customer needs and for new technology to break into the market. Did say that a technology would need to:

- Have no more than one new component or it would hit a wall.
- It would have to have very obvious benefits and
- It would have to be as reliable as existing technology.

He felt that it would be very important for DHT to partner with an establish service provider(s) to facilitate implementation. Dr. Robinson felt that the two best possible fits for a retractable bit technology were for casing type drilling and for offshore, especially deepwater, exploratory wells. Dr. Robinson thought that the casing drilling business might be a very good fit. He also said that deepwater exploratory drilling should be a market that would highly value the technology for two reasons. First, with \$200-250,000 day rates for rigs to drill these type holes, trip saving would be a major issue. Second, the trend is to drill as few exploratory holes as possible in this environment before making a development decision. Therefore, maximum data per hole is a must. If a retractable system could easily and reliably convert between drilling and coring it would be very attractive. In other words, if during drilling there was some advance reading of a possible production zone; the capability to quickly pull the bit and go back in to core would offer a significant advantage. He thought that the Texas A&M Ocean Drilling Program offered an excellent opportunity to attract the attention of deepwater operators. Agreed that larger drill pipe than current used in the U.S. offshore (5-5 ½ inch OD) would be needed. Pointed out though, that in parts of the North Sea operators were using 6 5/8 inch OD pipe (with about a 5 inch ID).

Dr. Robinson said that a very good contact point for a company like DHT was the Drilling Engineering Association (DEA). DEA is a loose consortium of operators that support various drilling related

technology to get through the development stage. You go make your presentation and if some companies want to commit to supporting it they can, others can decide to pass.

Chris Buckingham
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Mr. Buckingham's background is associated with the drilling fluid transport system. This includes things like fluid movement, carrying capacity of the fluid in regard to getting the drill cuttings from downhole to the surface, holding back downhole pressures, etc.

He thought that how the tool would move up and down in a horizontally drilled well and downhole pressure control, while the tool was going in or out of the hole, were the type things that operators might consider as possible issues. Therefore DHT would want to know the answers before hand.

Mr. Buckingham did say that there was another guy at Southwest that has worked on Measurement While Drilling (MWD) tools. He said he would try and get the person to give us a short call to talk.

He provided a good follow-up reference, the Gas Research Institute. Said that not long ago, they were asking for proposals for a study associated with whys to significantly reduce drilling costs. Their URL is <http://www.gri.org/>.

Users of Mining Technology

Mr. Matthew Egan
RC Operations Manager
Drillcorp Western Deephole
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Mr. Matthew Egan is currently with the Australian drilling operator Drillcorp Western Deephole. Mr. Egan is also a co-inventor of the Retractabit™, and a DHT shareholder, hence his input must be seen in that context. We would expect that a venture capitalist or potential partner, doing due diligence on the technology, would need to speak to a disinterested user of the technology. This was not possible for this report in the circumstances, as some key commercial negotiations are under way for the mineral drilling application. However, Mr. Egan was able to shed some light on the latest field performance of the technology, as well as the issues with its implementation.

Matthew has 16 years covering all aspects of exploration and mine service drilling requirements. He was the Manager of his family company Aquadrill Pty Ltd, which had been a leading contractor in Western Australia for 30 years.

Drillcorp Western Deephole's main focus is in exploration mineral drilling in Australia and Africa, with headquarters in Perth, Western Australia and bases in Johannesburg (Republic of South Africa), Mwanza (Tanzania) and Lusaka (Zambia). The Business in South Africa trades as Crisp Drilling. The business operates 42 drilling rigs in Australia and 21 in South Africa. There are four drilling rigs in Tanzania.

Drillcorp is the market leader in diamond drilling in Western Australia, with greater than half of the market. The company has been the catalyst for the development of advanced drilling equipment in Australia, being the first contractor to have in the field: operational automated drill rod handling machines, silenced drill rigs, dust suppression, drill rod spin guards and many more safety enhanced features.

The field performance of the mineral drilling Retractabit™ in the past three months has been the best ever. Mr. Egan attributes this to the fact that Drillcorp saw it as a competitive differentiator, and hence had committed to do what was necessary to make it a success. This mainly centered on change management,

in changing the culture of the drilling workers from one of self-reliance to one of following procedures and calling in assistance early when required. Also Drillcorp had decided to test the technology in friendly conditions, by using it initially for drilling in known fields with known conditions.

This implementation of the technology has been enormously successful. As well as the expected savings in trip times, Drillcorp has been able to demonstrate higher penetration rates with the technology. This has been coupled with the bit being 90% as durable as a conventional bit. Since the penetration rate is the key metric, this trade off is very beneficial. Mr. Egan expects that the Retractabit™ can achieve equal durability to conventional bits.

The market in WA has typically been for approximately 600m deep holes. There are now many going to 1000m or deeper, and these holes increase the economic attractiveness of the retractable technology. The land rights legislation and debate has focused the industry on achieving the maximum benefit from existing leases, rather than exploring new areas. Hence companies tend to drill deeper in existing tenements, making retractable bits more cost effective. The market is split approximately 30% exploration, and 70% delineation of existing prospects. The market is almost exclusively gold mining.

For onshore drilling in oil and gas, Mr. Egan believes the future of the Retractabit™ is tied to the adoption of a technique known as 'slimhole' drilling. This would remove the problems associated with the internal and external dimensions of the drill pipe versus the size of the retractable bit and its expansion ratio.

Regarding the 'hole conditioning' requirement of the oil and gas industry, Mr. Egan said this was also required in minerals. This has been solved with a technology to grease the drill pipe in situ, avoiding the need to retract the drill pipes.

As well as Drillcorp, there are two other drill operators in Australia using the technology now. The economics of the industry in Australia mean that the drilling operator retains any savings that flow from the retractable technology, although over time this would flow on to the end customer.

Ocean Drilling Program Representative

Leon Holloway
Texas A&M – Ocean Drilling Program
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The Ocean Drilling Program at Texas A&M University receives funding from the National Science Foundation and the Oceanographic Institute. With a budget of approximately \$60 million it enjoys the involvement of 22 countries. TAMU is developing the prototype for the ocean drilling application of the Retractabit™ technology.

The Russians have developed similar technology however it's engineering and poor stock machining was deemed inferior when tested at Terratec with the University of Utah by Dr. Oneasham in 1992. Due to the passage of sufficient time, he is confident that no old patents could be dusted off to make a credible challenge.

Professor Holloway anticipates market resistance because most pipe common in the industry does not have a large enough bore to accommodate the tools DHT has developed. Ocean drilling typically requires a 4 1/8" bore I'd. with a 7 1/4" bore old., while a 2"-3" I'd. bore is common in the oil and gas sector. He expects that opportunities exist in the geotechnical sector. In his view, only recently are tools compatible with all three sectors including mining, oil and gas, and, geotechnical.

An important barrier to market entry was identified to be in the drill string which could have a cost approaching \$2-3 million. If the technology was found to be robust and durable then perhaps downstream a leasing arrangement could make the drill string available. He considers the technology revolutionary when seen in the context of science drilling programs but broad commercial applications could easily be 5-6 years away.

The Japanese have active interest in the TAMU Program and could be seen as a potential development partner for the production of the drill string, thus reducing its development time. The Japanese are currently building a \$350 million drilling vessel that will offer day rates of \$200k. If the retractable bit can eliminate 12 bit trips per voyage, then development costs of the drill string can easily be recouped.

Competitors:

Marvin Gearhart, CEO
Rockbit International Inc.
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rockbit@rbi-gearhart.com

Mr. Gearhart was familiar with DHT and their efforts with TAMU. He appeared to be very familiar with the Ocean Drilling Program (ODP).

He said the saving round trip time is a big deal and would strongly encourage the acceptance of this type technology. But demonstrated quality and reliability, at least, as good as current technology would be a must and would have to be proven before the drilling market would accept a new drilling idea like this.

Mr. Gearhart felt strongly that the entry path would have to be via proving it on land at all reasonable depths before it would be considered offshore. He does not think operators will be prepared to use multimillion-dollar offshore wells as proving grounds.

He said that very good first step would be for DHT to use the old Amoco testing facilities at Catoosa, Oklahoma, (now run by GRI). There, a company can basically rent a rig to drill test hole to tryout new drilling technology. He said the cost was about \$4000/day.

Mr. Gearhart is familiar with the Russian retractable bit technology. Said there was an article about a year ago in the Oil and Gas Journal. Marvin had talked with an Alistair Shiver about the Russian technology. Mr. Shiver is with the British Geological Society and is on one of the technology committees for the ODP program. Mr. Shiver had seen it used on a test hole and said it did well.

He did not think that, if the technology was only used for coring in the Oil & Gas industry, there be a substantial market.

Mr. Gearhart said that in the oil and gas industry the operator is the real customer, not the drilling contractor or service provider. He also thought that the large operators needed to be the first group focused on to sell the technology.

Mr. Gearhart made two other suggestions the DHT might consider. First, they should consider trying to work with a major Australian operator, like Santos, to establish a track record of quality and reliability. Second, he suggested that the Drilling Engineering Association (DEA) would be a good place to start in the US. DEA is a joint industry focused on evaluating new drilling technology. Bill Maurer of Maurer Engineering, Houston, URL <http://www.maureng.com/>, heads it up.

Potential Service Partners and/or Competitors:

Tommy Warren
TESCO Drilling Technology
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tommy.warren@gte.net

Mr. Warren said threshold issues would be drilling life vs. trip savings. He listed the following as the most important needs a retractable bit would need to meet:

- Off course saving on bit trips.
- Adequate penetrate rate.



- ❑ Bit life equal or better than current bits.
- ❑ Operators would need to feel comfortable that the various part of the tool would not break-a-part downhole.
- ❑ Ability to drill various formations.
- ❑ Downhole pressure control also has to be addressed. He said to assure you did not swab in the well as you pull out the bit assembly, you have to be able to circulate through it as it is being withdrawn.

He was skeptical that the technology could be adapted for conventional drilling. Pointed out currently, most drill pipe has an inside clearance of only about 3 inches. The expanded bit would need to be in the range of 7 7/8 and 8 1/2 inches. This is about a 2.7 ratio. Mr. Warren did not think that there would be much of a market for coring. He thought, though, there could be a fit in regard to casing drilling (TESCO is a leader in this type of drilling). For a retractable bit for their system they would need about a 1.5 ratio between closed and opened positions of the bit. For example, if they were using casing that had an ID of about 6 inches then the bit would need to open up to about 8 inches.

Currently TESCO use system that consists of a pilot bit, smaller than the casing ID and a three armed under reamer system that opens out once the assembly has been lowered down and locked into place. For the pilot bit and under reamers, they have used both PEC and cone type bits. Said that the cone approach did not work well for the under reamers. For harder rock or directional holes they will also use a downhole mud motor. If the operator were using an MWD tool, then it would latch onto the top of this assembly. Everything would go in and come out of the hole together. They use a wire line or sometimes drill pipe to move the assembly up and down inside the casing. The bit assembly is about 30 feet long. With mud motor and MWD it is about 120 feet long. (Workable retractable bit system would reduce that 30 feet length quite a bit.)

Mr. Warren said, currently, the market for casing drilling is mostly for development wells in known fields. He said though, they are starting to get some jobs drilling the upper part of exploration holes. He said that he was not absolutely sure what the market size was for casing drilling. Seem to indicate, though, that it might be no more than 20% of total drilling. That would be 3,600 wells or less of the 18,180 drilled in the U.S. in 1999.

TESCO is in the position to be a user and/or developer of a good retractable bit technology. Currently focus is working on improving under reamers while looking for possible retractable bit alternatives. For right technology, would be prepared to work with a company that had a sound mechanical idea, to develop a working prototype. They would have significant \$ (100Ks) to put into a prototype partnership.

He said that Maurer Engineering of Houston had undertaken a Department of Energy funded project to evaluate various drilling technology. The retractable bits were highlighted by the evaluation. Maurer had an article in Oil and Gas Journal about a year ago about the Russian retractable systems. TESCO has evaluated the Russian retractable bit technology. Said it was developed in the '60s. They have 3 cone and drag bit types. It offered about the 1.5 ratios that TESCO was looking for but did not meet durability requirements.

Mr. Warren said that, while most bits are sold, there systems were rented. This is because a lot of the components are reusable and to protect the technology. He assumed a retractable system would take a similar approach.

In regard to pricing, he said that the customer would look at the alternatives to decide if they were willing to pay the asking price for a new technology. But he said if it was an enabling technology, then could ask more a premium price.

Potential Users:

Jeff Kushner
Suncor, Heavy Oil Group
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Mr. Kushner holds the opinion that in this industry the operator is the real customer for the bit technology. The issues of greatest concern to satisfy customer needs, he believes, would be penetration rates, the durability of the latching mechanism, trueness of holes, sustained drilling, and, not under-gauging.

The best fits for the technology in the coring sector, would not be in soft rock drilling, where coring was less common and usually occurred only to a depth of 30 to 60 feet making trip time savings less of an issue. Also, this technology in earliest versions would not be suited for directional and horizontal drilling. In some settings drillers want to make bit trip every so often to swap and clean the hole. In hard rock coring there might be a better fit for a retractable bit where trip savings are more of an issue. If a workable conventional drilling system of a PEC or drag bit type was developed, it would have to be designed to overcome penetration rates and gumming up problems which are critical to this sector of the industry.

Market acceptance could be higher in conventional drilling in a known development field in a soft rock environment where there was good control of drilling risks. This might represent up to 40% of the Canadian drilling market. In 1999 there were about 10,500 wells drilled in Canada and there were, on average, 246 rigs active during the year. This compares to about 18,200 wells drilled and 625 average rigs active in the U.S. in 1999.

Brian Sabin
Exxon-Mobil, Geophysical Engineer

Mr. Sabin is a Geophysical Engineer for Exxon-Mobil as a reservoir analyst. He stated that he is not familiar with any of the details of the actual drilling operation.

He commented that a bit with retractable cutters could be very useful. Bits are known to get stuck for a number of reasons. They can bind as they pass through different strata, which can cause shifting. Sometimes they are left down the hole for various reasons and they bind. Having cutters that retract could provide enough relief to bring the bits out without twisting it off. He thought it would be a good idea that it would probably sell.

Mr. Sabin said that when oil prices are high, oil companies would benefit especially from wells they own. With additional cash they are likely to take advantage of the opportunity to add new wells in regions with known reserves and drill exploratory wells in regions with likely but marginal potential for finding gas or oil. Drilling activity should increase rapidly if oil prices stay high. Drilling rates drop dramatically when prices are low and mostly occur when the probability of a find is high.

He indicated that most of the onshore drilling is done on contract. Smaller specialty companies do the drilling for the larger companies. He suggested trying to contact the drilling operators but did not know any names.

Mr. Sabin did not want to guess how long it would take for the industry to accept a new bit, as he is unfamiliar with the drilling operation.