New Methods of Inspecting and Maintaining Operational Oil and Gas Pipelines

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In recent years the North Sea has become a rich source of innovation and new technology. The maturity of the market, the relatively high production costs and the desire to extend operating lives of existing facilities, have all been drivers to ensure that new ways of operating and maintaining pipelines have been developed.

Weatherford Pipeline and Speciality Services (P&SS) has strategically positioned itself to become a key provider of new technologies and services, often developed in collaboration with client oil companies.

This paper shares the results of work to date on two such projects. The first project is the SAAM® Smart Utility Pig. Under development since 1994, versions of the tool have been in use in the North Sea since 1997. Recent developments have proven its ability to detect the presence of internal corrosion within a pipeline, housed within a standard bi-directional utility pig. The second project is the Autonomous Contra-Flow Tractor project. Under development since 1999, this tool can travel against the flow along a pipeline carrying a payload such as an inspection tool, or isolation plug. Field trials are planned for Q4 2003. This paper details the advances made, and key findings on both projects are also presented.

INTRODUCTION

Pipelines have long been recognised as assets of vital importance to national and international economies. Globally, the pipeline network excluding distribution pipelines, is thought to be of the order of 2 million km. In the US alone, the onshore network is of the order of 800,000km to 1,000,000km [1,2].

Offshore, the world's pipeline network is more difficult to estimate. For example, the UK has a reported 11,000km of offshore trunk and interfield pipelines, Brazil contains 12,000km-15,000km and according to the Minerals Management Service (MMS) the US has some 160,000km (although not all of this remains in production). A look through the MMS database reveals that this trend continues today. In 2002 a total of 384 pipeline permits were approved for offshore pipelines, with a total length of 3370km [3]. Table 1 below summarises the number of permits issued by the MMS over the past 5 years, which probably equates to some 15,000km –20,000km of new offshore pipelines.

Year	No. of P/L Permits
2002	384
2001	491
2000	390
1999	385
1998	282

Table 1 – MMS Approved New Pipeline Permits

In the mid-1970's the focus of pipeline industry moved from the US to Europe, with the development of the North Sea. This took offshore pipeline construction from the relatively shallow waters of the Gulf of Mexico to depths of 150m. In the mid to late 1990's this changed again with the proliferation of deep and ultra deepwater pipelines resulting in new lines being laid in 2000+m of water. For example, the Canyon Express pipeline in the Gulf of Mexico was laid in 2190m, and the Bluestream pipeline in the Black Sea in 2150m [4].

With this relentless drive into deeper and deeper waters, and the demands to commercially exploit ever more technically challenging fields, the pressure to develop innovative solutions to inspect and maintain pipelines has increased. This paper summarises the work on two such developments, carried out by Weatherford Pipeline & Specialty Services (P&SS). The first is the SAAM® Smart Utility Pig[1], and the second is the Autonomous Pipeline Contra-flow Tractor (known as 'the Crawler'). These developments have been driven by the specific needs of operating and maintaining pipelines in the UK Continental Shelf (UKCS), however both have applications worldwide. This paper details the market drivers underpinning the development of both technologies, the results of work so far, and R&D plans current and future.

THE MARKET DRIVERS

The UK has proven fertile ground for the development of innovative technology for the oil and gas industry. The reasons for this innovation are not hard to see. When the North Sea was first developed, the exploitation of reserves in 150m water depths and in such a harsh environment was truly pioneering. Much of the know-how, methodologies and technologies necessary had to be developed, and often from scratch! Good examples of some of the innovations that resulted during this stage are the Hutton Tension Leg Platform originally developed by Conoco, and the Central Cormorant Underwater Manifold Centre (UMC), developed by Shell.

Following on from this original phase, a succession of low oil prices resulted in a series of the drives to reduce production costs. Technology and innovation have been key contributors to ensuring that the UK remains a profitable place to do business. A good example of this has been the introduction of horizontal drilling techniques. These techniques have helped contribute towards the near doubling of oil recovery rates from the original 30+% in the 1970's, to approximately 60% today. In pipeline terms the pioneering work done on subsea tie-ins and the development of piggable wye pieces allowed secondary fields to be tied in subsea to existing pipeline infrastructure, dramatically reducing field development costs. Today this process continues through organisations like ITF (Industry Technology Facilitator). This cross-industry body has the remit and budget to *'accelerate the development of key enabling technologies for the UKCS'* [5]. It tends to result in the setting up of collaborative joint industry projects, which are then commercialised by one of the project partners. The *SAAM* technology detailed in this paper was helped, in part, by funding secured through ITF.

Fig. 1 UKCS Pipeline System by Year Commissioned (still in use)

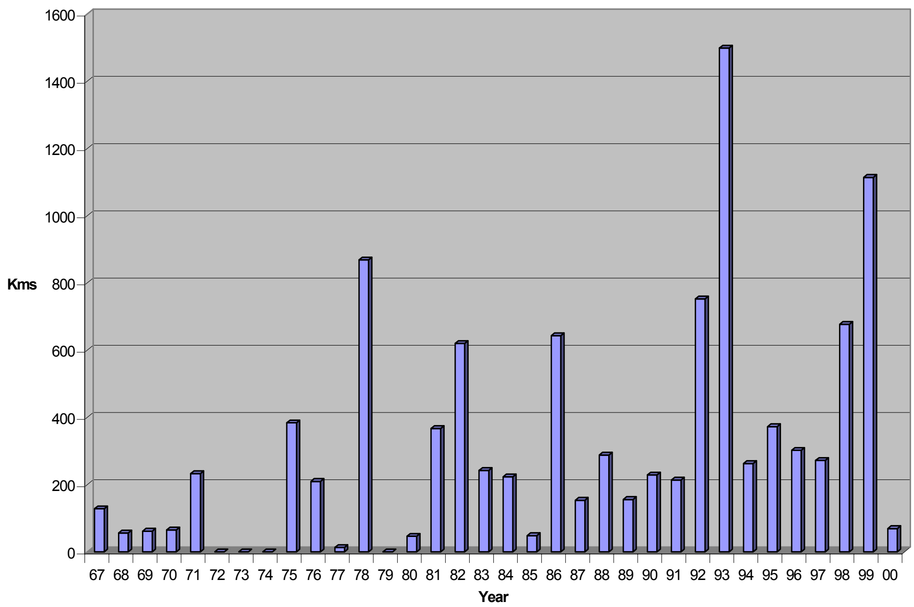

Figure 1.0 has been compiled from [5]. It shows the chainage of UKCS offshore pipeline by year commissioned and still in production. This shows some initial

activity in the late 1960's associated with gas lines in the Southern Sector of the North Sea. This is followed by a surge in activity in the mid to late 1970's tied in with the first phase of activity in the Central and Northern sectors. These lines remain in production today and are generally main export lines. Activity then generally increases through the 1980's and into the 1990's with peaks in 1986, 1993 and 1999 corresponding to construction campaigns following adjustments due to the low oil price. It should be noted that many of the lines installed since the mid-1980's have been tied in with the older 1970's assets. These newer lines often have 25 – 30 year design lives, so it can be expected that some of the original 1970's assets could well be in production for 50 years, twice their original design lives.

The North Sea has also been a test bed for the technologies necessary to enable 'difficult' fields to be developed. Examples here have been the development of the first high temperature, high pressure fields. The likes of Elgin-Franklin, Shearwater, and Erskine have all presented unique challenges. In pipeline terms the problems of buckling, upheaval and lateral, as well as wax management have had to be addressed. These have resulted in new techniques for the design and build of pipelines, as well as the creation of new inspection tools capable of operating in these difficult environments

A further important factor touched on previously, which is now stimulating innovation, is that of proving continued fitness for purpose of the existing pipeline infrastructure. The days of major pipeline construction programmes have passed, and the North Sea is now on a steady but gradual process of decline. The challenge is now being able to keep pipelines in production for as long as is practical. In doing so operators must comply with Statutory Instrument 1996, No.825 'The Pipeline Safety Regulations'. In this it states the *'the operator should ensure that a pipeline is maintained in an efficient state, in efficient working order and in good repair'.* In effect the operator is responsible for ensuring continued fitness for purpose of their pipeline asset. These regulations are quite different to, say, those in the US [6], which are quite prescriptive. The UK regulations do give the operators the freedom to make use of new technology, in a way which the authors would argue the US regulations do not. This regulatory framework, and the aging pipeline environment, does provide a stimulus for innovation and technology advancement.

One additional driver in the UK that needs to be addressed is the political backdrop. The UK government does attempt to encourage R&D within sectors such as the oil and gas industry. Support is available from the likes of the Scottish Executive (Scottish government), Scottish Enterprise, the Offshore Supplies Office (as was), and the European Union. These, combined with organisations such as ITF (discussed previously) and funding and support available from client oil companies, do create a climate that can be fertile for new technology. Indeed often it is not the creation of the technology in the first place which is the limiting factor, but rather the opportunities to trial and prove technology in service.

SAAM® SMART UTILTY PIG

The first project presented in this paper is the development of the *SAAM* Smart Utility Pig. This project started in the summer of 1994. It resulted in the first versions of the tool being deployed operationally in 1997. Since 1997, the *SAAM* technology has been used on 70 surveys and special projects, and to inspect approximately 5700 km of pipeline. Of these projects, 81% have been carried out in the UK, and at the time of writing this paper only 3 had been performed in Asia.

Today the development programme continues. With the support of Weatherford P&SS and the PIPEAIMS joint industry consortia[2], the focus of the current R&D programme is on improving the current corrosion detection capability and on preparing a recommended practice for its use.

What is a *SAAM* Smart Utility Pig?

A Smart Utility Pig is a standard pipeline cleaning or gauging pig that can be used to perform an inspection of a pipeline. A *SAAM* unit, which is in effect a package of electronics and instrumentation, is added to the pig. This package is used to monitor the passage of the pig through the pipeline. By the careful selection of the correct spread of instruments, combined with an understanding of how pig behaviour is affected by features present within a pipeline, it has been possible to develop an inspection tool capable of detecting;

- The presence and severity of wax and other debris.
- The presence of internal corrosion.
- The presence and severity of mechanical damage.
- The presence of pipeline shape changes (upheaval bucking, lateral buckling, sagging).

The ability to detect these features using a standard cleaning pig has provided a new approach to pipeline inspection. As a consequence it has enabled many pipeline operators to move towards more regular trend monitoring of pipeline condition, rather than relying on infrequent one-off inspections.

Why did it start?

The development of the *SAAM* Smart Utility Pig was in direct response to many of the changes occurring within the UK offshore pipeline market. There were clear drivers that are detailed in [7]. In summary, the view in 1994 was:

1. <u>High inspection price</u>. Traditional Intelligent pigs were seen as being very expensive.
2. <u>Market polarisation</u>. Available tools were either seen as high value, high cost, or low value, low cost. No intermediate level of technology existed.
3. <u>Increasing sophistication of Intelligent Pigs</u>. A perception that the Intelligent Pig was becoming increasingly more sophisticated rather than just fit-for-purpose.
4. <u>Too much focus on corrosion</u>. Offshore (upstream) operators wanted other information (presence of debris, shape change etc) and not just corrosion data.
5. <u>Fitness for purpose assessment</u>. A change in the regulatory regime placed the onus on the pipeline operator to demonstrate 'fitness for purpose'.

6. Aging pipeline infrastructure. Plans to operate assets already nearing the end of their design lives for a further 20 – 25 years.
7. Budget pressures. A drive to reduce OPEX, whilst still maintaining the required standards of safety and operability.
8. Change in personnel. A new breed of engineers who were prepared to challenge the way things were done.

It was this powerful mix that lead directly to the development of the *SAAM* Smart Utility Pig.

How does it work?

The *SAAM* Smart Utility Pig works on completely different principles to other inspection tools. These are discussed at length in [7, 8] and summarised as follows.

As a pig travels through a pipeline it exhibits certain characteristics. For example, it will require a certain amount of differential pressure to move, it will vibrate in a particular way and will acquire a certain attitude (nose up/down). Following research carried out by P&SS, it was discovered that these characteristics generally only change locally within a pipeline (over a number of hundreds of meters) if there is some feature external to the pig - but present within the pipeline, which causes the change. For example, the presence of a dent will cause: a pig to momentarily slow and then speed up, the differential pressure across the pig to rise significantly and the pig will vibrate more. So, measuring pig differential pressure, acceleration and vibration, and interpreting the data acquired can identify the presence of dents and other 'mechanical' damage within a pipeline. It is this principle that has been extended to identify other features present.

Key to the ability of the tool to detect features is the selection of the onboard instrumentation. The original tool was capable of measuring pig differential pressure or fluid absolute pressure, fluid temperature, pig vibration and pig acceleration (which doubles as a measure of the angle of tilt of the pig). Later versions of the tool have included absolute pressure and pig differential pressure, angular velocity sensors, tri-axial accelerometers and optical sensors. The *SAAM* unit itself is typically a 316SS cylinder approximately 450mm in length and 100mm in diameter (depending upon version). Contained within this canister are the instrument payload, batteries, a processor stack and several printed circuit boards. Figure 2 shows a typical *SAAM* unit and Figure 3 how a 'Smart Utility Pig' can typically look.

Fig. 2 SAAM unit (No. 1) as deployed on first survey in Scott pipeline, July 1997

Fig. 3 A typical *SAAM* carrier pig

The *SAAM* unit itself is fitted within the body of a standard cleaning pig. It is fitted much in the same way as a pig pinger. It switches on via a pressure switch activated when the unit is above approximately 2 bar pressure in the launch trap, and switches off when the unit is below approximately 1.5 bar pressure in the receive trap.

The Development Programme

The initial work programme ran for 3 years from the summer of 1994 through to 1997. It included:

- A feasibility assessment.
- Prototype build and testing.
- Improvements necessary for field trials.
- Testing and proving pre-field trials.
- First field trials in the Scott 24" oil export pipeline.

In the period post completion of the field trials, activities have followed two concurrent paths. The original technology has been commercialised through the provision of pipeline surveys and special projects. In parallel with this the development work has continued.

Increase in Operating Range

Development work was carried out to progressively increase the operational range of the tool. This involved:

- Reducing on-board power consumption by a factor of 4.
- Progressively moving from Ni-Cad, to Nickel Metal Hydride and ultimately to Lithium cells for long-range applications.
- Increasing the on-board memory capacity from 2 Megabytes with the first prototype, to 8 Gigabytes on the latest version.

The combination of these improvements has increased the range of the tools from 10 hours to 14 days, an increase of 33 times the original range.

Increase in Temperature Range

This improvement was driven by a requirement of ChevronTexaco to survey the Erskine pipeline. Details of the development work are contained in [9]. In essence it involved developing a tool capable of operating at 130°C, a 70°C increase over the capability of standard tools. It involved up-rating the operating range of the onboard electronics, plus incorporating a custom-made Mitco Thermoshield to protect the tool from the elevated fluid temperatures. This development was completed in 2002, with the tool run twice through the line.

Increase in Pressure Range

This improvement was driven by the requirements of operating in the deep water Gulf of Mexico. Specific variants were developed for the King (BP) and Canyon Express (TFEE) pipelines. This saw the pressure range of the tool increase to 400barg, from the 187.5barg of standard tools.

Reduction in Size
The original tools were designed for 10" diameter pipelines and greater. An 8" tool was required by Brass Exploration in Nigeria [10], which resulted in reduction in size of 15% volume. A 6" tool was then required by BP [4]. This required a complete redesign of the tool that resulted in a reduction of 75% by volume.

Where we are today
Today there have been some 70 *SAAM* surveys and special projects. A total of 12 tools are currently in operation, with 5 based in the US and 7 in Europe. With these tools it is possible to carry out surveys in any territory worldwide. The proven capabilities of the tool are outlined below:

Out-of-straightness (OOS) Detection
This is the ability to determine the local shape of a pipeline typically over a few hundreds of meters, known as its Out-of-straightness (OOS). The early versions of the tool had this capability and approximately two thirds of all projects have involved determining the local profile of the pipeline. Figure 4 shows an OOS feature known as an 'Upheaval Buckle' from a subsea pipeline in the North Sea.

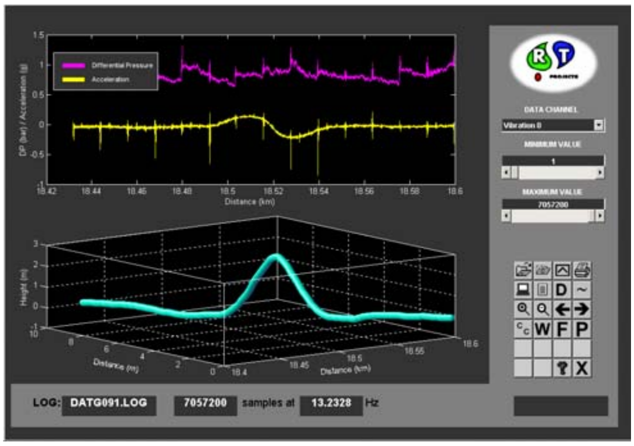

Fig. 4 Typical Upheaval buckle

The inclusion of angular velocity sensors has been a relatively recent addition, mainly driven by requirements in the Gulf of Mexico. These sensors are used to provide basic information on the lateral shape of the pipeline. The profiles generated are less accurate than the equivalent vertical OOS features. Typical accuracies are:

Vertical Accuracy: +/- 0.05% to 0.09% of horizontal length of feature
Lateral Accuracy: +/- 0.5% to 0.9% of horizontal length of feature

Details of the OOS capabilities are presented in [9,10].

Internal Corrosion Detection
This is the ability to provide information on the presence of internal corrosion within a pipeline. The presence of significant quantities of corrosion within a pipeline causes the pig differential pressure and vibration to change measurably. Much work has been carried out to develop methods for analysing these data. This focused on

extracting areas of actual corrosion data from the normal background differential pressure and vibration noise generated by a pig as it travels through a pipeline. [11] presents the results of this work as applied to the Beatrice Pipeline, which is owned and operated by Talisman Energy in the UK. In this case a statistical method involving the comparison of pig vibration on a pipe joint by pipe joint basis was employed. The vibration noise generated by a pig as it travels through a pipeline was found to be 'normal' and gives a Gaussian distribution when plotted on a histogram. However, the presence of corrosion causes the shape, and distribution of this histogram, to change markedly. Figures 5 and 6 are reproduced from [11] and show quite significantly different shapes associated with corroded sections of the line. Using this technique it is then possible to position these features along the length of the line.

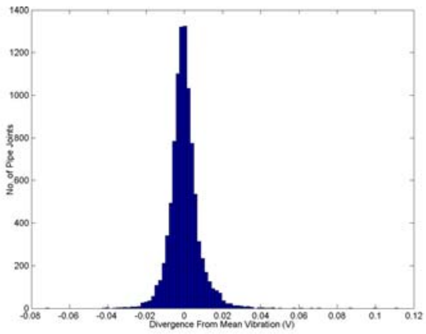

Fig. 5 Condition Histogram: Pipeline in good condition

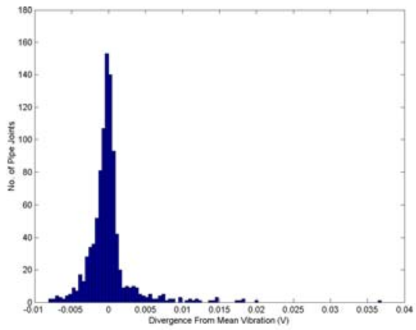

Fig. 6 Condition Histogram: Corroded Pipeline

Mechanical Damage Detection

This has been touched on previously in this paper. In effect it is the ability to detect the presence and location of mechanical damage to a pipeline. [12] presents this in more detail, but in summary major changes in the 'roundness' of the pipe will cause corresponding changes in the way a pig travels. Figure 7 shows an example of a dent.

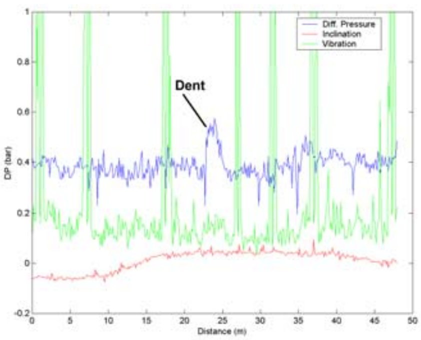

Fig. 7 Pipeline with a Dent

Wax and Debris Detection

This is the ability to determine the presence of wax and other debris within a pipeline. Wax and other non-permanent features with a pipeline cause transient behavioural changes to a pig as it travels through a pipeline. Being transient they are never identical from one survey to the next, but are generally similar and occur in the same general location along the pipeline. Experience has made it possible to differentiate between soft wax (where the wax is forming) and residual hard wax. Figure 8 shows behaviour typical of soft wax. Figure 9 shows the response expected in hard wax. Wax has also been shown to change the thermal gradient within a pipeline as it tends to act as insulation. Further work has also been done which has cross-referenced the on-set of behaviours classified as ‘wax’ with known wax formation temperatures, and a very strong link has been found.

Fig. 8 Pig Behaviour in Soft Wax

Fig. 9 Pig Behaviour in Hard Wax

Current R&D

Today the development of the Smart Utility Pig continues. The main development efforts are focused on the PIPEAIMS[2] Joint Industry Project. This project has the aim of developing the second generation corrosion detection capability of the tool, and then to produce a recommended practice for its use in the field.

A prototype tool has been built and an extensive programme of laboratory trials completed. This involved running the prototype tool through a test loop many hundreds of times. Pipe spools with 4 different types and severities of corrosion were inserted into the loop and the behaviour of the pig monitored. The spools tested were: un-corroded, severe general corrosion, slight general corrosion, severe channel corrosion and slight channel corrosion. The effects of pigging speed and pig design were examined. The results of this work have been very encouraging with clear and measurable differences in pig behaviour observed. Analytical methods for interpreting the data have been developed.

The project is currently at the field trials stage. Two trials have been completed to date, with encouraging results. At the time of writing this paper the third field trial was underway and a fourth is planned prior to the year-end.

AUTONOMUS CONTRA-FLOW PIPELINE TRACTOR

The second project presented in this paper is the development of the Autonomous Contra-flow Pipeline Tractor (known as the ‘Crawler’). The project began in 1999 with the intention of developing a pipeline tool that could both enter and leave a pipeline via a single point. This was seen has having both major operational and CAPEX advantages over traditional dual flowline methods required to deploy ‘pig based’ tools. The project has been mainly driven by Shell, with support from Weatherford. Details of the work carried out to date are contained in [13].

Background

In the late 1990’s Shell set about looking to develop a pipeline tool that could be deployed and recovered from the one entry point. The justification was that traditional methods required the ability to either round trip pig through a pipeline, or to reverse a pig back out of a line after it had been run in one way. The former approach requires the construction of dual flowlines in order to facilitate round trip pigging, with a resultant substantial cost. The latter requires the ability to be able to reverse the flow, which is not always possible and which would at least cause substantial production and storage difficulties.

To put this into a market context, Shell Expro alone identified some 52 single-ended pipelines and flowlines in the Northern Sector of the North Sea, which could lend themselves to using this type of technology. Factoring this for other operators and other production regions produces a potentially massive market for this technology, could it be developed. Furthermore the applications in deepwater are even more evident. Shell International looked at the potential costs savings associated with applying this to new deepwater subsea developments between 2002 and 2007. It identified savings of the order of $100million.

After an evaluation period, Shell selected Aberdeen based Astec Developments to carry out the development. Astec Developments was a specialist coiled tubing tractor developer and had technology that lent itself to the perceived need of the project. Weatherford acquired Astec in 2000, and the project was ultimately re-assigned to P&SS. Shell and Weatherford now jointly fund the development of the Crawler.

Progress To Date

A prototype 6” Crawler has been developed and successfully tested. Figure 10 shows the prototype as deployed in recent trials (May 2003) in a 6” oil-filled flow loop. It comprises a series of ‘Turbine’ Modules, ‘Tractor’ Modules and ‘Return’ Modules.

Figure 10 Crawler Prototype

Basic Operation
The following summarises the basic operation of the Crawler and is taken directly from [13].

- *"A turbine extracts power from the produced fluid.*
- *The turbine internal sleeve has a magnetic coupling to the harmonic drive gearbox.*
- *The gearbox output rotates a shaft, via an articulated joint, upon which are a series of offset facings or bearing surfaces.*
- *Mounted on each bearing is a five-spoked rimless wheel or rotor. The spokes constitute the legs of the crawler and bridge the gap from the hub to the inner surface of the pipe.*
- *Since the bearings are offset and skewed, the leg sets oscillate (forwards, backwards, inward, outward) as the shaft rotates……….. Thus the leg set progresses up the pipe in a walking action.*
- *A number of leg sets are set on the shaft at progressively different angles to balance the shaft and provide more traction.*
- *The action provides only forward drive and little or no wall contact or drag on the remainder of its cycle."*

Figures 11 and 12 show the Leg Set and Tractor Module. Figure 13 shows the Turbine and Gearbox Module.

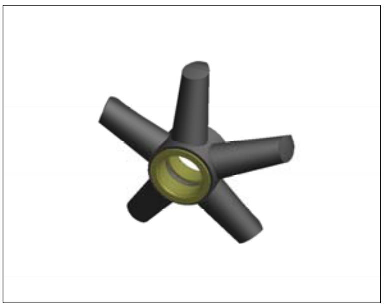

Fig. 11 Crawler Leg Set

Fig. 12 Tractor Module

Fig. 13 Turbine & Gear Box

One of the more recent additions to the tool has been the Return Module. This is designed to enable it to return (like a pig) with the fluid flow. It can be activated by a number of different means, such as line temperature, pig differential pressure, or an external signal. Whatever the trigger, a hydraulic ram or plunger is pushed into an orifice in the Return Module, through which the fluid normally passes. However, when activated, the ram blocks the orifice and the Return Module acts like a traditional pig. Placing two of these at different positions along the tool gives separate drive positions enabling the Crawler (which is now in effect a pig) to pass through difficult components such as Wye Pieces.

Current R&D

The main thrust of the current R&D programme is aimed at successfully carrying out a field trial with the prototype Crawler towards the end of 2003 or early 2004. This is dependent upon the commitment of an appropriate test site. One issue under particular focus is the speed of the Crawler. The tool currently has a crawl speed of about 80cm/min contra-flow. The aim is to increase this to approximately 2m/min. A number of modifications are being made including the selection of a new gearbox and the re-design of the shroud around the turbines. Table 2 below details transit times and corresponding crawl speeds and pipeline lengths. This shows that achieving a crawl speed of approximately 2m/min will make the deployment of the Crawler in lines up to 10 km in length a feasible option. However, for longer lines the prospect of increasing the crawl speed further will be required, and is likely to form part of an ongoing longer-term improvement.

Crawler Speed cm/min	1km	5km	10km	25km	50km
50	33	165	330	825	1650
100	17	82	165	412	824
150	11	55	110	275	550
200	8	40	82	205	410
250	7	35	70	175	350

Table 2 – Transit Time (Hours) by Crawler Speed and Pipeline Length

Applications

The pipeline Crawler is technology that enables other 'applications' to be developed, rather than being an end in its own right. In simple terms it provides the means for entering and leaving a pipeline from the same point. There are believed to be many different applications for this technology, which could include:

- Operational
  - Controlled Wax removal.
  - Controlled hydrate, scale or sand removal.
  - Controlled condensate removal from gas pipelines.
  - Controlled water drop-out removal.
- In-line Inspection
  - Deployment of *SAAM*-type tools.
  - Deployment of MFL or UT Inspection tools.
  - Deployment of Caliper tools.

        - Deployment of Mapping/Out-of-Straightness tools.
- Pipeline Isolation
    - Deployment of Pipeline Isolation Plugs.
    - Retrieval of Pipeline Isolation Plugs.
- Miscellaneous
    - Deployment of tethered inspection tools (camera/video).
    - Wax Deposition measurement.
    - Autonomous deployment of normally tethered tools due to high power requirements. Excess power from the Crawler turbines could be used thereby extending the operating range.
    - Chemical cleaning or dosing.
    - Product sampling.

All of these applications could be carried out without the need for subsea intervention and whilst keeping the line in production thereby avoiding deferred production. The cost benefit of using the Crawler instead of traditional methods is obvious.

WHERE IT ALL MIGHT LEAD

This paper has presented only two of the developments currently supported by Weatherford P&SS. These and other technologies currently under development are intended to position Weatherford at the forefront as a provider of innovative, game-changing pipeline inspection technologies. Although still some way off, it is not inconceivable that one day tools will be available which will be capable of 'living' in the pipeline and providing effectively real time information on pipeline condition. Furthermore, when combined with new and emerging science, the potential exists for a fundamental shift in how pipeline inspection and condition monitoring of both offshore and onshore pipelines are carried out. In short, it is conceivable that one day accepted ILI methods could be rendered obsolete.

ACKNOWLEDGEMENTS

The authors would like to thank the PIPEAIMS Joint Industry Project members and Shell International for their continued support of the projects presented in this paper.

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Footnotes:

1. SAAM® is a registered trademark in the UK (pending in the USA). SAAM was originally an abbreviation of 'Smart Acquisition Analysis Module'.
2. PIPEAIMS Joint Industry project has been running since July 2001. The project is supported by 8 major oil companies and Weatherford P&SS. The oil company sponsors are; BP, Enterprise Oil (now Shell), Kerr McGee, Marathon Oil, ChevronTexaco, Petro-Canada, Total E&P UK PLC and Shell. PIPEAIMS is an abbreviation of 'Pipeline Asset Integrity Management System'.