Landing the Big One—The Art of Fishing

Drillers often refer to tools and equipment left in the borehole as “lost.” In reality, these items have been misplaced thousands of feet below the surface. Removal of these objects from the wellbore has challenged drillers since the earliest days of the oil field.

In the oil field, a fish is any item left in a wellbore that impedes further operations. This broad definition encompasses every variety of drilling, logging or production equipment, including drill bits, pipe, logging tools, hand tools or any other junk that may be lost, damaged, stuck or otherwise left in a borehole. When junk or hardware blocks the path to continued operations, these items must first be removed from the hole through a process known as fishing.

The origins of this term are attributed to the early days of cable-tool drilling, in which a cable attached to a spring pole repeatedly lifted and dropped a heavy bit that chiseled away at the rock to create a wellbore. When the cable parted, drillers attempted to retrieve the cable and bit from the bottom of the hole using an improvised hook lowered on a length of new cable hung from the spring pole. Experts in the art of retrieving junk from the subsurface became known as fishermen. Over the years, their services have become highly sought after, and the art of fishing has grown to fill a specialized niche within the well services industry.

All manner of equipment may fail, become stuck, need replacement or otherwise require retrieval from a wellbore. Fishing operations may be needed at any point during the life of a well—from drilling through abandonment. During the drilling phase, most fishing jobs are unexpected and are often caused by mechanical failure or by sticking of the drillstring. Sticking may also occur during wireline logging or testing operations. Later, during the completion phase, operations may be thwarted by a variety of problems, including stuck perforating guns, prematurely set packers or failed gravel pack screens. After a well has been put on production, fishing operations may be scheduled as part of the overall process of maintaining, replacing or recovering downhole equipment and tubulars during workover or abandonment procedures. In many fields, the workover process entails cleanout or retrieval of tubing that has sanded up after years of production, thus prompting a fishing job at the outset of operations. During abandonment, operators often try to salvage downhole tubulars, pumps and completion equipment before plugging the well. Even the fishing equipment may become stuck, necessitating revision of the original fishing strategy. In the oil field, no operation, it would seem, is exempt from the possibility of fishing.

Statistics from the mid-1990s indicate that fishing operations accounted for 25% of drilling costs worldwide. These days, fishing can frequently be avoided or sidestepped using other, more cost-effective options. For instance, modern drilling technology, such as rotary steering, is creating a shift in fishing strategies by influencing the economics used to determine whether to fish, to buy the stuck equipment, known as the fish, and sidetrack, or to junk and abandon (J&A) the hole.

Each fishing situation—planned or unplanned, openhole or cased, coiled tubing or wireline—is unique, and each presents its own set of conditions...
and problems for which a retrieval solution must be adapted. Within this wide-ranging topic, this article focuses primarily on fishing techniques used during drilling; variations on these techniques have been adapted for cased hole, coiled tubing, wireline and workover applications. The article outlines common processes that may lead to the loss of equipment downhole and describes some of the tools and techniques devised in response. It also discusses strategies for deciding how long to pursue fishing operations and closes by discussing a program that trains new fishing personnel in the skills needed to continue the recovery of lost items from the wellbore.

Root Causes
Most fishing jobs may be traced to one of three basic causes: human error, faulty equipment or wellbore instability. Nearly everything that goes into the hole can become a fish. Under the wrong circumstances, any object smaller than the bowl diameter of the rotary table master bushing can be lost downhole (right). Hand tools, chains and flashlights have made their way from the drill floor into the wellbore, as have pieces of tongs, slips and other items that can junk a hole. Fortunately, most drilling crews are alert to such dangers, which are preventable through scrupulous attention to housekeeping and maintenance practices on the drill floor.

Downhole, mechanical failure of the drillstring can turn a routine drilling operation into a fishing job. Modes of failure are manifold. Tubulars—drillpipe, casing or tubing—may collapse, burst, part or twist off (right). The drill bit may break apart. A tool joint may simply come unscrewed from the drillstring, or the pipe may become stuck. Each case produces a different type of fish, which in turn dictates how the fishing job will be conducted.

Although pipe failure may not be common, avoiding this problem ranks as a top priority for drillers. Pipe collapses as a result of excess external pressure, bursts from too much internal pressure, parts when subjected to excess tension or twists off because of too much torque. The industry has instituted various practices to reduce the risk of drillstring failure, beginning with inspection of tools, pipe and threads for wear and corrosion before they go into the hole, followed by careful use of pipe handling equipment and avoidance of excess torque during makeup.

In today’s high-angle wells, pipe wear can be accelerated by sharp changes in trajectory. Sharp turns impose alternating bending stresses on the pipe as it works through a dogleg. In addition, high-angle wells are often beset by hole cleaning problems. To prevent cuttings from packing off around the drillstring, the driller may resort to high rotation and circulation rates to clean the wellbore. Such practices, however, increase the likelihood of creating a hole, or washout, in the drillstring itself. When a drillstring washout develops before the well has been cleaned out, the operator must choose between continuing to circulate the wellbore clean or attempting to trip...
out of the hole. Continuing to circulate runs the risk of enlarging the washout and weakening the drillstring; pulling out before the wellbore is clean runs the risk of sticking the pipe.4

To prevent pipe collapse, drillers keep the pipe filled with mud to offset external hydrostatic pressure of the mud in the annulus. They monitor makeup torque, hydraulics, rotary speed, weight on bit and hook load to avoid exceeding drillstring design limits. When tubulars do fail, they often produce a jagged, irregular length of pipe, which the fishing expert must contend with.

The drill bit is another common fish. Bits are engineered to withstand the rigors of weight, torsion and abrasion; nevertheless, drillers must be attentive to weight on bit, rotary speed, drilling fluid hydraulics, solids control, formation characteristics and time on bottom to prevent excessive bit wear and associated problems. Occasionally, a bit may seize up and break apart, leaving bit cones, bearings and teeth downhole (above). Although small, these components are hard and robust, and typically must be recovered to prevent damage to new bits or other equipment subsequently run in the hole.

Tool joints sometimes back off, or come unscrewed, from the drillstring. This development may occur when insufficient torque is applied as one joint of pipe is made up to another, or when the drillstring spins counter to its normal clockwise rotation. However, worn or damaged pipe threads may also be a culprit; this problem can be avoided in part through careful handling of tool joints during makeup on the drill floor and by monitoring vibration and rotary speed while drilling to minimize stress on the drillstring.

Sometimes, the fault is traced back to manufacturing controls, as one operator discovered. Having set a liner, the driller ran the bit to the top of cement. Although the top drive stalled several times while drilling out the liner shoe, the driller was able to continue some 150 m [490 ft] beneath the shoe before observing erratic torque readings at the drill floor console. Later, approximately 5.5 kg [12 lbm] of steel shavings, circulated to surface in the drilling fluid, were recovered from the shale shaker screens and ditch magnets, providing confirmation to the driller that there was a problem downhole.5

As the driller pulled out of the hole, the operator ordered junk baskets and a junk mill dispatched to the wellsite. (Upon its arrival, the junk mill was rejected for lack of proper inspection certification; the operator chose not to risk compounding the problems downhole.) The driller ran in the hole with a bit and junk basket, drilling slowly for 3 m [10 ft] before readings of normal parameters confirmed that the hole was free of junk. Several more kilograms of metal cuttings were recovered when the basket was pulled out of the hole, along with more at the ditch magnets. Further investigation revealed that the pipe threads on the liner shoe connection were not designed to withstand the same torque loads as those on the liner string. The operator concluded that back torque produced by stalling of the topdrive probably caused the left-hand thread of the liner shoe to break loose.

A large number of fishing jobs are instigated by sticking of the drillstring (next page). Many such incidents are caused by unstable formations; others are related to drilling practices:

- Loose or unconsolidated formation sands or gravels can collapse into the borehole and pack off the drillstring as supporting rock is removed by the bit. Schists, laminated shales, fractures and faults also create loose rock that caves into the hole and jams the drillstring.
- In regions where tectonic stresses are high, rock is being deformed by movement of the Earth’s crust. In these areas, the rock around the wellbore may collapse into the well. In some cases, the hydrostatic pressure required to stabilize the hole may be much higher than the fracture initiation pressure of exposed formations.
- Mobile formations—typically salt or shale—can behave in a plastic manner. When compressed by overburden, they may flow and squeeze into a wellbore, thereby constricting or deforming the hole and trapping the tubulars.
- Overpressured shales are characterized by formation pore pressures that exceed normal hydrostatic pressure. Insufficient mud weight in these formations permits the hole to become unstable and collapse around the pipe.
- Drilling vibration may cause caving of the wellbore. These cavings pack around the pipe, causing it to stick. Downhole vibration is controlled by monitoring parameters such as weight on bit, rate of penetration and rotary speed, which can be adjusted from the driller’s console.
- Differential sticking presents a common problem downhole. It happens when the drillstring is held against the wellbore by hydrostatic overbalance between the wellbore pressure and the pore pressure of a permeable formation. This problem occurs most commonly when a stationary or slow-moving drillstring contacts a permeable formation, and where a thick filtercake is present. Depleted reservoirs are the primary culprit for differential sticking.
- Keyseating takes place when rotation of the drillpipe wears a groove into the borehole wall. When the drillstring is tripped, the bottomhole assembly (BHA) or larger-diameter tool joints are pulled into the keyseat and become jammed. A keyseat may also form at the casing shoe if a groove is worn in the casing or the casing shoe splits. This problem normally occurs at abrupt changes in inclination or azimuth, while pulling out of the hole and after sustained periods of drilling between wiper trips. Wireline logging tools and cables are also susceptible to keyseating.
- Undergauge holes may develop while drilling hard, abrasive rock. As the rock wears away the bit and stabilizer, the bit drills an undergauge, or smaller than specified, hole. When a subsequent in-gauge bit is run, it encounters resistance in the undergauge section of hole. If the string is run into the hole too quickly or without reaming, the bit can jam in the undergauge section. This problem may occur when running a new bit, after coring, while drilling abrasive formations or when a PDC bit is run after a roller cone bit.
- Cement blocks can pack off the drillstring when hard cement around the casing shoe breaks off and falls into the new openhole interval drilled out from under casing.

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5. Ditch magnets are strong magnets placed in the flowline to collect metallic debris from the drilling fluid as the mud is circulated to the surface.

• Uncured, or green, cement may trap a drillstring after a casing job. When the top of cement is encountered while tripping in the hole, a higher than expected pressure surge may be generated by the BHA, causing the cement to set instantaneously around the BHA.
• Collapsed casing occurs when pressures exceed the casing collapse pressure rating or when casing wear or corrosion weakens the casing. The casing may also buckle as a result of aggressive running practices. These conditions are typically discovered when the BHA is run in the hole, only to hang up inside the casing.
• Hole cleaning problems prevent solids from being transported out of the wellbore. When the cuttings settle at the low side of deviated wellbores, they form layered beds that may pack around the BHA. Cuttings and cavings may also slide down the annulus when the pumps are turned off, thus packing around the drillstring. These problems are frequently caused by low annular flow rates, inadequate mud properties, insufficient mechanical agitation and short circulation time.†

† Sticking mechanisms. The driller must avoid or contend with a variety of potential problems in order to reach TD.
Indications that a fish might be lost downhole are usually seen on the drill floor as sudden changes in drilling rate, mud pressure, hook load or rotary torque; these changes typically spur a trip out of the hole. The condition of the last joint of pipe to clear the rotary table tells the drilling crew most of what they may have already suspected. A jagged joint of pipe, paired with an accurate pipe tally, tells the driller not only that the pipe has parted, but also how much pipe remains in the hole. By contrast, a damaged bit indicates that a few small metal pieces remain in the hole.

**Tools of the Trade**

The type of fish and the downhole conditions dictate the fishing strategy. Numerous innovative tools and techniques have been developed for retrieving pipe, downhole components and miscellaneous junk from the wellbore. Most fishing tools fit into one of five categories:

- Junk baskets catch small objects or pieces of debris that are too heavy to circulate out of the hole.
- Milling tools grind down the upper surface of an object.
- Cutting tools sever pipe.
- External catch tools retrieve fish by engaging the outer surface of the fish.
- Internal catch tools engage the inner surface of the fish.

The solution to any fishing problem depends on where the fish is, how it came to be there, its condition, its dimensions and its orientation within the wellbore. The orientation and size of the borehole are also critical; these parameters can limit the type and diameter of the retrieval equipment and restrict the space available for maneuvering retrieval equipment over the fish. A large-diameter wellbore, however, may make it difficult to locate the top of the fish.

To devise a fishing program, the operator must know the exact size and shape of the fish. Lack of correct dimensional data can doom a fishing job. For this reason, company representatives require each item that goes into the hole to be accurately drawn, then strapped with a measuring tape for length and calibrated for breadth.

If the driller is not sure what type of junk must be retrieved, the drilling crew may run an impression block in the hole to ascertain the position and shape of the top of a fish (below left). Impression blocks have a short, tubular steel body fitted at the lower end with a block of soft material—typically a lead insert. The tool is lowered on the end of the fishing string until it makes contact with the obstruction. Some impression blocks have a circulation port for pumping drilling fluid to clean the top of the fish before the block sets down on it. The weight of the fishing string helps press the lead against the top of the fish, creating an impression; the driller or fishing expert carefully studies this impression when the block reaches the surface. This preliminary information helps the operator determine the depth of the fish and the type of fishing equipment to deploy. Impression blocks can also be used on slickline, which is much faster than running in on drillpipe; however, there are weight and size limitations for this method.

Small pieces of junk or debris, such as hand tools, bit cones or pipe-tong dies, can be retrieved with a junk basket or junk magnet. Junk baskets are available in a variety of configurations, each taking a different approach to recovering lost items.

To retrieve small pieces of junk from the bottom of a well, fishermen sometimes use a core-type junk basket. By slowly cutting a core from the formation, this device recovers the junk along with the core. This operation is often employed in soft to medium-soft formations.

Boot baskets, used in drilling and milling operations, catch debris that is too heavy to be circulated out of the hole. These baskets are run as close as possible to the bit or mill and are sometimes run in tandem to increase junk retrieval capacity. The boot basket is used at the bottom of the hole and relies on circulating mud to carry the junk off-bottom. Because the annulus is wider above the junk basket, the annular mud velocity decreases, and as a result, the junk settles out of suspension and lands inside the basket (above).

A jet junk basket produces a circulating force that is capable of lifting stubborn items such as chain from the bottom of the hole. These baskets use ports near their base to produce a reverse circulation that forces the material up through the center of the basket. The jet junk basket can be run in cased or open hole to retrieve small debris from the wellbore and is effective in vertical or horizontal applications (see “Specialized Tools for Wellbore Debris Recovery,” page 4).

Junk magnets are used to retrieve ferrous debris such as bit cones, bearings, milled cuttings and pins that may be hard to retrieve using other methods (next page, top left). These tools have a highly magnetized internal pole plate within a nonmagnetic body. Junk magnets are also typically run in advance of diamond bits to remove debris that could damage the bit.

If the junk is not fully recovered, the operator may elect to run a used bit and attempt to drill and wash past the fish. Should this strategy fail, the junk can be broken into smaller pieces using a junk shot or a mill. A junk shot is a shaped charge, designed to direct its energy
downward to break up the object. A more conventional approach is to grind the object using a concave mill (below). The concavity of the mill helps to center the junk beneath a thick cutting surface of tungsten carbide that breaks the junk into smaller pieces, which can then be washed or circulated for capture by junk baskets above the mill.

Mills are available in a range of configurations for use in various applications (right). They are often used to dress the top of the fish to accommodate a fishing tool, but some are also used to grind float collars, bridge plugs and retainers. The debris produced through milling is then picked up by magnets or junk baskets or circulated from the well.

**Techniques for Larger Fish**

Retrieving large fish, such as drillpipe or collars, requires a different approach. Many of these jobs start with the assumption that any pipe left in the hole will likely become stuck. With no mud circulating around the fish, cuttings can settle around the pipe or the formation might pack off, which will restrict further movement. Thus, when a drillstring gets stuck, twists off or backs off, the recovery plan typically involves freeing the fish.

When fishing for pipe, the basic strategy involves running jars and an overshot into the hole, latching onto the fish, jarring the pipe free and then pulling the fish out of the hole. However, no fishing job is typical and no job is that easy; the top of the fish may be damaged, requiring a mill to dress the fish, or the fish may be difficult to engage, requiring several attempts to latch onto it. Furthermore, each of the basic steps above encompasses a number of procedures.

When a drillstring becomes stuck, the driller usually activates downhole jars to free the pipe through percussive force. In the case of differential sticking, the operator typically orders a pill—a special blend of surfactants, solvents or other compounds—to be pumped downhole to help free the pipe from differential sticking. The driller pumps this spotting fluid downhole to penetrate and break up the filtercake along the pipe and reduce the area of pipe subjected to sticking. This helps decrease the force required to move the pipe and free the drillstring. The likelihood that this approach will remedy the problem decreases rapidly with time, so once a drillstring

is stuck, it is essential to spot the fluid as quickly as possible. While the spotting fluid is working, the operator usually starts planning the fishing job and mobilizing equipment and personnel.

If the spotting fluid does not free the pipe, the operator may elect to sever the pipe and pull out of the hole to prevent sticking farther up the hole. The goal is to part the drillstring at the greatest depth possible and thus recover the maximum amount of pipe. The first step in this process, however, is to determine the uppermost depth at which the pipe is stuck. In accordance with Hooke’s law, when a drillstring is subjected to pull or torsion within its elastic limits, the pipe deforms linearly. Such behavior can be used to calculate how much free pipe remains above the stuck point.

The operator typically calls for an FPIT free-point indicator tool to precisely measure pipe stretch and torque. The FPIT device is lowered on wireline through the center of the drillpipe, then anchored in place as a given amount of force is applied to the pipe. FPIT strain gauges sense changes in torque and tension as the drillstring is subjected to rotation or pull, respectively. The stretch produced by this force is a function of the length of free pipe, the elasticity of the steel and its cross-sectional area. The tool should detect no tensile load or rotation when positioned below the stuck point.

If circulation is established, the FPIT device may be pumped down the center of the drillpipe; otherwise, the operator might resort to coiled tubing or a wireline tractor to convey the tool downhole. Once the free point has been established, the same conveyance method is used to lower any tools needed to sever the pipe. Parting the drillstring involves either unscrewing—backing off—the drillpipe downhole or cutting it.

Back ing off the pipe is the least drastic measure and leaves a threaded pipe connection at the top of the fish. Before unscrewing the pipe downhole, the driller must apply left-hand torque to the drillstring. The torque is worked downhole by reciprocating the pipe as the torque builds up. A string shot, consisting of a length of detonation cord, is lowered through the drillpipe to the depth opposite a tool joint above the free point. Upon detonation downhole, explosive pressures enlarge the thread in the box end of the tool joint and the left-hand torque unscrews the threaded connection to back off the pipe. The process may be repeated to force the pipe loose.

If the pipe cannot be unscrewed, a variety of methods may be employed to cut the pipe. A chemical cutter is a wireline tool that utilizes a propellant and reactant to create a series of closely spaced holes in the pipe. The holes weaken the pipe sufficiently to pull it apart. This method requires no application of torque on the drillstring and produces little burring and swelling of the pipe, thus obviating the need for milling. Another wireline device, an explosive cutter, sends out a 360° radial explosive jet to sever the pipe. Some explosive cutters leave a smooth cut, but others produce a flared edge that must be dressed with a mill to accommodate subsequent retrieval operations. A third method uses mechanical pipe cutters, which are lowered on washpipe to the desired depth. Hydraulic pressure forces the cutter arms against the inside of the pipe. The cutting surfaces are dressed with crushed tungsten carbide to sever the pipe as the tool rotates slowly inside the pipe.

Having separated free pipe above the stuck point, the driller trips out of the hole. The fishing expert will be on the drill floor to examine the last joint of pipe when it is brought to surface. The condition of that joint dictates the course of the ensuing fishing job.

**Catching On**

The two methods most commonly employed to retrieve a fish are the external catch and the internal catch. The dimensions of the fish and its orientation with respect to the wellbore determine which approach is used.

The external catch is provided by a box tap or an overshot. The box tap uses a tapered thread to screw over the top of the fish (left). Typically used to engage ragged, parted pipe, this tool is slowly rotated as it is lowered onto the fish. The bottom lip of the tool is often dressed with hard metal or crushed tungsten carbide to aid in cutting a thread into the surface of the outer diameter of the fish.

The overshot is designed to engage, pack off and retrieve parted drillpipe or drill collars (above). A tapered helical bowl within the overshot houses a grapple used to grip the outside of the fish. As the overshot is lowered toward the top of the fish, the driller circulates mud while reciprocating the fishing string to clean the top of the fish and flush out the inside of the overshot. Before engaging the fish, the driller records fishing string weight and torque. After washing over the top of the fish, the driller slowly lowers the overshot until a slight reduction in weight indicates it has landed on top of the fish. The overshot guide slides over the top of the fish as the driller slowly lowers and rotates the overshot. By turning to the right, the grapple opens to engage the fish. Upward pull, with no rotation, will cause the grapple to retract inside the tapered bowl, thus constricting around the fish. With the top of the fish gripped firmly inside the overshot, the driller pulls the fishing string and fish out of the hole.

Overshots can be fitted with a variety of grapples, control packers and accessories, with some strong enough to accommodate backoff and jar-ring operations. A common accessory is a mill guide, installed at the base of the overshot to grind away flared or jagged edges of the fish to permit passage into the grapple. The mill accessory makes it possible to dress off and engage the fish in one trip. Fishermen deploy another basic but useful device when the wellbore is enlarged or washed out near the top of the fish. The wall hook guide is attached to a bent joint of pipe or a hydraulic knuckle joint to sweep a washed-out section of hole (above). Once the overshot has passed the top of the fish, the string is slowly rotated until the rotary torque indicates that the fish has been hooked. The torque is held while the string is elevated. When the torque decreases, the fish slips into position for engagement by the overshot.

Although the basic overshot has changed very little over the past few decades, it continues to be used to great effect. An operator in New Mexico, USA, had to contend with a downhole pipe failure in a well. During drilling of a 7 ¾-in. hole, a joint of 6 ¾-in. drill collar twisted off, leaving behind a parted drill collar and the BHA. While pulling out of the hole, the operator called on Schlumberger fishing services to retrieve the remaining drill-string from the hole. The fishing expert made up a fishing string consisting of drillpipe, drill collars, a jar, a bumper sub and an overshot (above). The driller ran the fishing string in the hole and
succeeded in reaching the top of the fish. After the overshot engaged the twisted off collar, the fisherman noted an increase in weight as the driller slowly pulled on the fishing string. Once the fishing specialist was assured that the overshot had latched onto the fish, the driller tripped out of the hole and laid down the fish for examination on the pipe rack. There, the operator attributed the problem to pipe fatigue.

If the orientation or condition of the fish will not permit use of an overshot, then the fisherman must resort to an inside catching device to engage the fish. Variations on the inside catching device include the pin tap, taper tap and spear (above).

A pin tap is used with a fish that has been backed off from the string of pipe. This leaves a box tool joint facing upward so it can be engaged by the tap.

A taper tap provides an internal catch on tubulars that have a restricted internal diameter. It has a long tapered profile and is used to cut new thread while screwing into the top of the fish. This tool is run in the hole to the top of the fish and then rotated to engage the threads. It is normally used in conjunction with a safety joint, which provides a means of detaching the workstring from the fish in the event that the workstring becomes stuck.

A spear uses an internal grapple, or slip, that expands to grip against the inside wall of the pipe as the driller pulls out of the hole. The tool is made up on the end of the workstring then lowered through the top of the fish. When the fishing expert determines that the spear is positioned deep enough within the fish, the workstring is rotated to engage the grapple. A straight pull, with no further rotation, wedges the grapple against the pipe as the driller retrieves the workstring and fish from the hole. Some spears come with accessories such as mills, which are placed at the base of the spear to grind away jagged edges or other obstructions.

Another basic tool deployed inside tubulars may need to be run to open the way for further fishing. The casing swage is used to restore dented, buckled or collapsed casing to nearly its original shape and diameter (below). The swage relies on mechanical force supplied by downhole impact equipment such as a bumper sub or drilling jar to open casing obstructions. Incremental sizes allow swaging to repair various degrees of casing collapse. This tool is frequently run before production equipment is deployed to ensure that tools will pass cleanly through the casing.

**Economic Considerations**

The decision to fish—or not—must be weighed against a need to preserve the wellbore, recover costly equipment or comply with regulations. Each choice is fraught with its own costs, risks and repercussions. Before committing to a specific course of action, the operator must consider a number of factors:

- Well parameters: proposed total depth, current depth, depth to top of the fish and daily rig operating costs
• Lost-in-hole costs: the value of the fish minus the cost of any components covered by tool insurance
• Fishing costs: daily fee for fishing expertise and daily rental charges for fishing tools and jars
• Fishing timetable: time spent mobilizing fishing tools and personnel, estimated duration of the fishing job and the probability of success.

Cost usually dictates the maximum duration of the fishing job. Thus, a shallow hole with little rig time and equipment invested will probably warrant a minimal expenditure in fishing time. By contrast, when the lost equipment represents a large capital investment, more time and expense are justified. Some operators mandate that once fishing costs reach about half the cost of kicking off and redrilling, then fishing operations should be abandoned in favor of sidetracking.\(^{10}\)

Various formulas and proprietary programs have been developed to help operators determine how much time should be spent trying to retrieve a fish (above right). Experience has shown that the probability of successful retrieval diminishes rapidly with time. This conclusion tends to provide an incentive for starting fishing operations as soon as possible, with the assurance that beyond a certain point, the chances of catching the fish become nil. When it comes to fishing for stuck pipe, for example, many operators draw the line at four days, including time spent working the pipe or spotting pills.

If the decision is to abandon the fish, the operator must then decide whether to J&A the hole, complete the well above the fish or sidetrack around it. In the case of junking and abandoning the well, the operator’s geoscientists may be able to find value in the data obtained from the well, which may influence subsequent decisions regarding whether or not to drill an offset well.

Some wells encounter productive horizons on their way to deeper pay zones. If reserves in shallower horizons are sufficient to justify completion, the operator may decide to forgo pursuit of deeper pay when faced with a fishing job; instead, the company can abandon the deep hole and set pipe in the shallower pay. This option will be impacted by the replacement cost of the equipment left in the hole, the probability of its recovery, the cost of the shallow completion and the amount of reserves in the shallow zone.

Another option is to sidetrack. In addition to accounting for the cost of equipment left in the hole, the operator should weigh the following:
• the cost and time required for shipping a whipstock, drilling motor or other equipment used to sidetrack the well
• the cost of setting cement plugs down to the kickoff point, setting time and tripping in preparation to sidetrack
• the cost of drilling from kickoff point to TD
• the probability of getting stuck in the same interval again.

In certain areas, an operator may find that fishing is more expensive than sidetracking, or that the latter may have a more reliable outcome. For openhole jobs, setting a cement plug and whipstock may be an attractive alternative to days of nonproductive time. This option is not popular in all regions, however, and demand for fishing may actually see a resurgence in some areas.

Training for the Future
Fishing expertise is hard won, gained primarily through on-the-job exposure to a myriad of challenging operational situations in difficult wellbores. Currently, the “great crew change” is sweeping a number of experienced fishing hands into retirement, thus reinvigorating the imperative to train more fishing specialists. In response, Schlumberger has instituted a training program for fishing crews. The curriculum is designed to develop students’ fishing skills and sharpen their technical knowledge; the curriculum is supplemented by actual field operations to strengthen proficiency.

The program provides progressive exposure to a wide range of tools and fishing techniques. With a prerequisite that ensures all trainees are familiar with the tools used in their region of operations, the first-level course provides field specialists and field engineers with hands-on training that concentrates on shop assembly and disassembly, supplemented by classroom instruction and rig-site training.

The trainees are then assigned to the field to a number of fishing, wellbore departure and well abandonment jobs before they become eligible for the next step in their development. These jobs are carried out by experienced personnel with the trainee assisting.

The second level of training goes into greater depth on fishing techniques and is supplemented by case studies. The trainees conduct job planning exercises based on actual fishing jobs. They design a complete BHA for the job and present their plans to the class for evaluation and brainstorming. Following this class, the trainees continue their field training and conduct a number of solo jobs before moving on to the next level.

The final level of training focuses on the managerial side of fishing and remediation to train personnel for supervisory roles. Such training is vital to the future of the oil patch, because as long as downhole equipment or wellbores fail, fishing expertise will be in demand. —MV