Systems which aid in underwater oil drilling highlight examples of aerospace technology applications to energy exploration, supply and conservation

Spinoff for Deepsea Drillships

In the quest for new energy supplies, oil explorers are stepping up their efforts to tap undersea sources. In doing so, they are moving more and more into deeper parts of the oceans where water depths measure thousands of feet.

As might be expected, this creates new drilling problems whose solutions demand application of new technology. Space spinoff systems are providing answers in one important area of deepwater drilling operations.

In shallow water—a few hundred feet—oil companies employ fixed-position drilling rigs anchored to the seabed by sturdy steel legs or by massive chains. But there are practical limits to the length of support legs or chains.

So for deepwater operations the self-propelled oil drillship is employed. This type of vessel resembles a cargo ship except for its large derrick, which supports the drilling equipment. Extending from the drillship to the well thousands of feet below is a "marine riser," a cylindrical steel tube usually one to two feet in diameter. The drilling equipment, or drill string, is lowered to the well through this riser. The riser is not rigid nor strictly vertical; it is described by one expert as "a very long piece of spaghetti," held in tension at the well and at the ship end by strong cables.

Obviously, the ship must remain—often for months—in a position directly over the well. If it were to drift excessively forward, aft or to either side, its movement could snap the riser and disrupt operations at a cost of millions.

That's where space technology is playing a part. The same technology employed to locate a spacecraft in orbit and maintain a precise position is applicable to drillship operation. In space, automatic navigation equipment sights on reference points—the Earth, the sun or other stars—to determine spacecraft location. If the space mission requires the spacecraft to hold a certain position, it is accomplished by the firing of computer-directed control thrusters. Two major aerospace companies—Honeywell Inc. and TRW Inc.—have applied their extensive experience in spacecraft positioning and control to the offshore drilling technique known as dynamic positioning, meaning holding the drillship in precise position over the work site.

Honeywell's Commercial Marine Operations, Seattle, Washington, developed the first computerized anchor-free mooring system for drillships and it now manufactures several dynamic positioning systems, each tailored to the needs of a specific type of vessel or to different types of offshore operations.

For a positioning reference point, the systems employ a small, battery powered beacon placed on the seabed at the drilling site. The beacon emits a sound signal which is picked up by sensitive receivers, called hydrophones, on the hull of the drillship. The signal is relayed to a shipboard computer, which studies the "phase lag" of each acoustic pulse. If, for example, the signal reaches the hydrophones simultaneously, that means the ship is exactly over the beacon. But if there is a time difference in signal reception, that indicates the ship has moved off center. The computer analyzes the signals to determine what correction is needed to nudge the ship back to proper position. Then the computer directs the ship's engines to move the vessel backward or forward, or directs lateral thrusters to move it to one side or the other, until beacon signals indicate the ship is once again properly spotted. This operation goes on continuously.

A real boon to the oil industry, this type of dynamic positioning system is now used on most drillships and it is proving effective. However, because position maintenance is vital to successful drilling, it is standard practice to employ a backup system. Sound signal systems are occasionally subject to what is called "acoustic drop-

Deepsea drillships such as Discoverer Seven Seas *drill for oil and gas through thousands of feet of water. Unanchored, they need a method of holding position directly over the drill site, often for months. Spinoff systems which trace their origins to NASA's Apollo program are providing answers.*

out," the deepsea equivalent of radio static. Other noise in the vicinity—for example, the ship's engines and thrusters, the clanging of the riser or the movement of marine life—may cause temporary interference with hydrophone signal reception and inadequate input to the computer.

Applying its experience in spacecraft control, TRW Subsea, a unit of TRW's Defense and Space Systems Group, has developed a backup system which does not rely on sound signals. Called the Riser Positioning System, it measures the angles of the riser at its top (ship) and bottom (seabed) connections. Small pendulum-like devices at either end maintain a continually vertical attitude; the angle between riser and pendulum is measured and transmitted electrically through a cable to the computer. The computer compares the angles with other stored information—water depth, tension of the riser connections, riser buoyancy, and a number of other characteristics of the riser and the drill string within it. Computer analysis then determines the ship's position and, as in the primary system, the computer sends adjusting instructions to the ship's engines or thrusters. The backup system gathers information continuously and is always ready for immediate service, but it goes into action only when the primary system experiences dropout.

The Honeywell Automatic Station Keeping System, which is based on spacecraft positioning technology, is an anchor-free mooring system for drillships. Using a beacon on the sea-bed as a reference point, the system computes the ship's location relative to the well and automatically directs fore-and-aft and side-to-side movement to keep the ship properly positioned.

Drillship positioning is vital to successful drilling, so it is standard practice to use a backup ship positioning system in case undersea sounds interfere with a primary acoustic system like Honeywell's. A non-acoustic backup instantly available if the primary system encounters interference is TRW Subsea's Riser Positioning System, whose development was based on the company's experience in spacecraft control. The system measures angles between ship and well as reference points for determining proper ship location, then automatically corrects ship's position.