Rig instrumentation technology: Facilitating drilling operations and reducing cost

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INFORMATION CRITICAL TO efficient, safe and cost-effective drilling has not, in times past, been easy to access and analyze. Vital information, key to both the identification of drilling problems and ways of improving drilling performance, can be difficult to find. Dispersed and often well hidden among routine data collected in morning reports, tour reports, mud reports, bit records, drill recorder charts, circular charts, and the mud log, this information is tedious and time-consuming to identify and assemble together in a meaningful form.

Data-acquisition equipment must be able to withstand punishment in the rig environment. This single-board data-acquisition computer is cased in metal, combining ruggedness and miniaturization, as the comparison to a US penny above shows.

But things have changed. A rapid evolution in drilling instrumentation, thanks to innovations in sensing technology and improved computer designs, has brought to the drilling operation a powerful tool with great potential. Now, at the same instant that the driller is watching the drilling parameters at the console in front of him, a complete and accurate record of the entire drilling process from spud to TD is being stored automatically. These valuable data from routine, significant, and extraordinary events recorded on a foot-by-foot and time basis have become easy to access and review, both during and after drilling, providing valuable insight into the causes of equipment failures and hole problems. The accuracy of the data documented usually leaves little room for doubt or conjecture as to exactly what events took place and when.

Engineers learn early on that inaccurate data leads to incorrect conclusions and poor decisions. It is not necessary to work with rough estimates and approximations of drilling data, when accurate information is available from an instrumentation system, the cost of which will probably be dwarfed by its contribution to savings in time, materials and effort. Not all instrumentation systems perform in the same way, however. Selecting the best system components to match the user's needs and the rig's intended operating environment, while taking full advantage of the numerous advances in sensor display, computing power and communications technology, can be a challenge for even the most technologically competent.

SENSORS

Accuracy in measurement of drilling parameters begins at the sensors. The sensors are the most important and fundamental part of any rig instrumentation system. Most drilling rigs carry as original equipment electro-mechanical and hydraulic sensors. While it would be difficult to operate a rig without them, subtle changes in drilling parameter behavior which are important in identifying developing drilling situations are often masked. These types of sensors have built-in inaccuracies that produce non-linear responses and, in addition, tend to show variations in readings with temperature changes.

A new generation of highly accurate sensors has become available in recent years which makes use of solid-state measuring techniques. Compensation for sensor drift over a wide operating temperature range is precise and reliable, and ultra-stable calibration characteristics mean that time-consuming calibration procedures at the rig site are eliminated. The sensors' small size and weight make logistics and installation much easier.

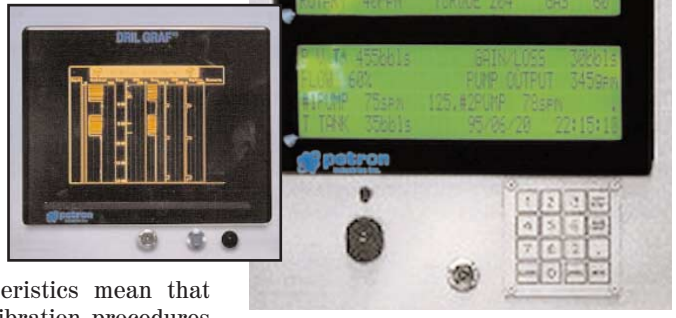
It is extremely important that the sensor's accuracy is fully utilized and that it measures the drilling parameter as directly as possible. Electronic sensors piggy-backed onto the rig's existing hydraulic or electro-mechanical sensors inherit the limitations of the original devices. The response, reliability and accuracy of the measurement may be severely compromised. The accuracy of such hybrid instrumentation systems is therefore significantly limited.

DATA ACQUISITION

The design of the front-end data acquisition system is equally important. Its construction must withstand punishment from the rig environment, weather, and drill-floor personnel. The mission of the data acquisition system is to guarantee a continuous, accurate flow of data under the drilling unit's tremendous variety of operational difficulties.

DRILLER'S DISPLAY

As the success of a drilling operation very much depends on what takes place at the brake, the display presenting information to the driller is critical. An alarmable alphanumeric display gives the driller tight control of important drilling parameters. Digits need to be large enough to be seen clearly from a distance, while the complete display should be easily comprehensible at a glance. As this display may be subject to severe punishment from time to time , it must be very rugged.



Driller's display: An alarmable alphanumeric display gives the driller tight control of key drilling parameters. Digits should be large enough to see from a distance. Inset: Optional graphical and gauge displays driven from the driller's console are useful supplements.

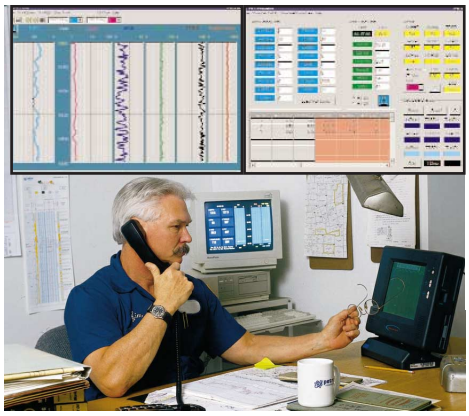
Optional graphics and gauge displays for the drill floor, driven from the main driller's console, are useful supplements to meet the specific needs of the rig. The level of sophistication of these displays will depend on the driller's level of expertise and responsibilities. Where the drill floor environment and level of training (and budget) permits, a fully computerized work station can be installed, giving the driller the same computerized data management capabilities as the company man and drilling engineer.

THE WORK STATION

A drilling project is successful due to the efforts of rig specialists—driller, company man, toolpusher, mud engineer, directional driller. Individual remote workstations with access to graphic and digital data displays of the drilling data can be used by each of these specialists with alarms set to monitor a particular vital area of interest. In this way, each skilled member of the drilling team is able to become more focused and productive. The onset of lost circulation, washouts, dog-legs, key seats, increasing formation pressures, kicks, and blow-outs can all be detected by monitoring real-time information and graphic displays of developing drilling trends.

One of the work station's most important functions is to reliably document significant events in the drilling process. Pressure tests can be *accurately* recorded, providing precise documentation of leak-off and BOP tests. Recorded on a foot-by-foot and time basis, maximum values of drilling parameters such as torque and hookload can give valuable insight into the causes of equipment failures and hole problems. This heightened level of accuracy leaves little room for doubt or conjecture should a mishap occur. With so much information easily and quickly accessible in one place, its efficient utilization can result in significant savings in drilling time and expertise. This is particularly valuable when tight AFE's have been set or in a turnkey situation.

Today's PC technology has made it possible to include some very powerful features that are extremely valuable to the drilling process. In Petron's new PNT workstation, for example, there is a large array of easy-to-use graphics screens to make the drilling process easy to follow and analyze. Full details of important rig data such as pump specifications, hole geometries and



The work station: Individual remote workstations displaying data digitally and graphically enable members of the drilling team to become more focused and productive. Insets: State-of-the art displays include drilling paremeters with TVD and lag correction(left inset) and real-time hydraulics (right inset).

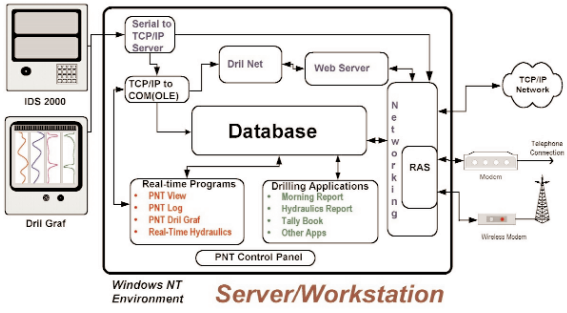
more are stored for reference by numerous application programs. One of the most useful programs with a wide range of practical applications is a real-time hydraulics function. Hydraulic parameters for any part of the hole can be calculated as often as every 2 seconds. "What if" scenarios can be examined instantly, using real-time data to see if changes in annular flow regimes, pump pressure, jet nozzle size and mud properties, would minimize related hole problems or improve drilling performance. Formerly, this kind of computing power was available only from expensive, full-service mud logging units or as separate time-consuming programs which performed the required calculations on a personal computer.

Many of the sophisticated functions of a mud-logging unit can be provided by this type of work station. Accurate depth and ROP with lagged gas and correction for TVD can be displayed automatically. Where accurate foot-by-foot geological descriptions are not required, this feature can in many cases provide more reliable and less subjective information than that from the average mud logging service, saving a substantial amount of money on services and personnel costs. The system, while packing a powerful technological punch, is surprisingly easy to use and operate.

THE IT CONNECTION

Communications links have improved dramatically in the last few years and are rapidly approaching a highly uniform quality worldwide. The last geographical frontiers will soon be conquered when stationary-orbit communications satellite networks currently being put in place are fully functional. Communications technology is opening the door to unprecedented rig-site information transfer and knowledge exchange at such a reasonable cost. For example, 24 hours of detailed drilling data can be downloaded in less than 30 sec in a data-dump mode. In Petron's PNT system, any computer loaded with inexpensive Internet software can access a drilling data overview field easily and cheaply. Even though Internet technology is being used, data security is not sacrificed, as access is made directly through a secure telephone line. WITS protocol can be used for data communication with other vendors.

If a drilling problem needs to be discussed with someone off-site, data from the rig can be received with equal ease by a personal computer in the office, or an engineer with a laptop in a hotel room. Both historical and up-to-the-second drilling data can be reviewed, with control over the screen data display and cursor operation transferable between rig-site user and off-site user. In this manner, unequivocal and well-coordinated examination of data relating to important drilling events is facilitated. In addition to the important aspect of drilling data review and data transfer, which in itself can enhance the efficiency and cost effectiveness of the drilling



IT Connection: Communications technology allows historical and current rig data to be received off site with relative ease. The value of this type of workstation is just now being recognized.

operation, more routine tasks such as filing drilling reports to the office are easily done.

The worth of this kind of work station, when used in conjunction with an accurate and reliable instrumentation system, and its potential to improve the drilling process, are only just beginning to be recognized. How it is to be used in the future will be limited only by the resourcefulness of the user and the technical capabilities and cooperation of the service company providing the instrumentation. Its value to the company man, drilling engineer and drilling contractor is evident. It is an extremely powerful drilling tool in the hands of those who most need it, whether on the rig or in the home office.

MUDLOGGING

A powerful computer system similar to the Petron PNT can be used as the information engine to perform many of the sophisticated functions of a full-service mud logging operation. With the further addition of a mud logging software package to the system's program base and a chromatographic gas analysis data stream, this stand-alone instrumentation system can easily carry out the data acquisition and reporting tasks of a fully computerized mud logging unit. This leads to great flexibility when coping with the variously changing mud logging requirements of a drilling operation. It can transform a rig instrumentation system into a top-of-the-line mud logging data service when it is required, at very little extra cost.

GEOLOGGING

When this kind of sophisticated drilling instrumentation package is already installed on the rig, geological services need be called for only as necessary. By drawing from a pool of highly qualified well-site geologists, many of whom are specialists in the target formations being sought, the level of geological services can be matched to the requirements of the individual well or drilling project. This GeoLogging concept introduced only recently to the industry has met with great success. The manpower levels commonly associated with full service mud logging units can be reduced, while ensuring high quality drilling data and the presence of highly trained, yet affordable geological personnel during critical drilling periods.

Highly focused geological professionals working at the rig site can take full advantage of the computing power of the PCs, and their sophisticated, yet easy to use data processing programs. Additional data from MWD and wireline services can also be imported and incorporated with the geological and drilling data, and a composite log quickly and accurately crafted. Valuable time is saved, and the decision-making process greatly accelerated. In the present industry climate of continued unrelenting efforts at minimizing personnel and increasing efficiency, this sophisticated yet practical approach can be of substantial economic value. By utilizing the geologging concept to its fullest, rig space, manpower, logistics costs and time can all be saved.

Mud logging: By adding mud-logging software and a chromatographic gas-analysis data stream, the rig's instrumentation system can acquire mud-logging data and create reports.

ON THE HORIZON

Future directions of development for rig floor instrumentation are many, and will depend largely on the extent of interest expressed by the industry and the willingness to pay for the product once it is developed. Faster data streams may be used for feed-through to rig-floor control systems. More accurate measurements of certain key drilling parameters could enhance some of the leading edge drilling technologies presently under development. Sophisticated mud cleaning and waste management equipment can be instrumented to optimize performance. Extending data acquisition functions to measuring the function of motors, generators and prime movers and adding rig maintenance software is a logical progression which will increase the value of rig instrumentation to the drilling contractor. Artificial Intelligence in the drilling industry has met with limited practical success so far, and though potentially very useful, cautious use of "smart systems" seems in order. As many other industries have discovered—aviation, railroads, nuclear power plants—over-reliance on smart systems can lead to complacency. In addition, the common problem of "smart" algorithms not taking into account all of the possibilities before sounding an alert can lead to the "cry wolf syndrome", when false alarm situations become so common that a real alarm is ignored. This is a direction which begs further development, but will require a lot of R & D investment for truly useful products to be developed.

CONCLUSION

In the present industry climate of ever-developing technology and the pressing search for the lowest overall project cost, the value of accurate drilling data has assumed new importance. There is still no substitute for training and experience however. As an instrumentation manufacturer, the single most important role must be as the provider of accurate, reliable drilling information in an easy-to-digest form. By imparting greater clarity to the sequence of events which contribute to both success and failure in a real-life drilling operation, the true nature of cause and effect becomes evident more quickly. The learning process can be accelerated, facilitating increasingly efficient completion of the multitude of tasks involved in the many different facets of a drilling operation. Successful application and conscientious use of high quality instrumentation contribute to minimizing drilling problems and increasing safety while reducing overall cost. Rig instrumentation in its presently developed form has never before played such an important role in the drilling of a well and the planning of future wells. It is a valuable tool made tremendously more useful in recent years by advances in technology. *It is a tool whose time has come!*

ABOUT THE AUTHOR

***Peter Buckley**, Vice President of **Petron Industries**, studied geology, physics and chemistry at the **University of London**. After working as an engineering geophysicist and petroleum geologist, he joined **Dresser Industries**, where he worked for 10 years, the last 6 as chief engineer. Mr Buckley and 2 partners formed Petron Industries in 1983.*