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The Evolution of Automation in Drilling

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Abstract

This paper has been written for the keynote speech to be given in the “Drilling Automation – Where Are The Game Changers?” plenary session for the 2007 SPE Annual Technical Conference and Exhibition in Anaheim, California. The paper covers the evolution of drilling mechanization and automation from the mid-nineteenth century to today. In the history of drilling, there have many aspects of drilling mechanization and automation that have been investigated, machines designed and built, and operations implemented with varying levels of success and many failures. These aspects include drilling fluid systems, cementing operations, downhole automation, and the rig floor. Because drilling mechanization and automation history has been centered on the rig floor and related surface operations, the focus of this paper is on the rig floor for drilling operations such as rate of penetration, rotary systems, rig floor mechanization and automation, and entire drilling rig automation.

Introduction

Mankind has always found wealth under the Earth’s surface, whether it be water, brine, oil, gas, or gems and minerals. Accessing that wealth has been the challenge. The drilling rig is one of the machines developed to access that wealth.

It all started with a pole, a rope, a heavy weight, and a lot of labor. These first rigs were percussive drilling units called cable tool rigs. These units, popular until the mid-twentieth century, were the only way to drill until the mid-nineteenth century. On January 9, 1845, Robert Beart in Great Britain was granted a patent on the first of a new style of rig, the rotary rig with continuous circulation.^{5,8}

Regardless of whether percussive or rotary systems were used in these early years, the tasks were repetitive and required human manual strength. These early rigs were a nightmare of dangerous and unguarded equipment and hazardous operations. The roughneck was not named thus for his knowledge.

Anywhere repetitive or dangerous operations take place, the allure of mechanization and autonomy beckons. The automotive and aeronautical industries have recognized this for years. The automotive industry in particular has mechanized and automated the manufacturing floor and leads in many areas of robotics. The drilling rig floor is clearly one of those places where this can be useful.³

The process for technology development follows a path. Phil Vollands of Varco International has stated that there are three eras of evolution: mechanization, semi-automation, and local automation.¹² The process starts with mechanization. That is, removing human power and labor and substituting mechanical power. Not only does that get the human out of the way, it allows for more force and torque to be applied. The next step is to automate the particular operation. At this point, the human’s role changes from brute strength to using their intelligence to supply the machine the brains and vision for the automated operation. That makes this a local semi-autonomous operation. An ultimate goal is to completely automate an operation making it totally autonomous. No human intervention is needed except for startup and for emergencies. This is becoming a reality with the advent of robust computers and programmable logic circuits (PLC).

The motivation for rig mechanization and developing autonomous rigs are many. It starts with safety. Removing people from the area of heavy moving machinery clearly enhances safety. This is the goal of many operators, contractors, service companies, and regulatory agencies around the world.

Another motive is to reduce the number of people on the rig floor. Over the last few decades, the number of people entering the drilling industry has been declining. Mechanization and automation can reduce the required number of people not only on the rig floor, but also on the rig itself. It also reduces costs associated with the head count.

Operating in harsh environments is another motive. In cold and windy or severe wave conditions, human ability to control the rig floor diminishes. Machines designed for the particular environment are not as affected and can continue operations whereas human operations would have to wait on weather.

There are also efficiency motives. For example, efficiencies manifest themselves in the area of drilling operations where the “optimum” rate-of-penetration can be determined and operations set at that condition. Operational efficiencies can be gained with the automation of repetitive tasks such as tripping. The tripping operation can be faster, safer, and more precise. Tripping speeds can be more precise