Evolution of Drilling Data and Geological Data Utilization in Drilling Optimization

By

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Ernest Onyia is the President at GPRESS Energy LLC. He retired as a Drilling Engineering Fellow from ConocoPhillips in 2016 after 35 years in various global roles in drilling. He joined Conoco Inc. as Chief Engineer in the Well Operations Group, Deepwater Business Unit, Lafayette, LA, in 1997. Ernest holds B.S. degrees in Mining and Geological Engineering from the University of Missouri, Rolla, and an M.S. in Geology from Wright State University, Dayton, OH. Prior to the positions with ConocoPhillips, he worked at Amoco Research in Tulsa for 16 years in drilling mechanics research, technology development and technology transfer. He performed field rotational drilling engineering operations duties at the Amoco Critical Drilling Facility (CDF). He specializes in pore pressure prediction, wellbore stability, drilling mechanics, and coiled tubing technologies. He has developed and taught several in-house and industry schools on pore pressure, borehole stability, Coiled Tubing Drilling and other topics in drilling. He has over 20 technical publications in various aspects of drilling mechanics technologies. He holds two patents in drilling technology. He was a Society of Petroleum Engineers Distinguished Lecturer for the 2001-2002 program.

Outline

- Introduction
- What is Digital Transformation with reference to Drilling?
- Review the evolution of drilling and geological data in drilling optimization.
- Current State
- Summary

Introduction

Digital Transformation of the Geosciences - Hype or Hope

According to Jason Bloomberg[1] "Digitization, Digitalization And Digital Transformation: Confuse Them at Your Peril"

Digitization - Analog to Digital

Digitalization – digital technologies to transform business models

Digital Transformation – *"..refers to the customer-driven strategic business transformation that requires cross-cutting organizational change as well as the implementation of digital technologies"*

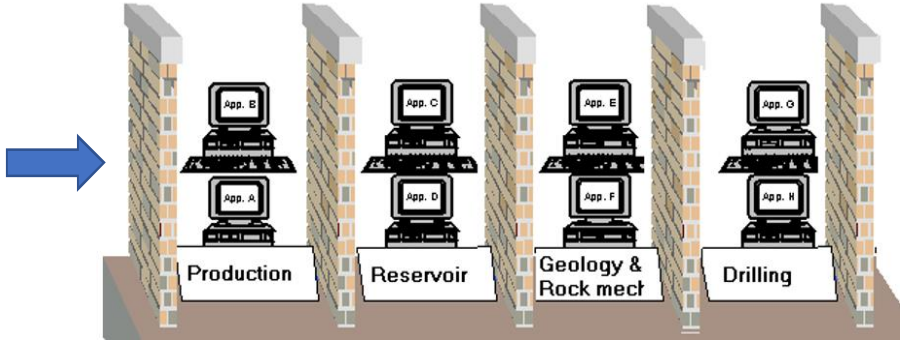
1. Jason Bloomberg, Forbes Contributor, April 29, 2018

What is Digital Transformation in Drilling?

Hope

- A major dilemma associated with obtaining the necessary drilling parameters, logging data and other geological data in drilling is that there is no envisioned end-use for most of the information. *(Onyia SPEDE March 1987).*

- Factors
  - Rig data (non-digital)
  - Organizational Walls – Geology, Drilling, and others
    - Lack of integration
  - Learning Culture - Limited at best.



Modified from ITC As

- Where is the industry now and where are we going?
  - Drilling optimization and Real Time Operations Centers -RTOCs
  - Safety
  - Value proposition

Digital Transformation in Drilling: Evolution

Early to mid-80's

Geology Drilling Log (GDL)

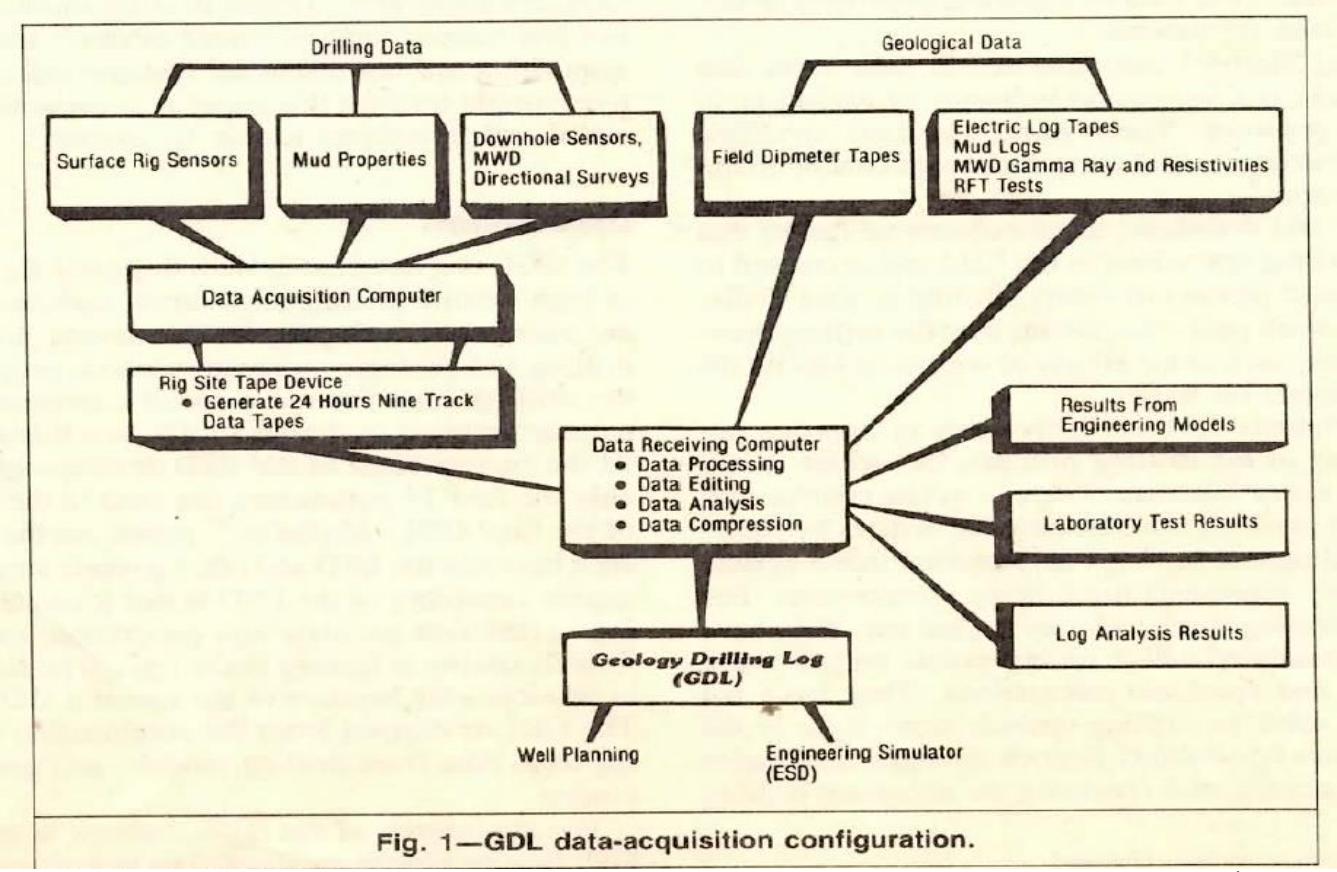


Fig. 1—GDL data-acquisition configuration.

Onyia, E.C.; SPEDE March 1987.

Digital Transformation in Drilling: Evolution

Geology + Drilling data

Geologic Data from:

- Wire line logs
- LWD
- Mud Logging
- Cores

TABLE 2—DATA RECORDS

Field	Parameter
1	Sequence number
2	Record type
3	Activity number
4	Time
5	Date
6	Depth of hole
7	Depth of bit
8	True vertical depth
9	Standpipe pressure
10	Hook load
11	Hook-load maximum
12	Connection-hook-load constant
13	WOB
14	Revolutions on bit
15	Revolutions per minute
16	Time on bit
17	Amps
18	Volts
19	Torque calibration factor
20	ROP
21	Block position
22	Block speed
23	Block-speed maximum
24	ECD at the bit
25	Impact force
26	Jet velocity
27	Drilling cost per foot
28	Surge/swab
29	Flow-in ultrasonic
30	Flow-out ultrasonic
31	Flow ultrasonic
32	Pump 1 revolutions per minute
33	Pump 1 gallons per revolution
34	Pump 1 percent efficiency
35	Pump 2 revolutions per minute
36	Pump 2 gallons per revolution
37	Pump 2 percent efficiency
38	Pump revolutions total
39	Pump-rate total
40	Trip-tank volume
41	Slug-tank volume
42	Pit-volume total
43	Pit-volume change
44	Temperature in
45	Temperature out
46	Conductivity in
47	Conductivity out
48	Density in
49	Density out
50	Plastic viscosity
51	Yield point
52	10-second gel
53	10-minute gel
54	pH
55	Fluid loss
56	Total gas
57	Bottoms-up time
58	Bottomhole-assembly length
59	Out-of-slips time
60	Seven spaces plus a carriage return

Onyia, E.C.; SPEDE March 1987.

Digital Transformation in Drilling: Evolution contd.

Geology + Drilling data

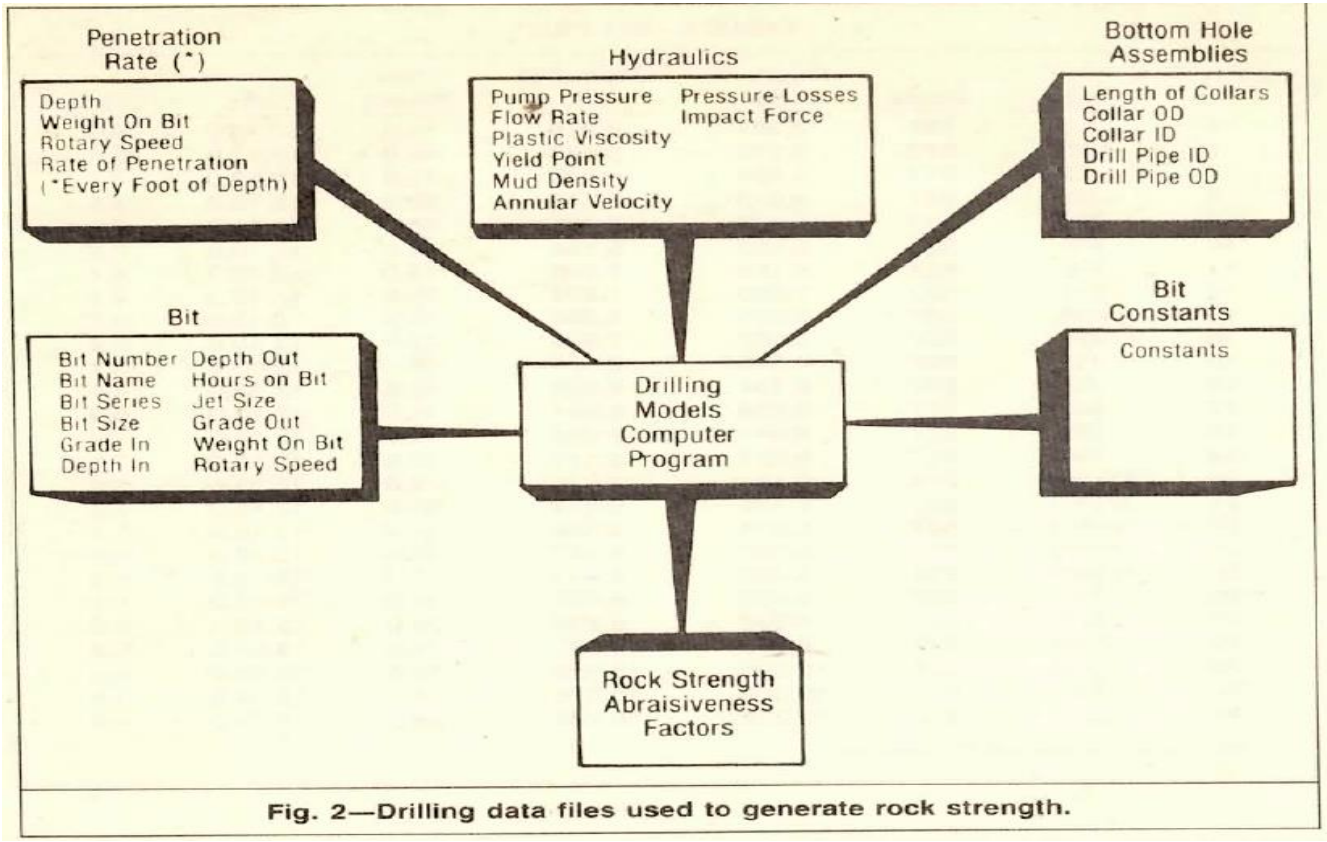


Fig. 2—Drilling data files used to generate rock strength.

Onyia, E.C.; SPEDE March 1987

Digital Transformation in Drilling: Evolution

Geology + Drilling data

End Result: Rock Strength or Drillability Log

$$R = \left(\frac{aS^2D^3}{NW_b^2} + \frac{b}{ND} + \frac{cW_m\mu_p D}{Q} \right)^{-1} \mathrm{f}(p)$$

Onyia, E.C.; SPEDE March 1987.

Digital Transformation in Drilling: Evolution

Early to mid-80's

Application in Drilling Simulation

Full drilling interactive simulator

Amoco's Engineering Simulator for Drilling, ESD

Mid 90's to early 2000's

- Emerged, the concept of Mechanical earth Model
  - Same concept of integration of Geological Drilling data for well design PLUS more elaborate simulation taking advantage of faster computing capabilities.
  - Multiple well paths
  - But NOT a *full-blown interactive* simulator like the Amoco ESD
- Others – Apparent Rock Strength (ARS) by Geir Hareland

Current State

- Better computing power
- High fidelity digital drilling data – time and depth based, including rig equipment sensors in real-time
- High fidelity wireline and Logging While Drilling (LWD) data
- Real-time geophysical data
- Remote operations monitoring:
  - Distributed
  - Real Time Operation Centers (RTOCs)
- Deep-water wells
- Movement to Unconventionals

RTOC

High Fidelity Data

Credit to Genesis RTS:
http://www.genesisrts.com/tools-rtoc.shtml

Challenges

- Real-Time Data (while drilling)
  - Data overload
  - Limited experienced personnel
- Post Drilling
  - Persistent limited end use of drilling data
  - Data mining tools
  - Personnel

Summary

- Significant advances have been made in digital data transformation in drilling in the use of drilling and geological data among the majors.

- Post-drilling: Limited end-use of the acquired data in drilling models development and simulation.
  - Safety – Proactive rather than reactive use of data

- Opportunities
  - Unconventionals
  - Value

THANK YOU