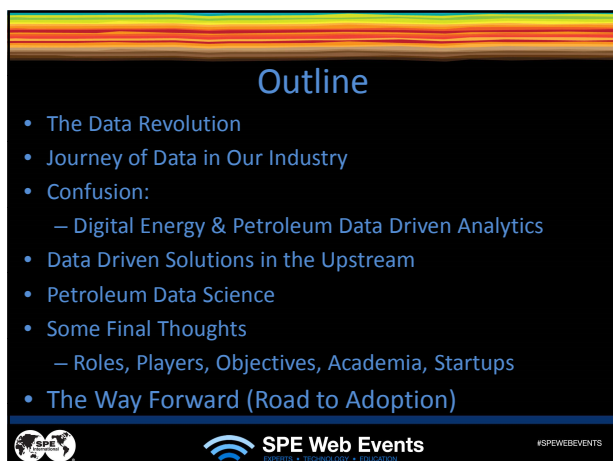
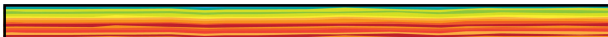










Game Changing Role of Data in our every day life

DATA REVOLUTION

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The Data Revolution

- Data is the new buzz word.
- It is changing the way we:
 - Shop,
 - Receive news and information,
 - Manufacture,
 - Farm,
 - Receive healthcare,
 - Plan travel,
 - ...

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Data-Driven Solutions

- Data-Driven Solutions are now used across multiple industries:
 - Self-Driving Cars (Google, Apple, Bez, Nissan, Tesla)
 - UPS (Fleet Tracking Devices) to cut operational costs
 - Boston and Rio (event anticipation) to cut municipal costs
 - Healthcare, Pharmaceutical, Manufacturing, Retail, Consumer Tracking, ...

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Data-Driven Solutions

- In oil and gas industry:
 - Drilling ahead of the bit (on-bottom and off-bottom NPT prediction)
 - Formation Evaluation (Core-Log Correlation, Synthetic Logs)
 - Reservoir Modeling (Data-Driven Reservoir Models)
 - Reservoir Management (Smart Proxy)
 - Production Optimization (Hydraulic Fracturing optimization in Shale, Re-Frac Candidate Selection & Design)
 - Surface Facility Modeling
 - Accurate estimation of the discharge rate only days after the Deepwater Horizon incident (coupled smart proxies).



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How Data is Used Now and How Will it be Used in the Future

DATA JOURNEY IN E&P



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The Data Journey

- Deterministic Solutions (numerical, Analytical, etc.)
 - Our today's understanding of the physics (model) dictates the type and the quantity of data used.
 - Data is there to serve our models.
- Data-Driven Solutions
 - Data is the major source of information about the asset.
 - Data serve as the main building blocks of the models.



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The Journey of Data in the E&P

- Data plays two major roles (goes through two phases) in the E&P industry:
 - **Phase 1.** Consumer of Resource: EXPENSE
 - **Twilight Phase:** The transition mode
 - **Phase 2.** Contributor to the Bottom-line: ASSET



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The Journey of Data in the E&P

- Phase 1.** Consumer of Resource: Data is an *"EXPENSE"*



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The Journey of Data in the E&P

- Phase 2.** Contributor to the Bottom-line: Data is an *"ASSET"*



Make Use of Existing Workflows. It Requires:

- Open Mind
- Domain Expertise
- Basic Understanding of AI & Data Mining



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The Journey of Data in the E&P

- **Twilight Phase:** The transition mode – learning the trade – testing the water

Cleaned & Summarized

Basic Statistics

Visualized

Build Your Own Workflow. It Requires:

- Massive Amounts of Patience
- Domain Expertise
- Expertise in AI & Data Mining

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The Journey of Data in the E&P

Data = Expense
Data as a Consumer
of Resources

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Much Clarity Needed in the Role of Data and People Involved

CONFUSION

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Confusions

- What is the objective of Petroleum Data Analytics?
- Who are the main players?
- What is the role of IT and Engineering in the Petroleum Data Analytics?
- Who should be doing What?



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The “Data Confusion” in our Industry

- People are most productive when their roles are well defined and clear.

Digital Energy

Petroleum Data-Driven Analytics

- They **ARE NOT** the same thing.
- One’s ability to distinguish between these activities, is a function of his/her understanding of role of Data in E&P.



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Confusions

- In general data-driven analytics includes two major components:

– The IT Component

Digital Energy

This component of data-driven analytics deals with data infrastructure, data standards, data maintenance, and on-demand data delivery to the scientists and engineers.

Petroleum Data-Driven Analytics

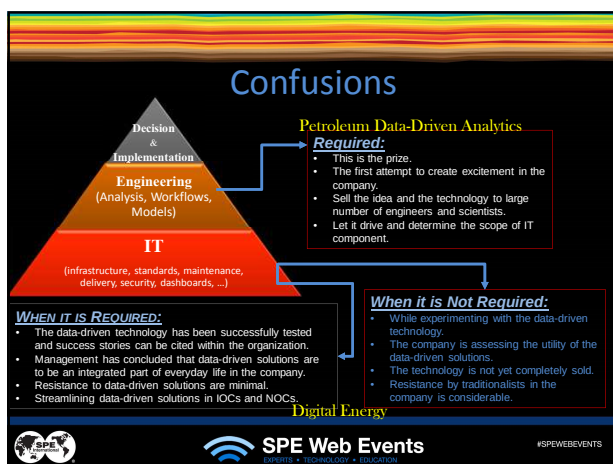
– The Engineering and Geosciences Component

This component of data-driven analytics makes use of data in order to perform analysis, build workflows and models that directly impacts operational efficiency and ultimate recovery.



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Even More Confusion

- Within the context of data-driven solutions there are confusion too.
- Is Data Mining the same as Statistics?
- Is Machine Learning and Artificial Intelligence the same as Statistics?
- Not a new issue. Been around for decades.
- Differences are Philosophical as well as technical. (Aristotle vs. Plato)

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Game Changing Applications in the Oil and Gas Industry

DATA-DRIVEN SOLUTIONS IN E&P

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Data-Driven Analytics; Definition

- Letting data be the main driving force toward the solutions that form the foundation of decision making.
 - What are the main building blocks of our models?
 - Our today's understanding of physics
- vs.**
- The Facts (data – field measurements)



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DATA DRIVEN ANALYTICS CONSTITUTES A PARADIGM SHIFT IN HOW WE SOLVE PROBLEMS IN E&P

Incorporation of Data-Driven Analytics in the Everyday Life of Petroleum Professionals has been an Uphill Battle.



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Paradigm Shift

“a change in basic assumptions within the ruling theory of science”

Kuhn, T.S. *The Structure of Scientific Revolutions*.
Chicago: University of Chicago Press, 1962. ISBN 0-226-45898-3.

The techniques and technologies for data-intensive science are so different that is worth distinguishing data-intensive science from computational science as a new, *fourth paradigm* for scientific exploration.

Jim Gray: (1944-2007) Legendary American computer scientist, received the Turing Award for seminal contributions to computer science.



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Paradigm Shift

- Thousands of year ago: **FIRST PARADIGM**
 - Science was Empirical (describing the natural phenomena)
- Last few hundred years : **SECOND PARADIGM**
 - Theoretical branch (using models, generalizations)
 - Kepler's Law, Newton's Law of Motion, Maxwell's Equation,
- Last few decades : **THIRD PARADIGM**
 - Computational branch (simulating complex phenomena)
 - Theoretical models grew too complicated to solve analytically



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Paradigm Shift

- Today: **FOURTH PARADIGM**
 - Data-Intensive, Data Exploration, eScience
 - Unify theory, experiment, and simulation
 - Data captured by instruments or generated by simulator
 - Processed by Software
 - Information/Knowledge stored in computer
 - Scientists analyze database/files using data management tools and statistics



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Role of Physics & Geology

- Application of Data-Driven Analytics in the upstream, is intimately tied to physics and geology.
- Domain expertise (**NOT STATISTICS**) is the most crucial aspect of successful implementation of data-driven solutions in any organization.



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Role of Physics & Geology

- Effective data-driven workflows are developed in our industry by drilling, reservoir, and production engineers that have become expert practitioners in art and science of Data-Driven Analytics.
- These workflows withstand the piercing scrutiny of physics and geology.
- There is no way around this.



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"Data-Driven Solutions" in the Upstream

- There are many success stories of Data-Driven Solutions in the upstream oil and gas industry.
- Large number of case studies are available.
- More and more innovative solutions are being introduced every day.
- Here are examples in: Drilling, Reservoir Modeling, Reservoir Management, and Production Optimization



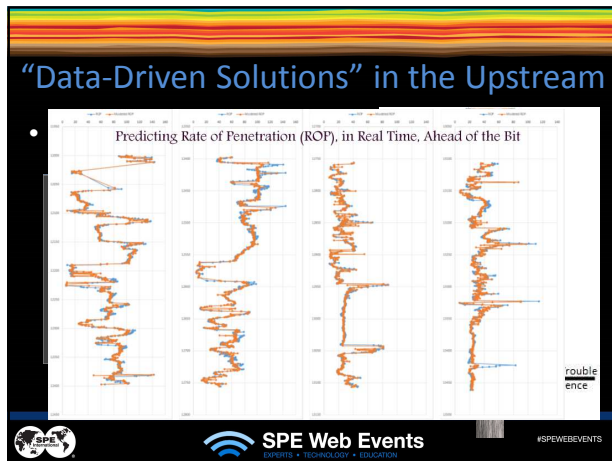
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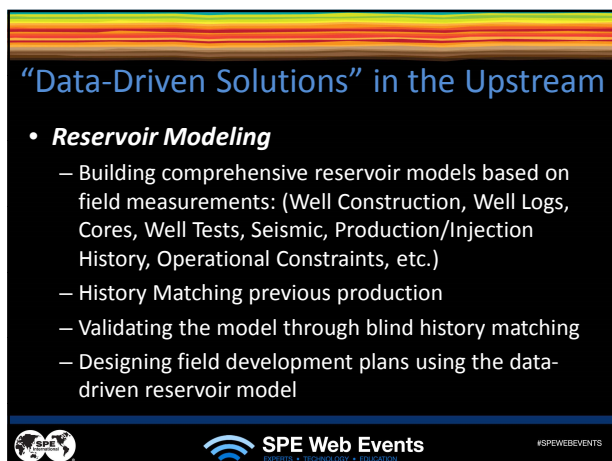
"Data-Driven Solutions" in the Upstream

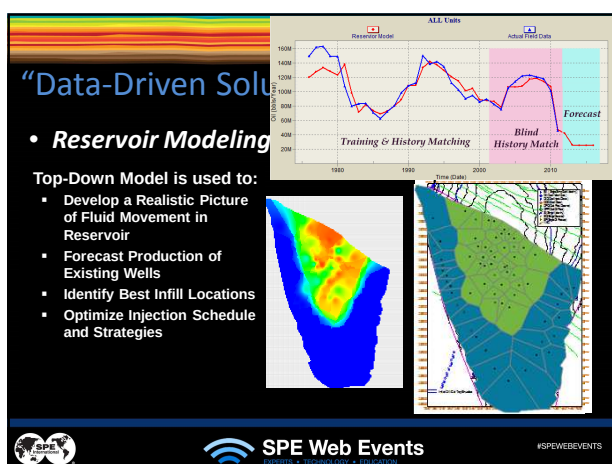
- **Drilling**
 - Predicting NPT using real-time data (MWD-LWD):
 - Tens of feet ahead of the bit, during active drilling (bit on-bottom)
 - Tens of minutes before the incident, during tripping and reaming (bit off-bottom)
 - Identifying the combination of impacting factors
 - Recommending actions to avoid NPT



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"Data-Driven Solutions" in the Upstream

- **Reservoir Management**
 - Building "Smart Proxy" of the large, complex reservoir simulation models without compromising:
 - The complex physics
 - Space-Time resolution
 - Quantify uncertainties associated with the static, geo-model
 - Exhaustively search and optimize field development planning

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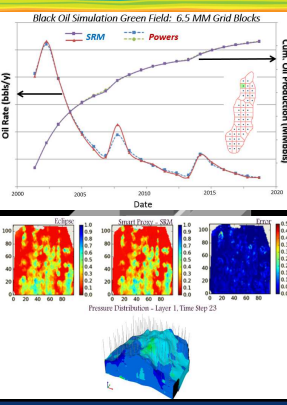
"Data-Driven Solution"

- **Reservoir Management**

Smart Proxy (SRM) learns fluid flow behavior from data generated by numerical model and mimics it, with high accuracy.

SRM is trained using only a handful of simulation runs.

SRM runs are measured in seconds.



Block Oil Simulation Green Field: 6.5 MM Grid Blocks

Smart Proxy - SRM

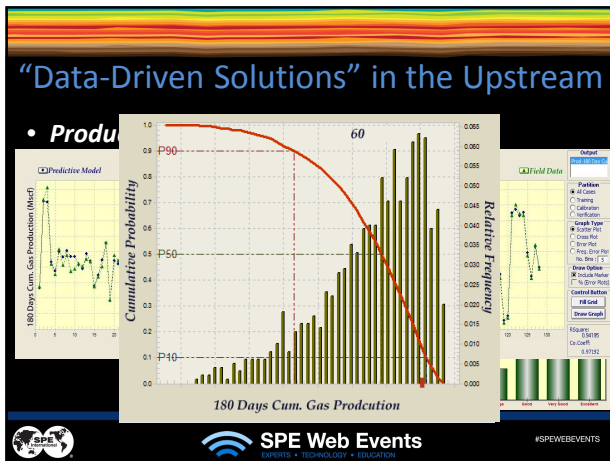
Pressure Distribution - Layer 1, Time Step 23

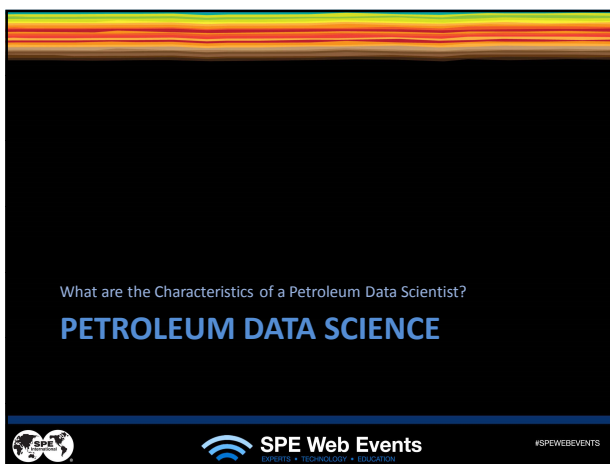
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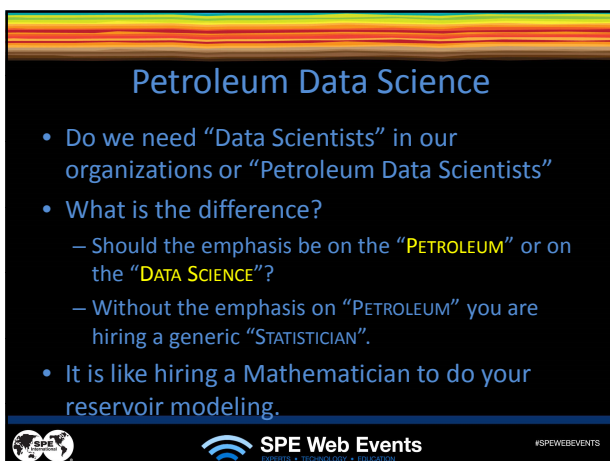
"Data-Driven Solutions" in the Upstream

- **Production Optimization**
 - Building predictive models of hydraulic fracturing practices in shale using "Hard Data"
 - Validating the models with new wells
 - Extracting "Data-Driven Best Practices" from historical data (no human bias)
 - Designing Optimum frac jobs for new wells
 - Ranking best Candidates & Design Re-Frac

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Petroleum Data Science

- Application of Data-Driven Analytics in the upstream, is intimately tied to physics and geology.
- A Petroleum Data Scientist (PDS) is a petroleum engineer with training in AI, Data mining, and Statistics. (not the other way around)



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Petroleum Data Scientist

- Unfortunately, our university Petroleum Engineering Departments are not (systematically) training Petroleum Data Scientists.
- Existing Petroleum Data Scientists are mainly self-trained, enthusiast that are being under-utilized and often over-looked in their organizations.



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Petroleum Data Scientist

- Development of an **International Petroleum Data Science Academy** is quite timely.
- This can be accomplished by involvement, input, support, and active participation of NOCs, IOCs, large Independents, and service companies.



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Questions that need to be Addressed

SOME FINAL THOUGHTS




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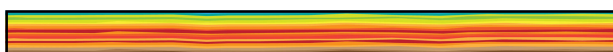


Academia

- Why isn't academia involved?
 - Data Confidentiality in E&P
 - Lack of Funding Sources (Industry needs to get involved)
 - Lack of Expertise (COMBINED petroleum engineering AND data-driven technologies)
- Can academia have a role in the development of the **International Petroleum Data Science Academy?**




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Startups

- The hype around data and data-driven solutions has found its way in to the E&P.
- Along with the hype, many startups have formed with the objective of bringing the data-driven technologies into the upstream oil and gas industry.




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Startups (The Warning Signs)

- We will come over and study your operation and use your data to tell you how you can enhance your operation.
- Give us your data, so we can tell you, what the data is trying to tell you.
- We have a magic tool that can solve all (some) of your problems, and we are not telling you how its done.



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Startups (The Warning Signs)

- Lack of Domain Expertise
- Lack of Data Mining & Machine Learning Expertise
- Lack of Transparency (Cloaked in IP Protection)
- Using examples related to :
 - Social media (Facebook, LinkedIn, ...)
 - Retail: Consumer Relation Management (Amazon, ...),
 - Pharmaceutical (Medicine development, ...)
 - Any non-physics-based solutions



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Where Do We Go From Here?

THE WAY FORWARD



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Important Decisions

- E&P Companies have two important decisions to make when they are contemplating to make the most of the data that is in their possession:
 - Administrative
 - Technical



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Administrative

- There are three administrative path to adoption of Data-Driven Solutions:
 - Develop in-house data solutions
 - Completely Outsource
 - Purchase (lease) data-driven solutions & train/hire Petroleum Data Scientists
- Best Analogy: Numerical Simulation



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Develop or Outsource?

- Using Numerical Reservoir Simulation analogy
- Majority of the companies would be better-off to outsource.
- Some bigger NOCs and IOCs will decide to develop their own technology.
 - Not going to be as easy as Numerical Simulation
 - Not all the details are published
 - Many key solutions remain confidential



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Technical

- There are two main technical options available when it comes to taking maximum advantage of your data.
 - Exploratory Data Analysis
 - Complete Data-Driven Solutions (workflows)



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Roads to Adoption

- There are two different approaches to adoption of data-driven analytics:
 1. Acquire Data Analytics Tools & Develop In-House Solutions:
 - Patience is required – Success is Possible
 2. Acquire Complete Data-Driven Solutions
 - Much better chances of Success – Quicker Response
- In both cases training of the workforce is highly recommended.



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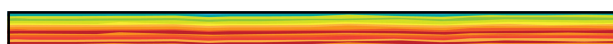
Road to Adoption

- Make a culture of it.
- Everyone in the company must understand the basics of data driven analytics.
- Some will become experts. They would drive the innovation and use.



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Road to Adoption

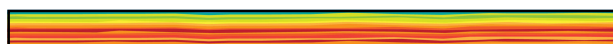
- Data-Driven Solutions must be treated as a tool to improve engineer's ability to do their jobs better.
- It works best when it is invisible to the end user.
- Start with a problem to solve.
- Manage Expectations.





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