The Society of Petroleum Evaluation Engineers

SPEE Denver Chapter announces its July Luncheon/Hybrid Meeting,
An in-person meeting that will be simulcast on a Zoom Platform

(Members and Guests are cordially invited to attend either virtually or in-person.)

Wednesday, July 13, 2022

Zack Warren

Principal, Velocity Insight

Will be speaking on:

Fitting Square Pegs into Square Holes:

Data Analytics Trends in Reserves Evaluation

Abstract: Talk about O&G applications for AI, machine learning, big data and the rest gets louder by the year. Where is the value coming from? How do reserves and reservoir engineering fit in? This presentation will focus on promising areas of analytics for reserves and evaluation work, how they integrate with other upstream disciplines, and real-world barriers to adoption.

Speaker Bio.: **Zack Warren** is a data analytics leader and reservoir engineer with over 18 years of experience. In 2021, he founded Velocity Insight to be a full-stack, full-function data management/analytics consulting firm focused on upstream oil and gas. Most recently, he was the Director of Strategic Studies and Analytics at Great Western Petroleum, leading data analytics and reservoir characterization efforts. He started his career at ExxonMobil, with additional experience at Netherland, Sewell, & Associates and various tight oil operators. Zack is a professional engineer in Texas and Colorado, a member of SPE, and serves on the Board of Directors for the Society of Petroleum Evaluation Engineers International. Ask him about his 300-horsepower station wagon.

Fitting Square Pegs Into Square Holes:

Data Analytics Trends in Reserves Evaluation

SPEE Denver
July 2022

PEGS, HOLES, MISMATCHES and MATCHES

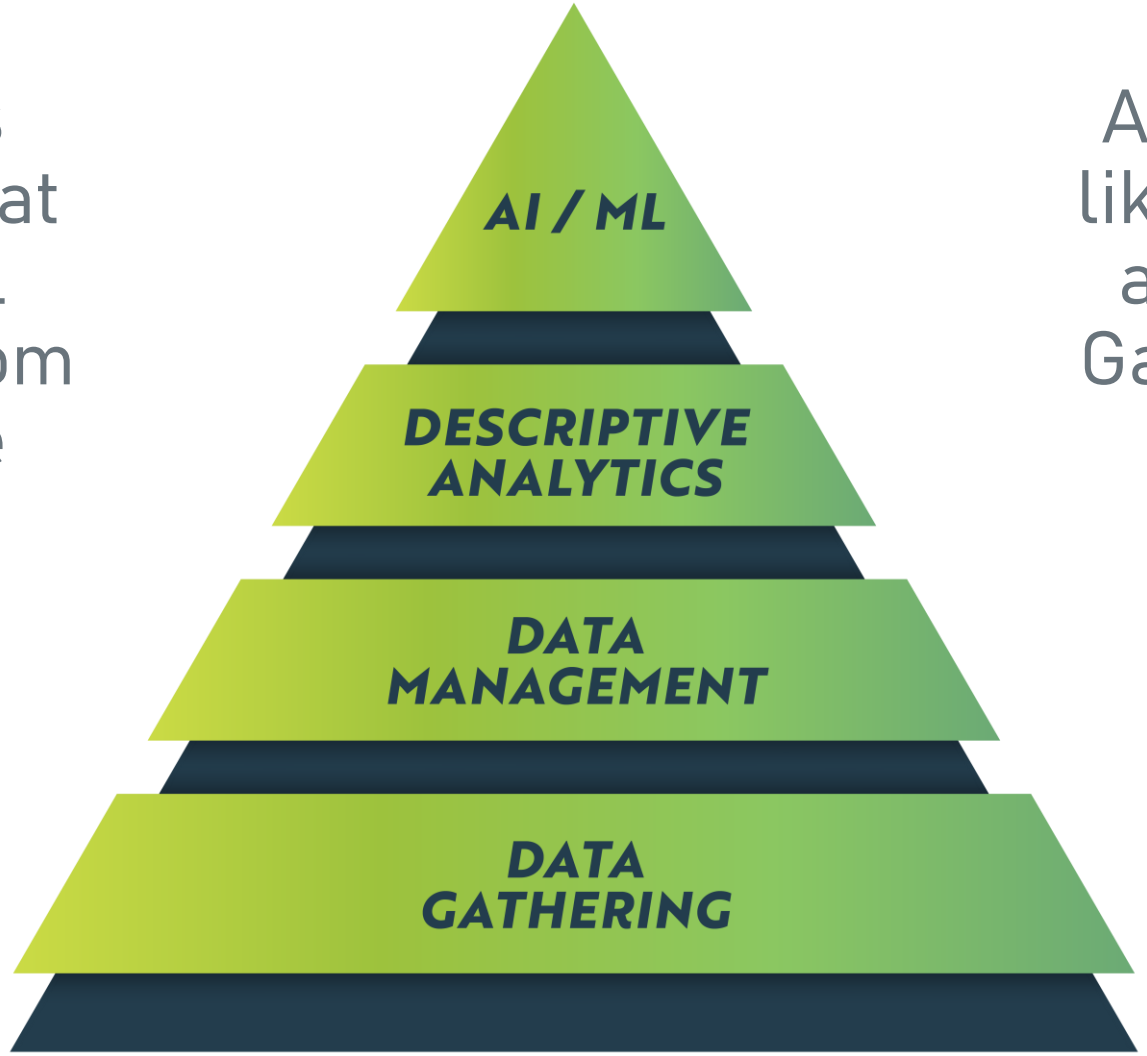
OUTLINE

- How have Data Analytics and Reserves/Evaluation interacted historically?
- Velocity Insight 2021 E&P Software Survey Results
- What's happening in the marketplace today?
- What's exciting going forward? What are the barriers?

All statements in this presentation are Zack's and Zack's alone and don't represent the views of any former employers, the SPEE, or his wife

THE DATA PYRAMID

Effort required is arguably smallest at the top – the real work is at the bottom and in the middle



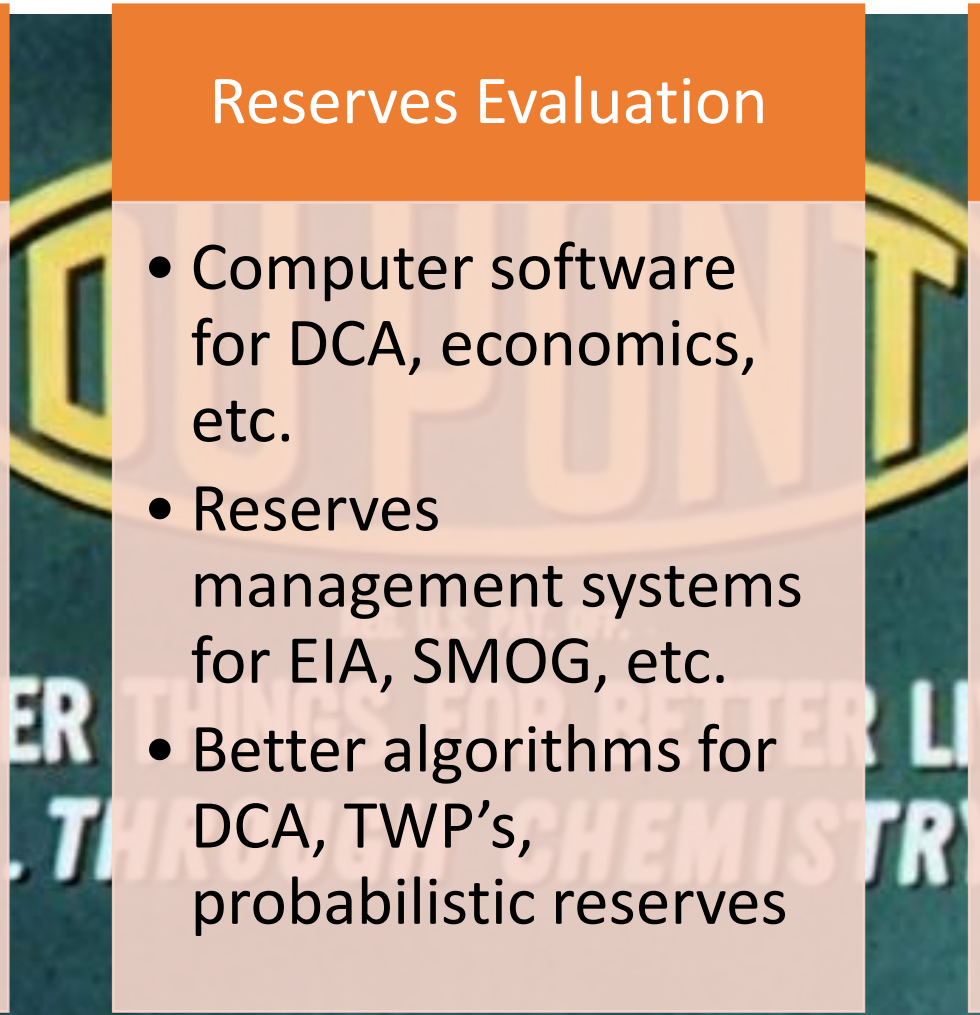
AI and ML are just like other advanced analytical tools – Garbage In leads to Garbage Out

Those who don't learn the past.....

WHAT'S OLD IS NEW AGAIN…

- Better valuation and reserves work through data is ***NOT*** new

Reservoir Characterization	Reserves Evaluation	Asset Valuation
• Subscriptions datasets for production, logs, etc. • Smoothing algorithms for PBU analysis • Noise reduction in geophysics • Neural nets for petrophysics	• Computer software for DCA, economics, etc. • Reserves management systems for EIA, SMOG, etc. • Better algorithms for DCA, TWP's, probabilistic reserves	• Comp A&D databases • Surveys, e.g. SPEE Parameter Survey • Swanson's Mean approximations • Black-Scholes option pricing

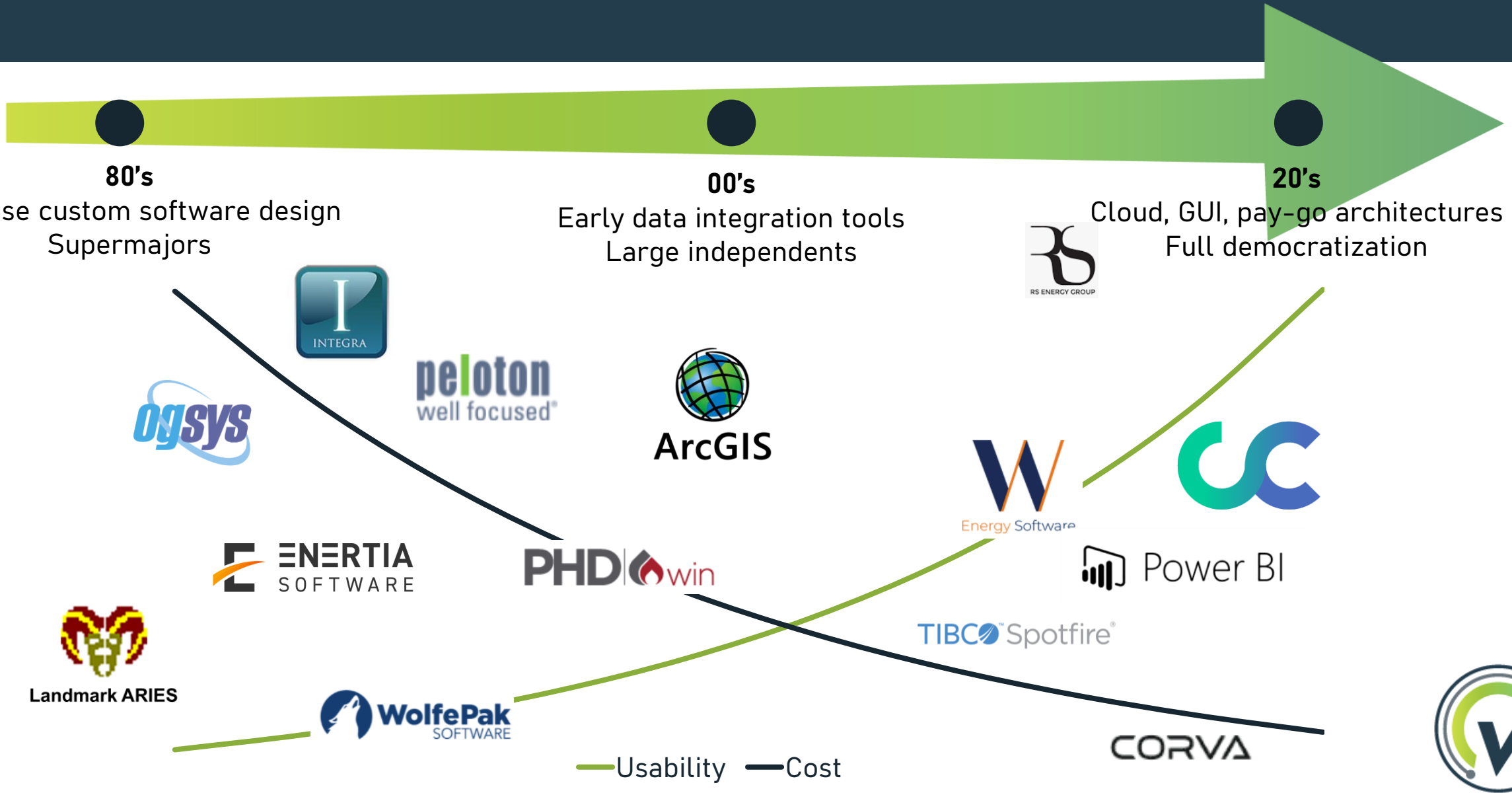


THE SOFTWARE PROLIFERATION LANDSCAPE

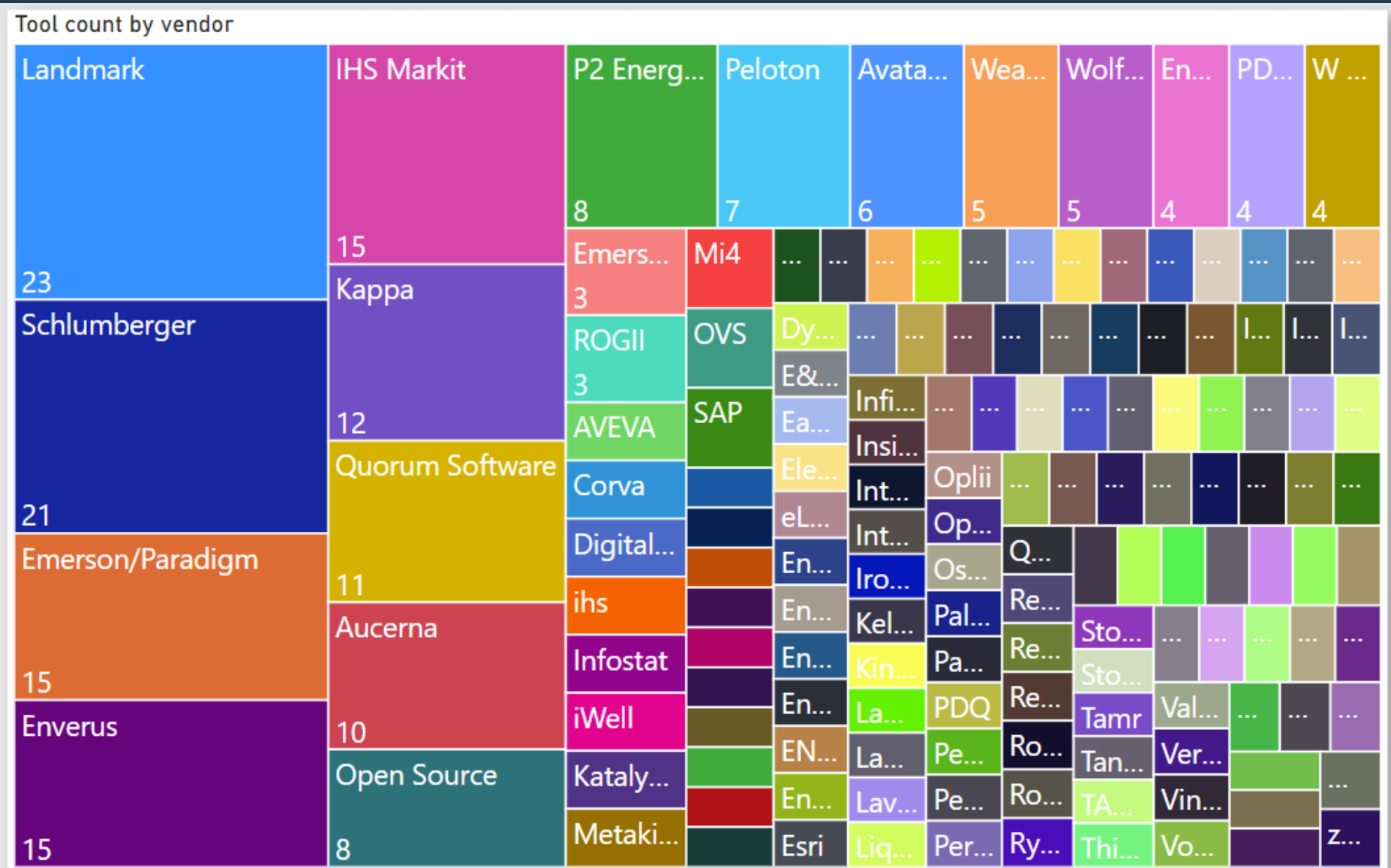
80's
In-house custom software design
Supermajors

00's
Early data integration tools
Large independents

20's
Cloud, GUI, pay-go architectures
Full democratization



SOFTWARE INVENTORY – 300 AND GROWING



Vendor	Count
Landmark	23
Schlumberger	21
Emerson/Paradigm	15
Enverus	15
IHS Markit	15
Kappa	12
Quorum Software	11
Aucerna	10
Open Source	8
P2 Energy Solutions	8
Peloton	7
Avatar Systems	6
Weatherford	5
Wolfepak Software	5
Enerpact	4
PDS Energy	4
W Energy Software	4
Emerson	3
ROGII	3
AVEVA	2
Corva	2
Digital Oil & Gas Solutions	2
ihs	2
Infostat	2
iWell	2
Katalyst Data Management	2
Total	**322**

2021 E&P Software Survey Results

THE BIG SIX

1) Highly integrated with the rest of the Big 6
2) Central to the basic functions of an E&P
3) Expensive to Rip & Replace

2021 SOFTWARE SURVEY – SUMMARY

- Three big themes:
  - ***Compartmentalization – by region, size, business model, etc.***
  - ***The Long Tail – hundreds of low-utilization tools on the market***
  - ***Widespread Dissatisfaction – "I hate it, but we use _____"***

- Barriers to modernization:
  - High cost of ripping and replacing
  - "We're just about to sell/buy/merge/go bankrupt"
  - Risk aversion
  - Lack of better options

2021 SOFTWARE SURVEY - SUMMARY

- 101 participants, ranging from 1-person companies to supermajors
  - Covers ~65% of US-listed public E&Ps
  - Focused on Lower 48, handful from Europe and Canada
- 497 software implementations
  - Several hundred million dollars in annual software spend
  - 75 separate applications

Email askus@velo-insight.com for data

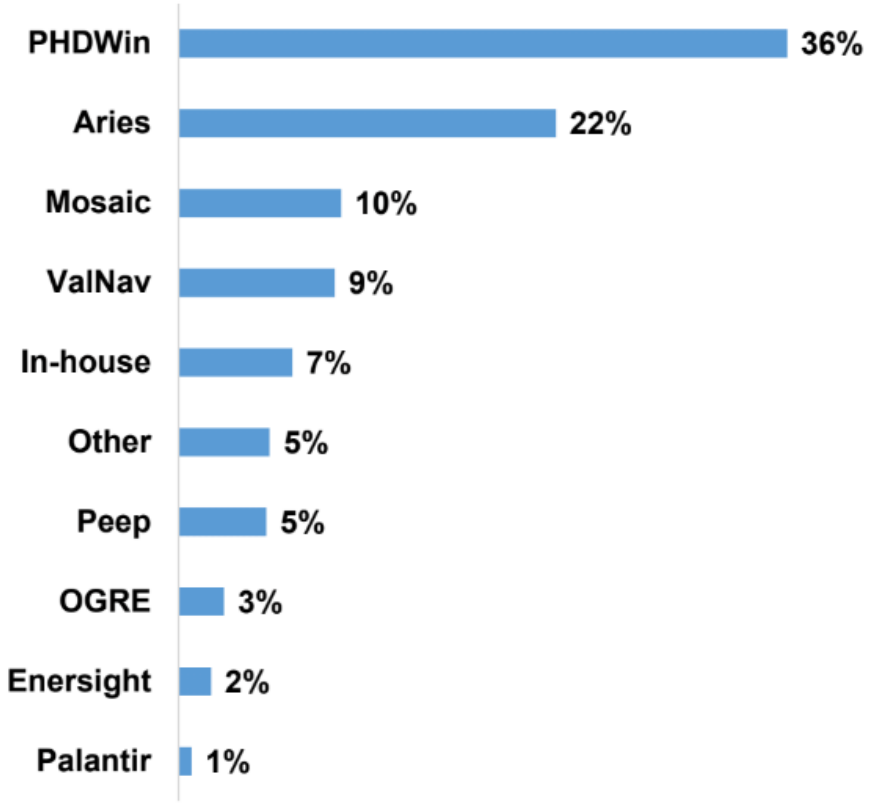
RESERVES/PLANNING

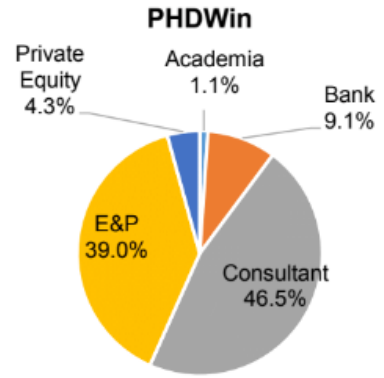
- ARIES dominates, but struggles to handle full workload
- Lots of companies using multiple tools to accommodate limitations – Enersight, ComboCurve, etc.

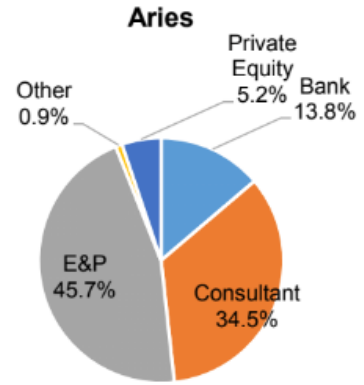
Email askus@velo-insight.com for data

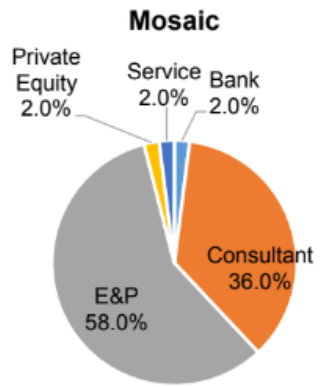
2018 SPEE SYMPOSIUM SURVEY

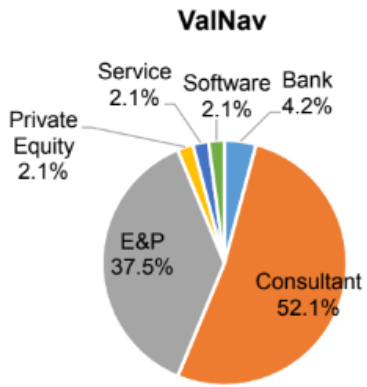
Which economic/reserves management software do you regularly use?







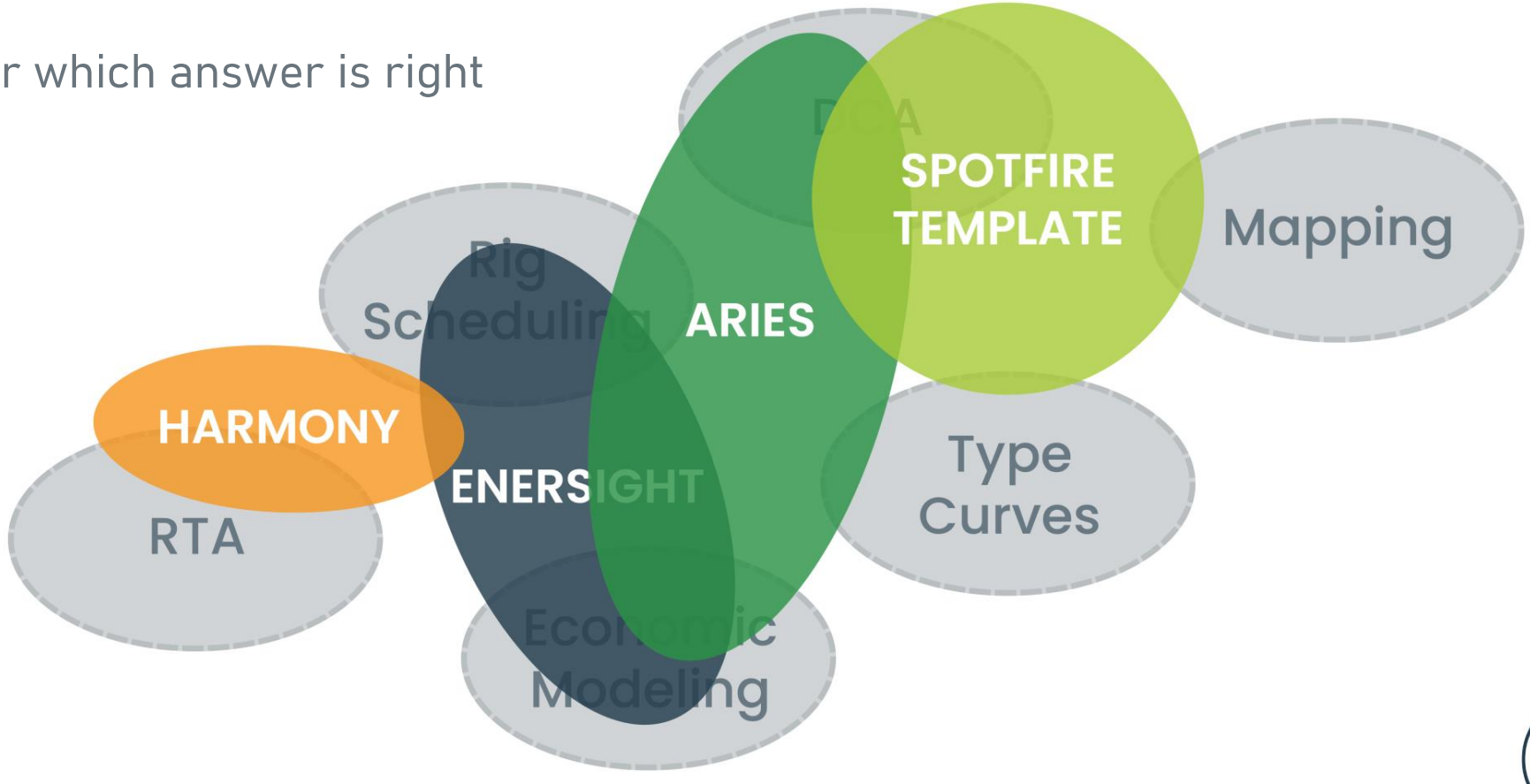




THE VENN DIAGRAM OF DOOM

Overlapping capabilities can actively harm digitalization at an E&P company

- Multiple destinations for data
- Budget bloat
- Arguments over which answer is right



SOFTWARE A&D and MAJOR UPDATES

Big changes in who owns which piece of software

- **MOSAIC** goes from Entero → Quorum → Omnira
- **ValNav** goes from Energy Navigator → Aucerna → Quorum
- **Enersight** goes from Enersight → Aucerna → Quorum
- **petroLook** goes from Aclaro → Aucerna → Quorum
- **Peep** goes from Schlumberger → Quorum
- **ComboCurve** raises >$50mm via Series A and Series B

Legacy tools also going through big changes

- PHDWin 3.0 on SQL
- ARIES v6 goes 64 bit with daily calcs
- What's the future for ValNav/Enersight/petroLook/Peep/PlanningSpace at Quorum?

TIME FOR A QUIZ!

What is the Total Addressable Market for E&P Reserves/Planning software in North America?

A
- <$50mm/yr

B
- $50-150mm/yr

C
- $150-300mm/yr

D
- >$300mm/yr

..are doomed to repeat it.

VALUE PROPOSITIONS

Cheaper

- Focus on the bottom of the Data Pyramid
- Fire all the reservoir engineers!
- Automate data processing (aka fire all the techs!)
- Less money on 3rd party auditors

Faster

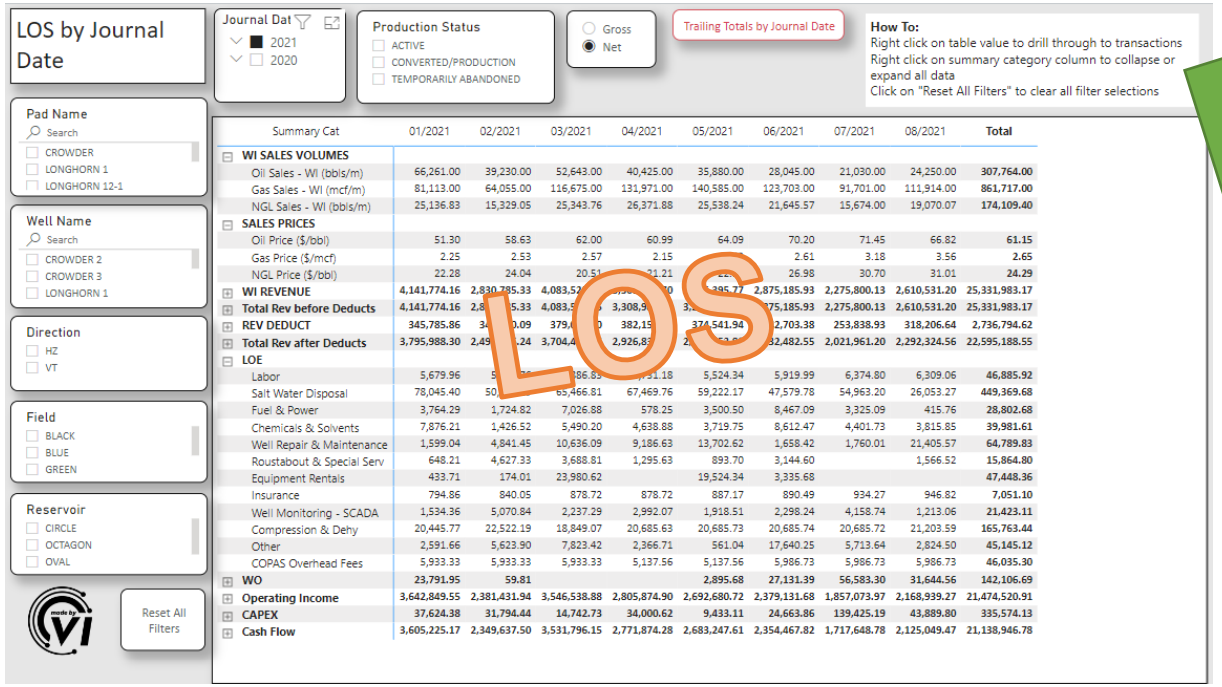
- Better data access to adjacent functions for commercial parameters like LOE, diffs, CAPEX, etc.
- Outlier detection/data cleansing
- Automated DCA
- Assisted type curve building

Better

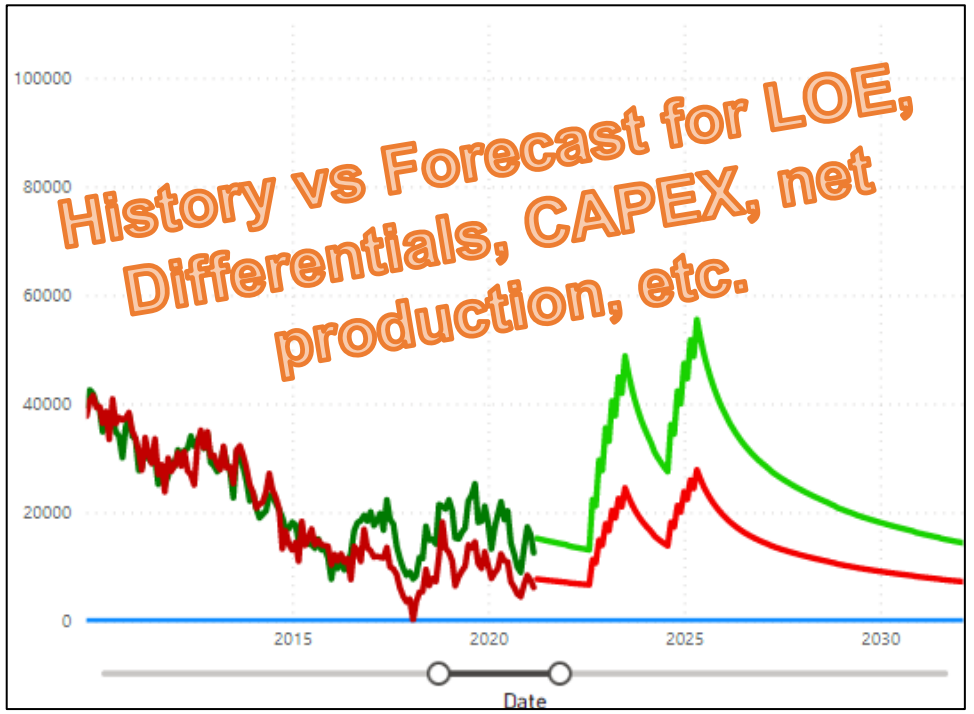
- Remove bias, remove bias, remove bias
- Improve run QC to minimize errors
- Discover unexpected factors for type curve binning/scaling

EX 1 – TIE-OUT GRAPHS

- How do you QC reserves runs against Accounting actuals?
- Typically solved with VLOOKUP or a modern BI tool (Spotfire, Power BI, etc.)



Summary Cat	01/2021	02/2021	03/2021	04/2021	05/2021	06/2021	07/2021	08/2021	Total
WI SALES VOLUMES									
Oil Sales - WI (bbls/m)	66,261.00	39,230.00	52,643.00	40,425.00	35,880.00	28,045.00	21,030.00	24,250.00	307,764.00
Gas Sales - WI (mcf/m)	81,113.00	64,055.00	116,675.00	131,971.00	140,585.00	123,703.00	91,701.00	111,914.00	861,717.00
NGL Sales - WI (bbls/m)	25,136.83	15,329.05	25,343.76	26,371.88	25,538.24	21,645.57	15,674.00	19,070.07	174,109.40
SALES PRICES									
Oil Price ($/bbl)	51.30	58.63	62.00	60.99	64.09	70.20	71.45	66.82	61.15
Gas Price ($/mcf)	2.25	2.53	2.57	2.15		2.61	3.18	3.56	2.65
NGL Price ($/bbl)	22.28	24.04	20.51	21.21		26.98	30.70	31.01	24.29
WI REVENUE	4,141,774.16	2,830,785.33	4,083,52			2,875,185.93	2,275,800.13	2,610,531.20	25,331,983.17
Total Rev before Deducts	4,141,774.16	2,8	4,083,5	3,308,9		2,875,185.93	2,275,800.13	2,610,531.20	25,331,983.17
REV DEDUCT	345,785.86	3	379,4	382,15	374,541.94	2,703.38	253,838.93	318,206.64	2,736,794.62
Total Rev after Deducts	3,795,988.30	2,49	3,704,4	2,926,8		32,482.55	2,021,961.20	2,292,324.56	22,595,188.55
LOE									
Labor	5,679.96	5	86.85	31.18	5,524.34	5,919.99	6,374.80	6,309.06	46,885.92
Salt Water Disposal	78,045.40	50	65,466.81	67,469.76	59,222.17	47,579.78	54,963.20	26,053.27	449,369.68
Fuel & Power	3,764.29	1,724.82	7,026.88	578.25	3,500.50	8,467.09	3,325.09	415.76	28,802.68
Chemicals & Solvents	7,876.21	1,426.52	5,490.20	4,638.88	3,719.75	8,612.47	4,401.73	3,815.85	39,981.61
Well Repair & Maintenance	1,599.04	4,841.45	10,636.09	9,186.63	13,702.62	1,658.42	1,760.01	21,405.57	64,789.83
Roustabout & Special Serv	648.21	4,627.33	3,688.81	1,295.63	893.70	3,144.60		1,566.52	15,864.80
Equipment Rentals	433.71	174.01	23,980.62		19,524.34	3,335.68			47,448.36
Insurance	794.86	840.05	878.72	878.72	887.17	890.49	934.27	946.82	7,051.10
Well Monitoring - SCADA	1,534.36	5,070.84	2,237.29	2,992.07	1,918.51	2,298.24	4,158.74	1,213.06	21,423.11
Compression & Dehy	20,445.77	22,522.19	18,849.07	20,685.63	20,685.73	20,685.74	20,685.72	21,203.59	165,763.44
Other	2,591.66	5,623.90	7,823.42	2,366.71	561.04	17,640.25	5,713.64	2,824.50	45,145.12
COPAS Overhead Fees	5,933.33	5,933.33	5,933.33	5,137.56	5,137.56	5,986.73	5,986.73	5,986.73	46,035.30
WO	23,791.95	59.81			2,895.68	27,131.39	56,583.30	31,644.56	142,106.69
Operating Income	3,642,849.55	2,381,431.94	3,546,538.88	2,805,874.90	2,692,680.72	2,379,131.68	1,857,073.97	2,168,939.27	21,474,520.91
CAPEX	37,624.38	31,794.44	14,742.73	34,000.62	9,433.11	24,663.86	139,425.19	43,889.80	335,574.13
Cash Flow	3,605,225.17	2,349,637.50	3,531,796.15	2,771,874.28	2,683,247.61	2,354,467.82	1,717,648.78	2,125,049.47	21,138,946.78



EX 2 – SEC SMOG AND EIA-23L

- Standardized Measure of Oil & Gas
  - *"The most audited unaudited disclosure in an E&P's 10-K"*
  - Requires multiple reserves runs, detailed calculations
- EIA-23L Annual Report of Domestic Oil and Gas Reserves
  - Gross reserves and production for operated wells
  - Again – multiple (yet different!) reserves runs and detailed calculations

Change in Standardized Measure of Discounted Future Net Cash Flows Relating to Proved Oil and Gas Reserves

Consolidated and Equity Interests (continued)	2021		
	Consolidated Subsidiaries	Share of Equity Method Investees	Total Consolidated and Equity Interests
		(millions of dollars)	
Discounted future net cash flows as of December 31, 2020	26,554	8,441	34,995
Value of reserves added during the year due to extensions, discoveries, improved recovery and net purchases/sales less related costs	11,922	22	11,944
Changes in value of previous-year reserves due to:			
Sales and transfers of oil and gas produced during the year, net of production (lifting) costs	(35,813)	(9,948)	(45,761)
Development costs incurred during the year	7,033	1,563	8,596
Net change in prices, lifting and development costs	118,946	47,434	166,380
Revisions of previous reserves estimates	27,126	2,507	29,633
Accretion of discount	3,762	1,201	4,963
Net change in income taxes	(43,650)	(13,281)	(56,931)
Total change in the standardized measure during the year	89,326	29,498	118,824
Discounted future net cash flows as of December 31, 2021	115,880	37,939	153,819

Source: ExxonMobil 2021 10-K

Table 1. U.S. proved reserves, and reserves changes, 2019-20

	Crude Oil billion barrels	Crude Oil and Lease Condensate billion barrels	Wet Natural Gas trillion cubic feet
U.S. proved reserves at December 31, 2019	**44.2**	**47.2**	**495.4**
Total discoveries	3.0	3.2	39.8
Net revisions	-8.8	-9.6	-98.2
Net Adjustments, Sales, Acquisitions	1.2	1.6	73.4
Production	-3.8	-4.2	-37.1
Net changes to U.S. proved reserves	**-8.4**	**-9.0**	**-22.1**
U.S. proved reserves at December 31, 2020	**35.8**	**38.2**	**473.3**
Percent change in U.S. proved reserves	**-19.0%**	**-19.0%**	**-4.5%**

Notes: Oil includes lease condensate; wet natural gas includes natural gas plant liquids.
Percent change calculated from unrounded numbers.
Source: U.S. Energy Information Administration, Form EIA-23L, *Annual Report of Domestic Oil and Gas Reserves*.

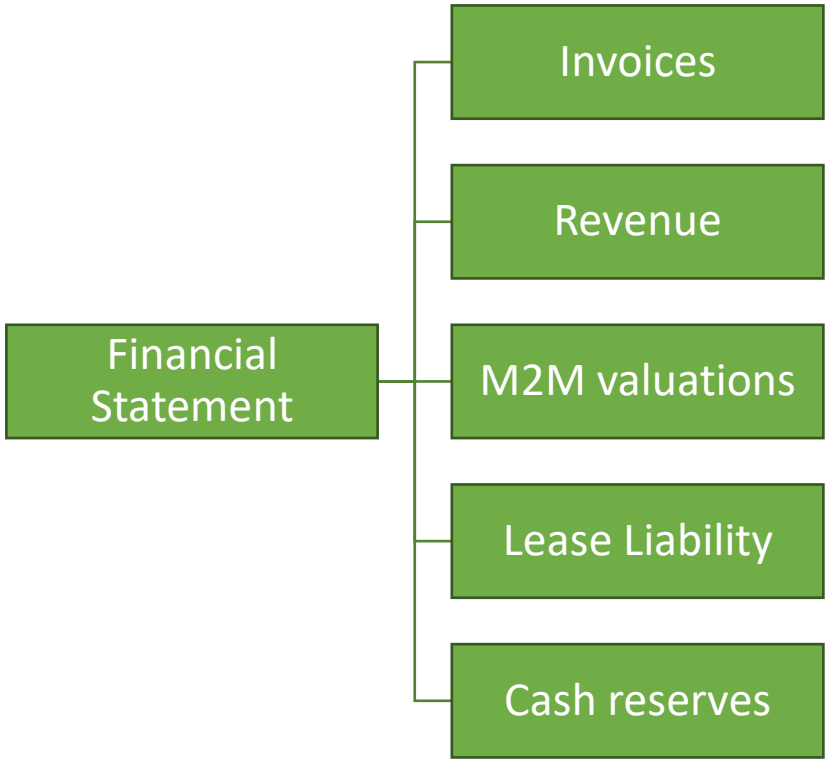
SO WHAT ABOUT AI AND ML?!

Lots of buzz on Artificial Intelligence and Machine Learning – what should we be focused on?

- Automated DCA starting to mature, but will a human always be in the loop?
- Type curve creation making progress, especially clustering and R^2 loss techniques for multivariate regression

Questions for adoption:

- Are they "reliable technologies" in the eyes of the SEC?
- Are they transparent and explainable enough for all stakeholders (auditors, executives, bankers, etc.)?
- How does the signing of a reserves report compare (or not) to the signing of a financial statement?



SUMMARY

- This isn't new, it's a continuation of 40+ years of evolution
- Focus on the bottom of the Data Pyramid first
- Think about the roles of all stakeholders in the use of AI and ML

WHO WE ARE

Full-stack, full-function data management and analytics consulting firm helping with both ***advisory*** and ***implementation*** projects

Deep O&G Experience

State-of-the-Art Tools

Real-World Digitalization Experience

TO HEAR MORE....

VI News of the Month

LinkedIn

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