

Artificial Lift
R&D Council



2021 International Sucker Rod Pumping Virtual Workshop

February 8-12, 2021

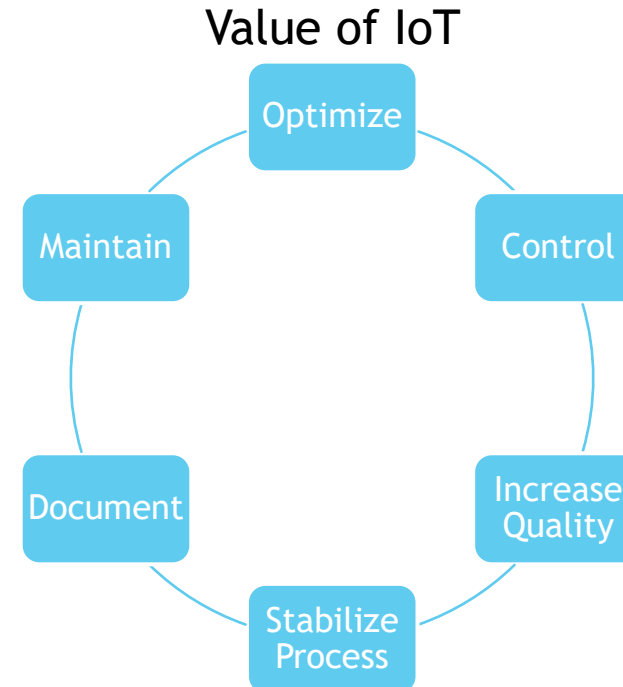
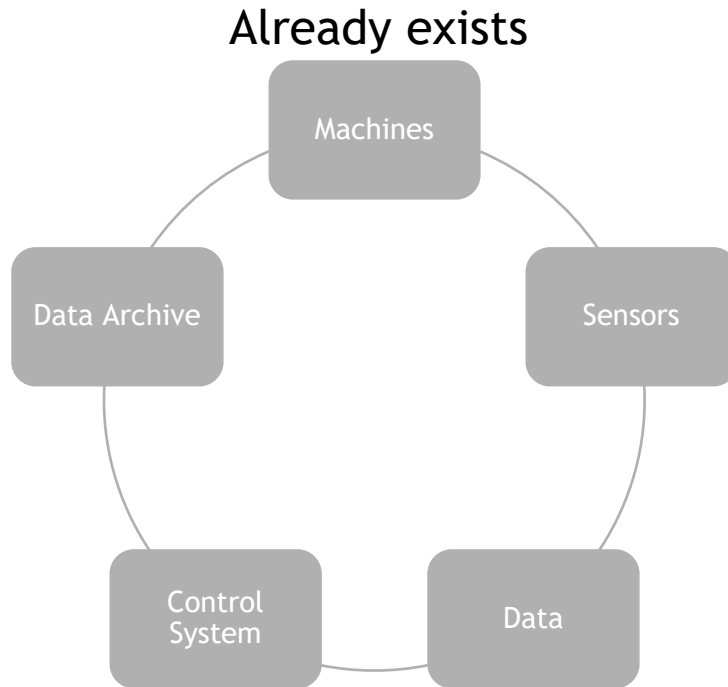
Artificial Intelligence in Oil & Gas

Patrick Bangert,
Samsung SDS

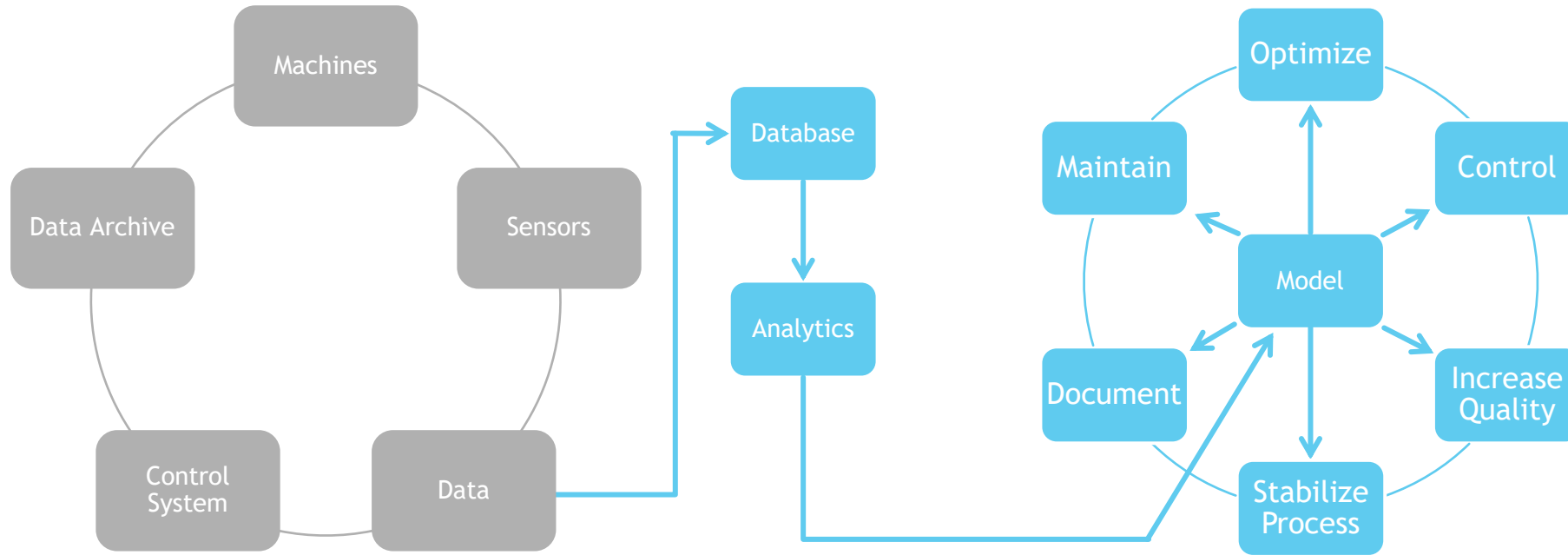


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Internet of Things creates value from data



Analytics bridges the worlds



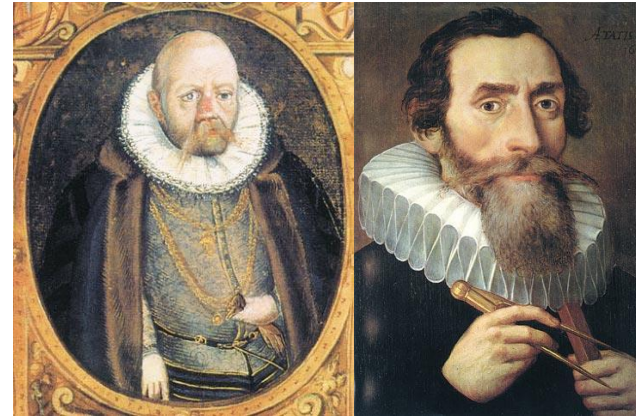
Models from Empirical Data

Brahe observed the planets every night for over 21 years.

Kepler: (1) Planets move on ellipses, (2) sweeping out equal areas, (3) $\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$

Newton concluded the law of universal gravitation: $\underline{F} = m\underline{a}$

Model summarizes data, can be used to interpolate & extrapolate, and understand



Tycho Brahe
(1546-1601)

Johannes
Kepler

PARS QUINTA. 305

Anno	Distantia Martis	Distantia Solis	Inclinatio	Viti latitudo.	Nota tabulae exp. XV.
1 1580	152976	98223	9.37.42	1.45 1/2 Bor.	1.40.
2 1582	162255	98233	1.36. 6	4. 3/4 Bor.	4. 6 vel 4.3.
3 1585	166335	98724	1.50. 3	4.30 1/2 Bor.	4.31 1/2.
4 1587	164635	99641	1.25.42	3.37 Bor.	3.37 vel 3.41.
5 1589	157045	100860	0.23.20	1. 5/8 Bor.	1. 7/8 vel 1.12 1/2.
6 1591	144774	101777	1.11. 9	3.59 1/4 Auf.	4. 1/2 vel 3.56.
7 1593	138556	100666	1.39.40	6. 3/4 Auf.	6. 2 1/2 vel 5.58.
8 1595	148817	89756	0. 1.39	0. 5/8 Bor.	0. 8 circiter.
9 1597	159200	98203	1.19.17	3.20 Bor.	3.33.
10 1600	165406	98478	1.49.24	5.30 1/4 Bor.	4. 3 1/2.
11 1602	166004	99205	1.39.35	4. 7/8 Bor.	4. 8 vel 4.10.
12 1604	160705	100359	0.52. 9	2.18 1/2 Bor.	2.21 1/2 vel 2.26.

The good news: Analytics is worth it

process was
automated

physical
sensors were
installed
and computer
systems
constructed

value of existing systems

effort for existing systems

effort for digitization

value of digitization

only need to
compute

process becomes
sustainably
better and
more profitable

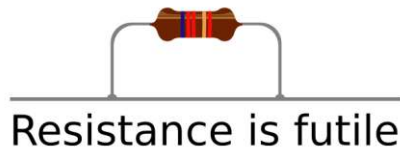
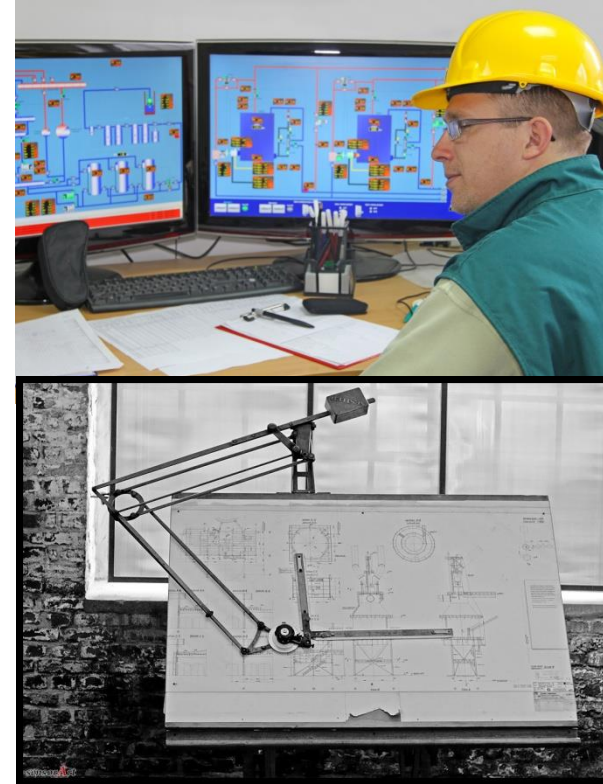
The alternative is to fall behind

- Can you imagine a plant without a DCS?

- DCSs were installed around 1985 and on PCs since 1995

- Would you design technical products on the **drawing board**?

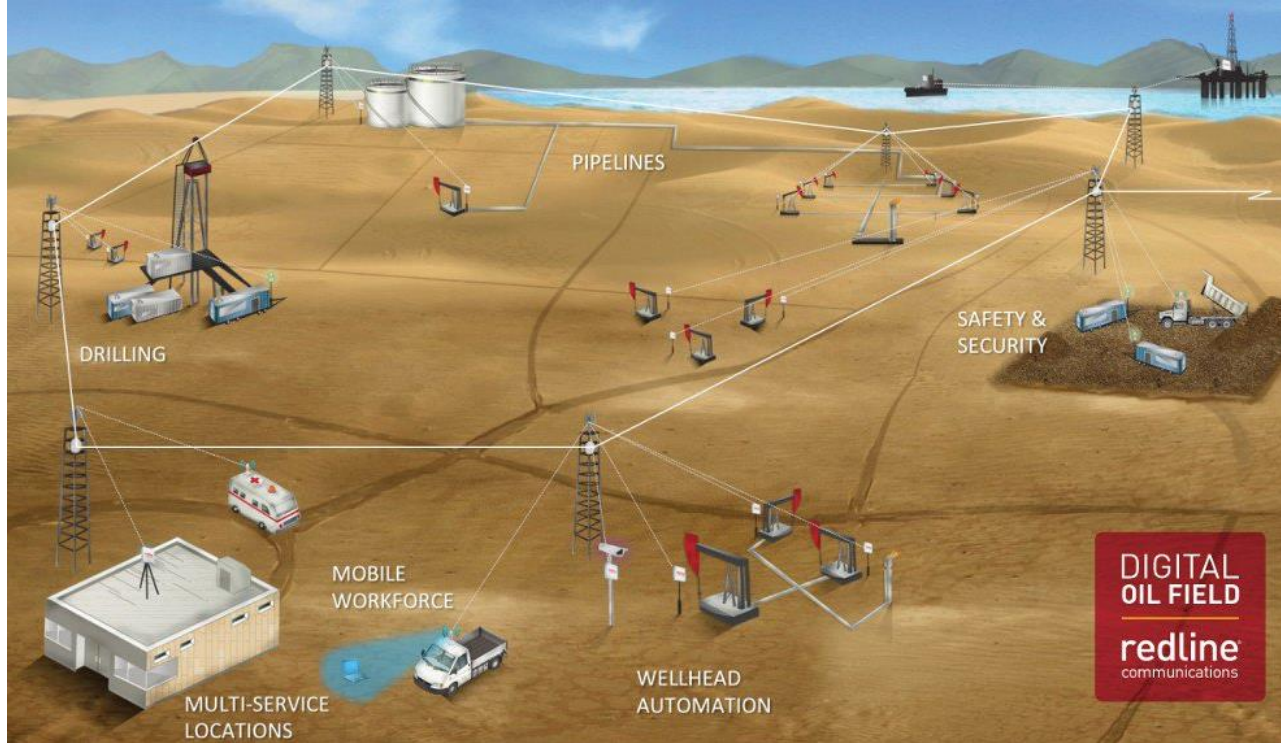
- CAD was introduced at the end of the 80s





“ The purpose of the digital oilfield is to maximize **oilfield recovery**, eliminate **non-productive time**, and increase **profitability** through the design and deployment of **integrated workflows**. ”

PetroWiki, SPE



Order of work: (1) digitization, (2) integrated workflow, (3) predictive maintenance, (4) increased yield, (5) profits

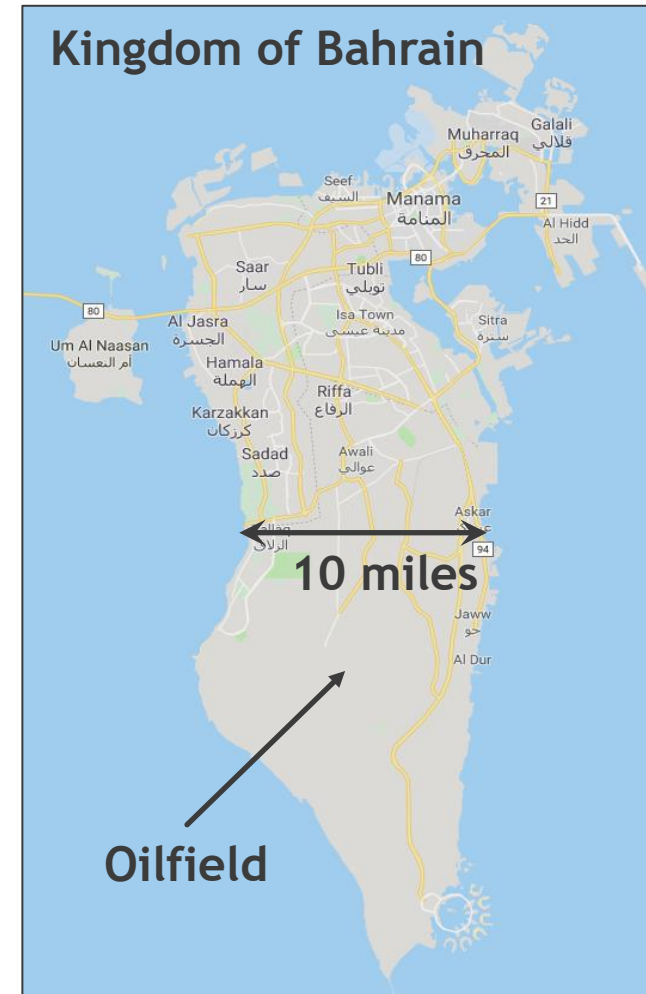
Key differences to “normal” IoT

Harsh environment => expensive sensors

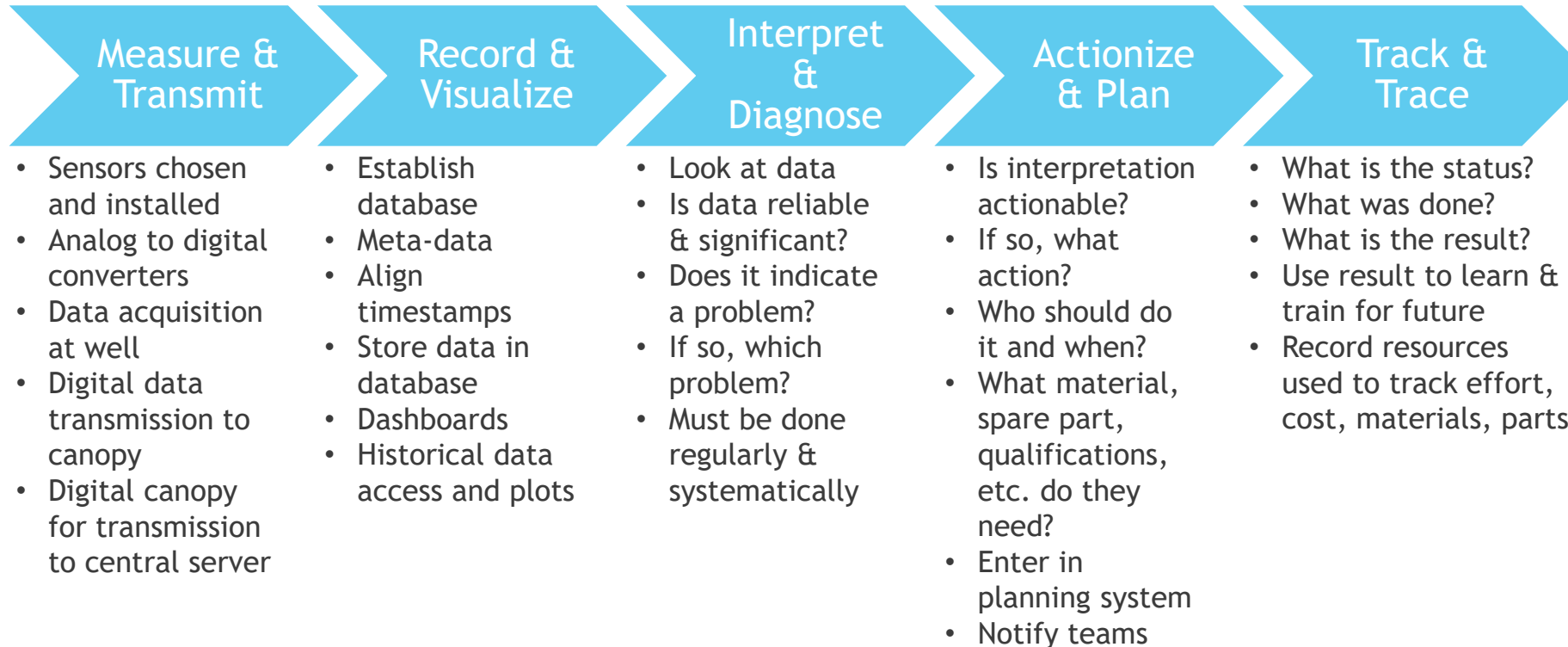
Large area => data transmission issues

Inaccessible location => long response times

Bahrain: 100 sq. miles of oilfield, thousands of wells, dedicated electricity grid

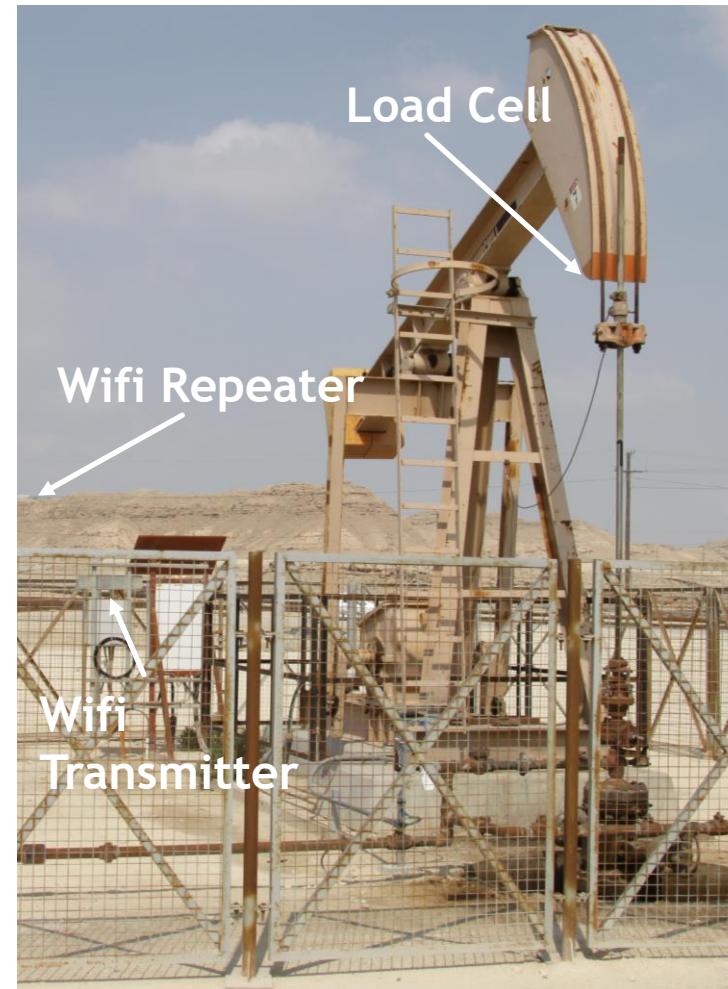


IoT & Integrated Workflow



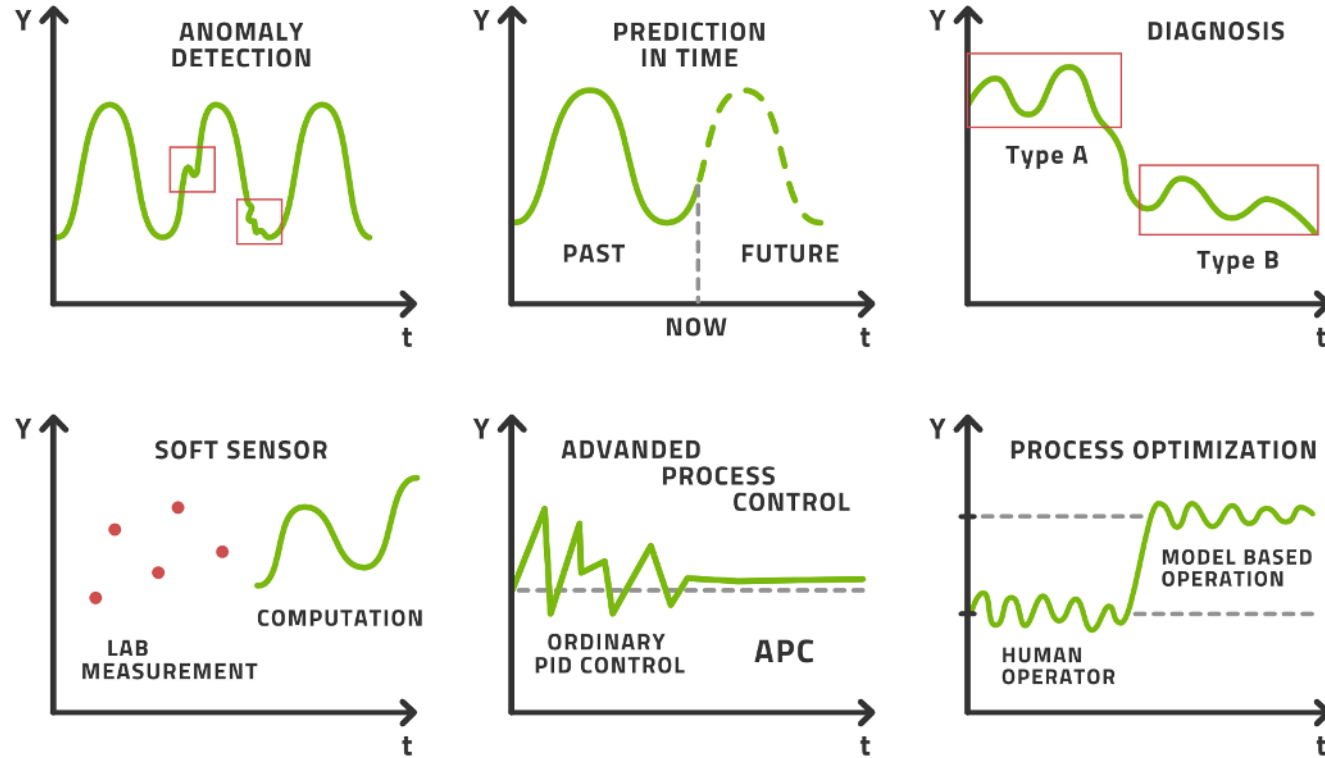
Measure & Transmit

- Oilfield is illuminated by wifi repeater network
- Each rod pump gets a wifi transmitter
- All measurements are collected at the transmitter and regularly sent
- E.g. the load cell that measures the load is clearly seen in the picture





Record & Visualize: Control system and historian, meta-data and diagrams, set-points transmitted back to field.



Various applications in the process industry exist and are being pursued by operators.



Exploration

- Data Combination
- Seismic Inversion
- Drill site selection
- Bidding on leases
- Reservoir Model
- Rock Properties
- Diffusion and Flow
- Fracturing
- Decline Curve

Drilling

- Variable Speed
- Layer Detection
- Maintenance
- Reduce Drill Time
- Safety
- Shock Detection
- Steering
- Mud Loss Prediction
- Non-Productive Time

Completion

- Project Timetabling
- Labor Organization
- Logistics Optimization
- Risk Management
- Advanced Sourcing
- Training
- Design

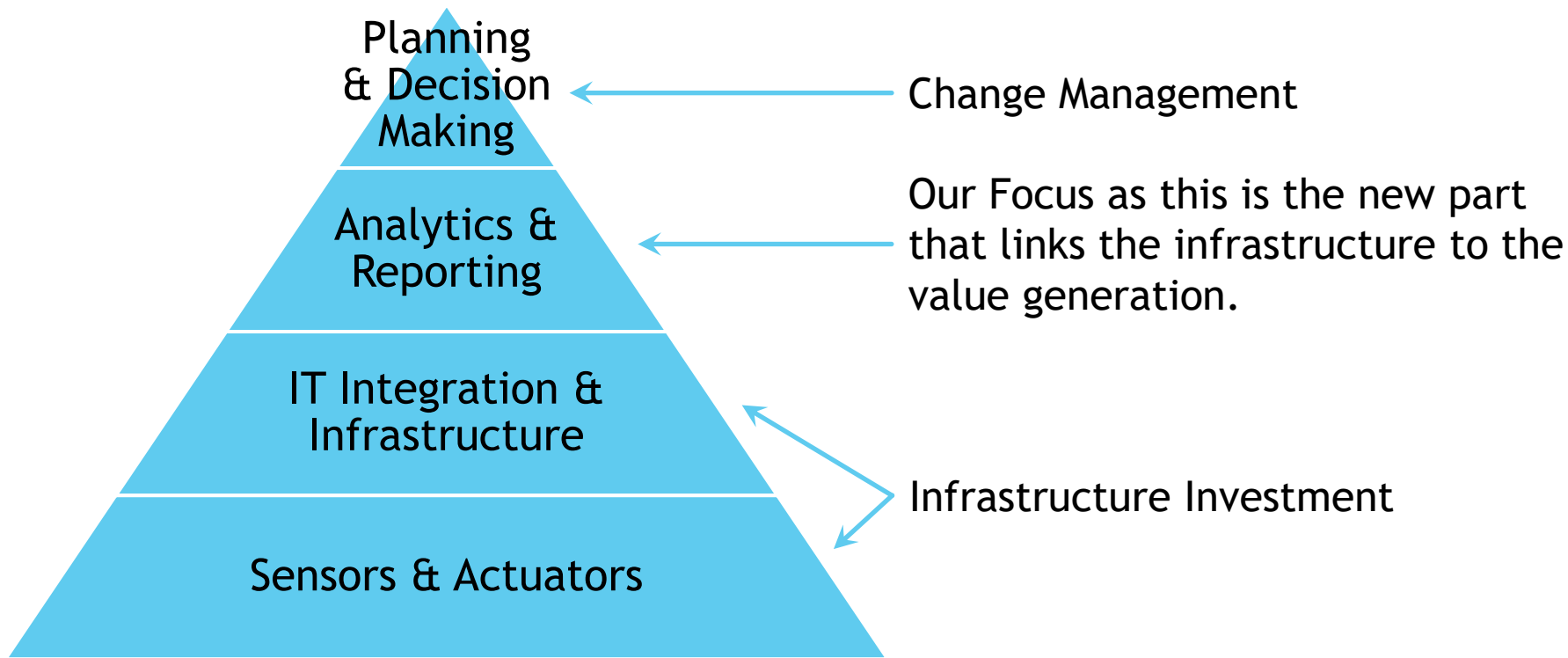
Production

- Optimization
- Advanced Process Control
- Yield Forecast
- Slugging Prevention
- HSE
- ESP
- Steam Injection
- Fracture Fluids
- Rod Pump Optimization
- Multiphase Flow Meter

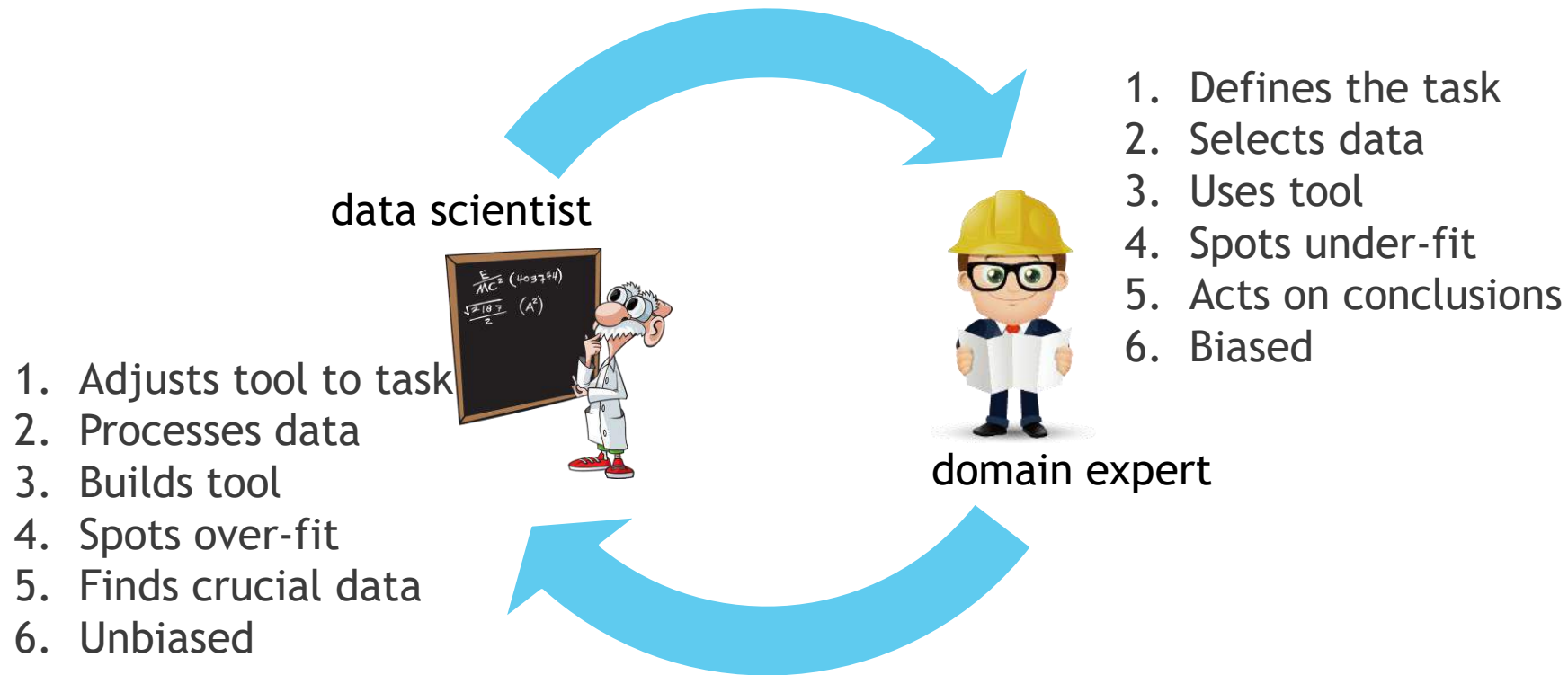
Maintenance

- Predictive
- Prescriptive
- Diagnostic
- Drill String Failure
- Pressure Loss in Pipelines
- Drone & Unmanned Surveillance
- Parts Orders

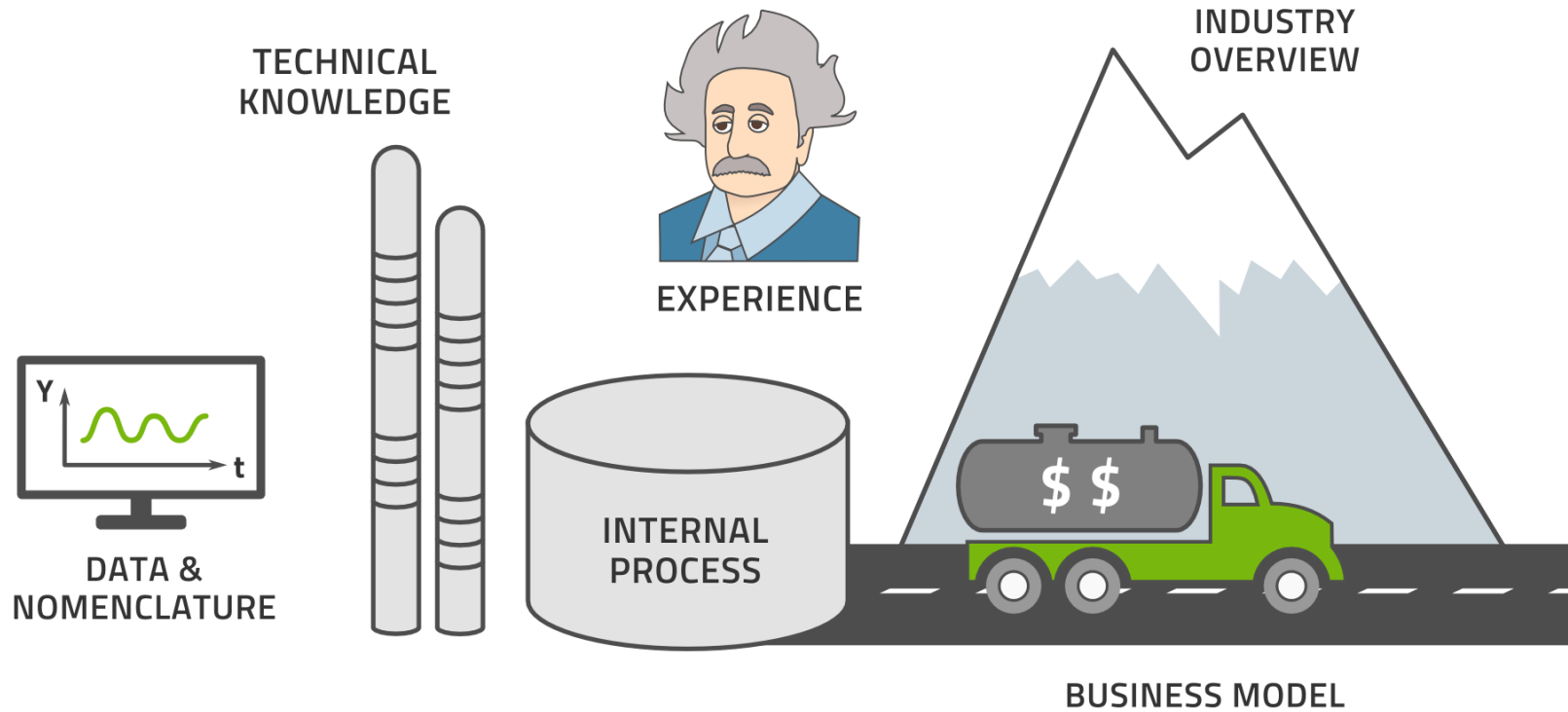
There are many applications in all aspects of the oil and gas industry from exploration to production. The most significant application is predictive maintenance.



The physical oilfield and equipment must be instrumented with sensors and we must have influence over actuators. This is combined with IT and analytics to allow decision making.



The data scientist and domain expert interact and cooperate to solve the problem together.



Now we are prepared for decision making and thus acting on the prediction. Machine Learning provides information. Value is generated by people acting on the information!

Lessons Learned

- **Investment**
 - In sensors is significant
 - In software is small
 - Software creates ROI
- **People**
 - Everyone must support and agree
 - Change management is important
- **Integration**
 - Effort is spent integrating IT systems
 - Departments must be integrated in expectations
- **Effort**
 - Mostly integration/organization
 - Some domain knowledge
 - Little data science
- **Conclusions**
 - There is much more to a data science project than data science!
 - It is not necessary for operators to have dedicated data science software developers - rather knowledgeable persons to organize, and manage the project and domain knowledge

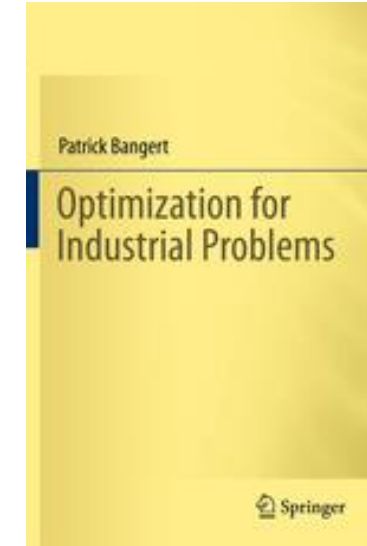
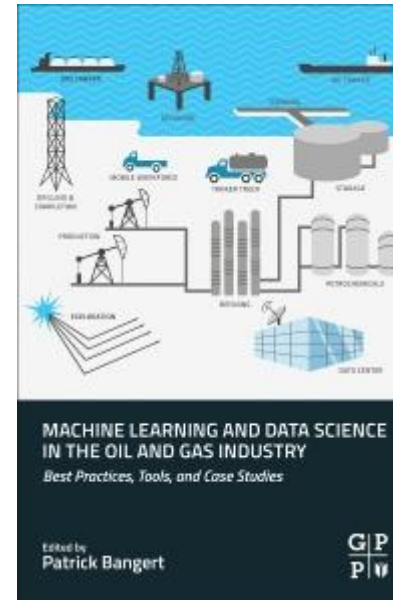


Acknowledgements, Thank You & Questions

Questions? Feel free to reach out. Find details and case studies in my books.

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