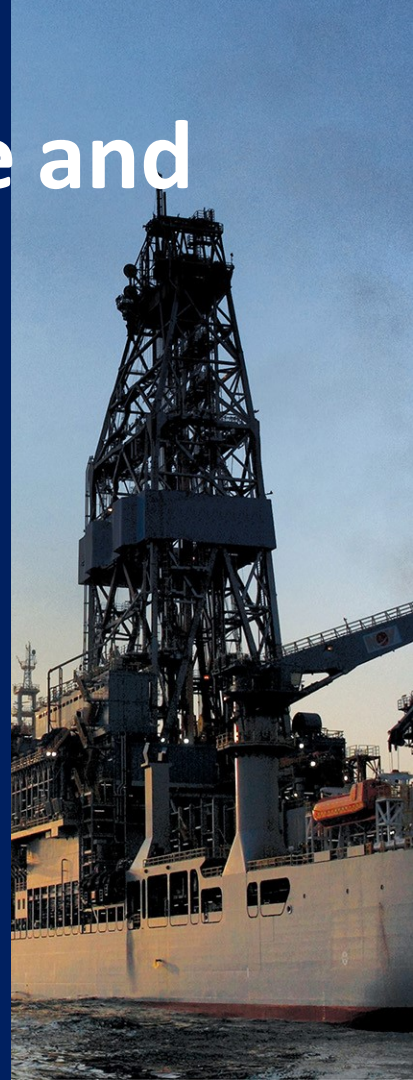
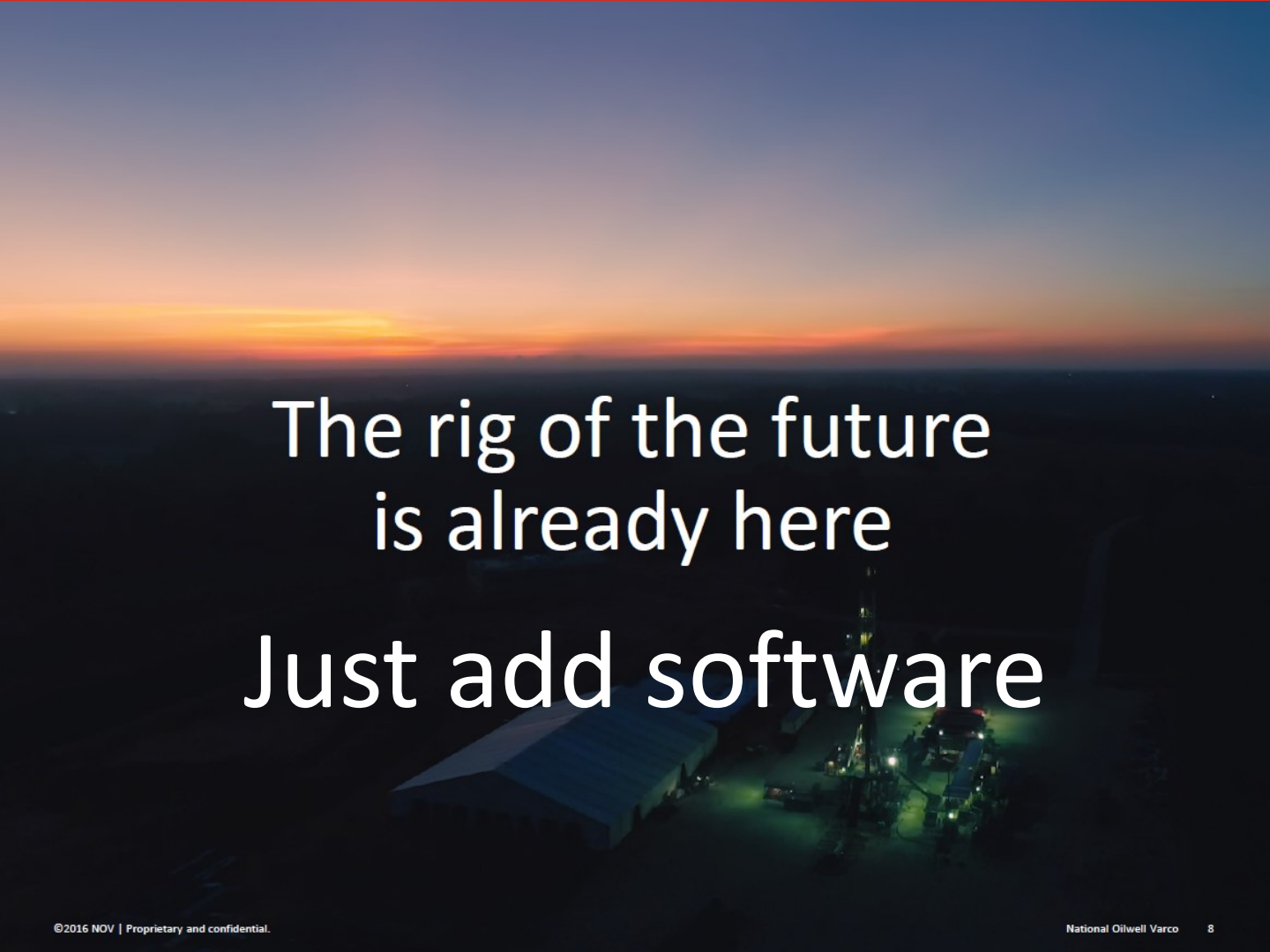


Predictive maintenance and monitoring of drilling equipment

Julian Zec
Chief Engineer
National Oilwell Varco

November 27th, 2018



An aerial night photograph of an offshore oil rig, illuminated by its own lights. The rig is positioned in the lower right quadrant of the frame. To its left is a large, dark, rectangular structure, possibly a storage tank or part of the rig's infrastructure. The background is a vast expanse of the ocean under a twilight sky, with a bright orange and yellow sunset or sunrise glow along the horizon. The overall scene is dark, with the rig's lights providing the primary source of illumination.

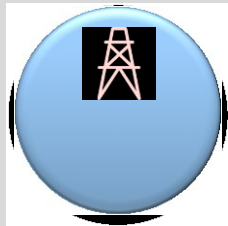
The rig of the future
is already here

Just add software

Potential- Rigs supplied by NOV since 2006



■ Jackup ■ Semmi ■ Drillship
■ Land

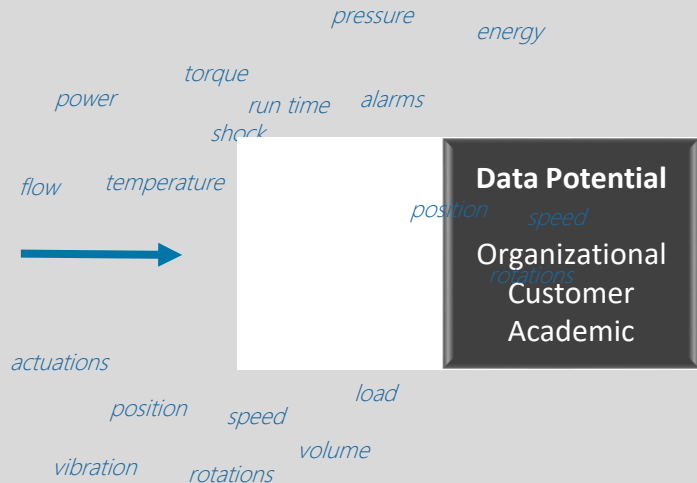


300+
Offshore

Integrated
Drilling
Controls



300+
Land

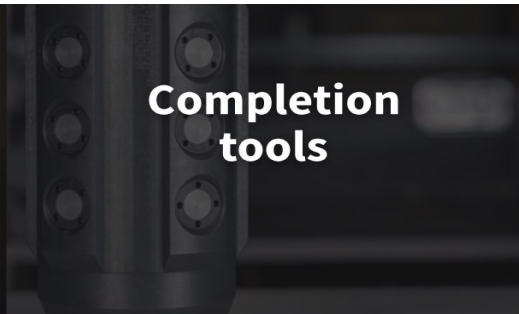


**Use technology to reduce
customer's overall spend—
continuous recertification**

**Yield better returns and higher
performance—surpassing
uptime goals**



**Directional
drilling tools**



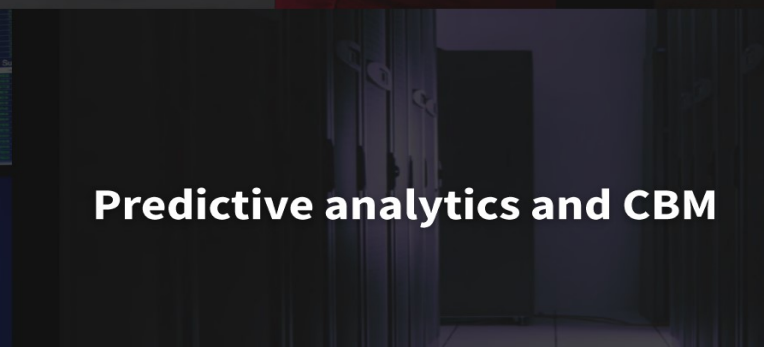
**Completion
tools**



NOVOS



Drilling automation



Predictive analytics and CBM

Current CBM Programs

Condition Based Maintenance

Service for continuous recert and remote monitoring

Suitable for individual equipment or small suite sets

55

rigs with CBM contracts

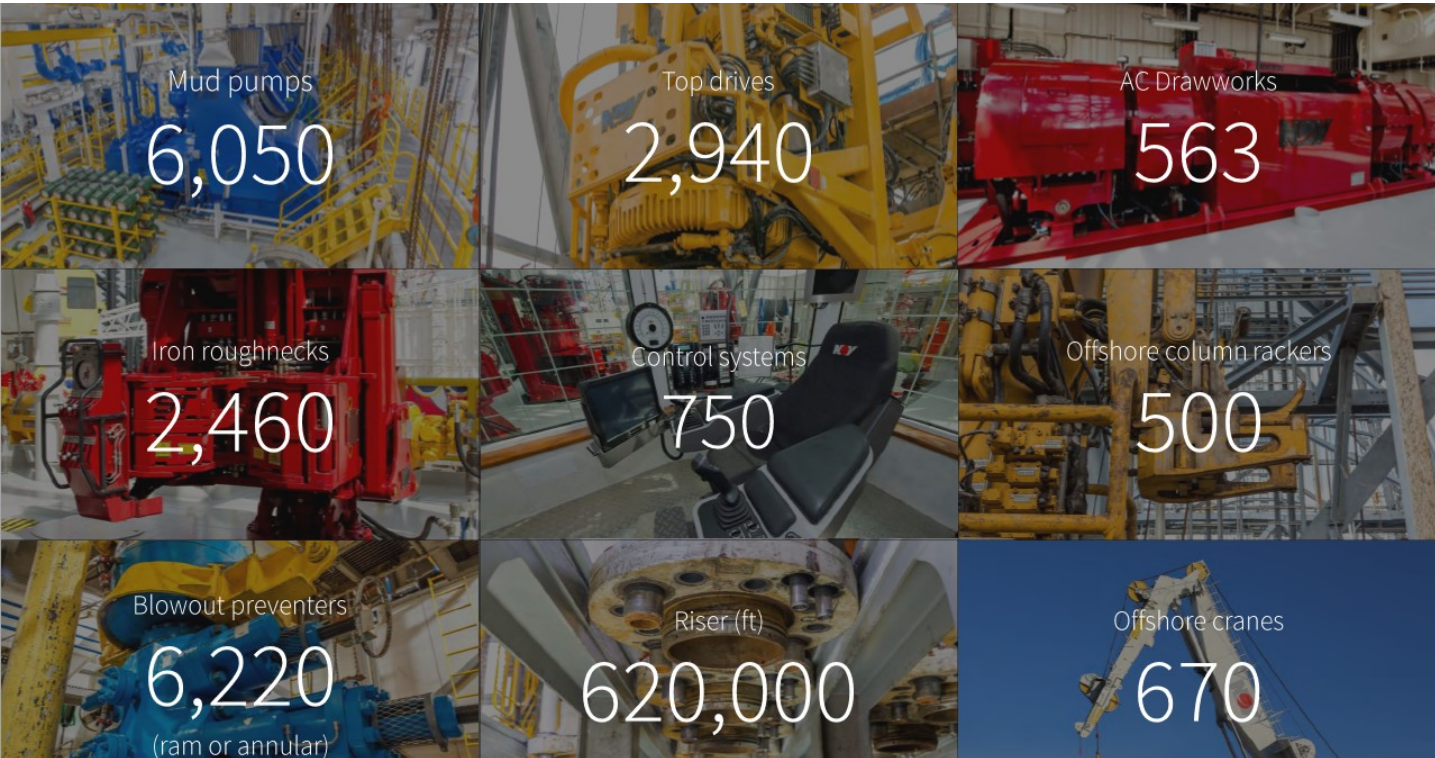
17%

of active NOV fleet under
contract

5

current unique
customers

Real CM/CBM Potential. (NOV)



Industry in recovery

- Unstable Oil price
- Increasing but still low investments
- Imperative to do more with less
- Less money, fewer people
- Less investments
- Value

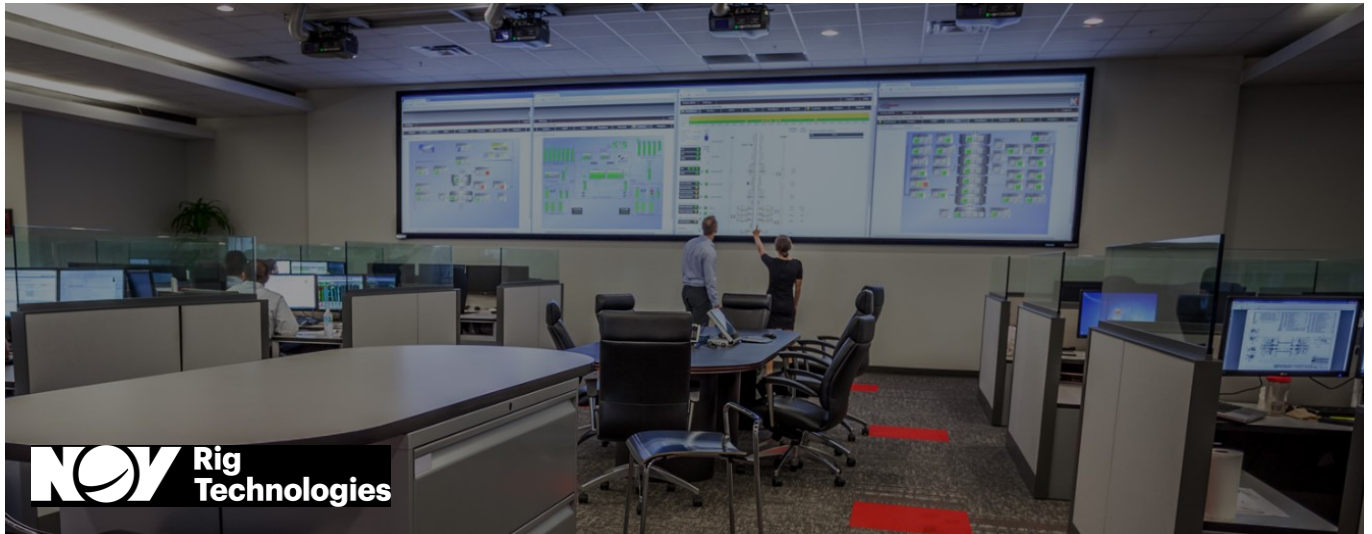
The Value

Compelling correlation is needed between spending money and outcomes:

Lacking this correlation:

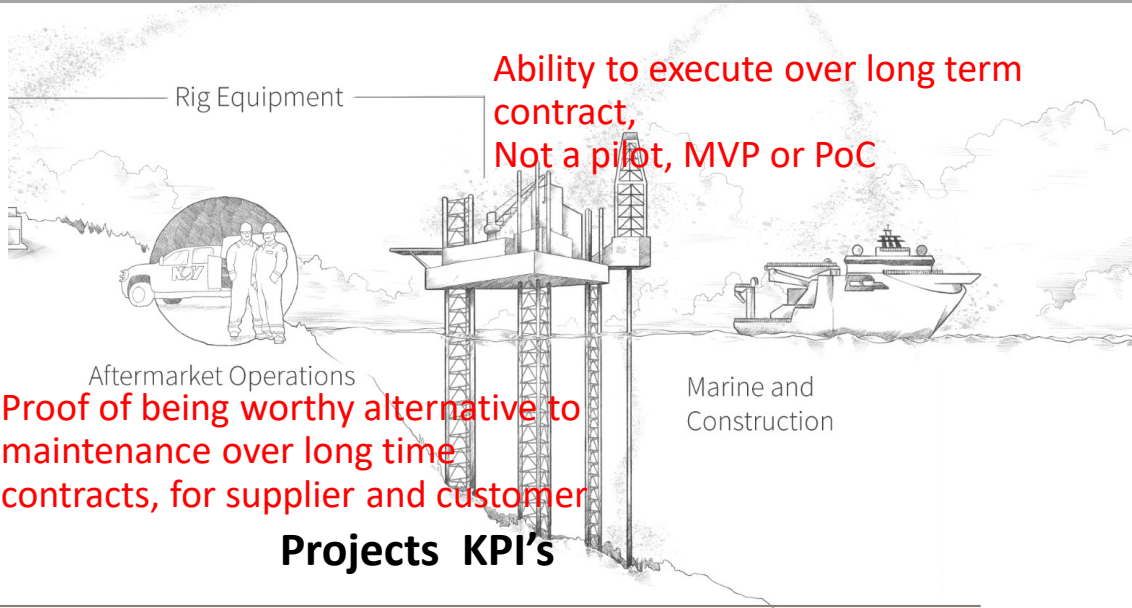
- Make money
- Save money
- Likelihood of project getting green light is exceedingly low.

How do we make CBM work



NOV Rig
Technologies

Data driven execution of maintenance



Asset Management/CBM long term KPI-s

Understanding process & managing expectations



Data



Analytics



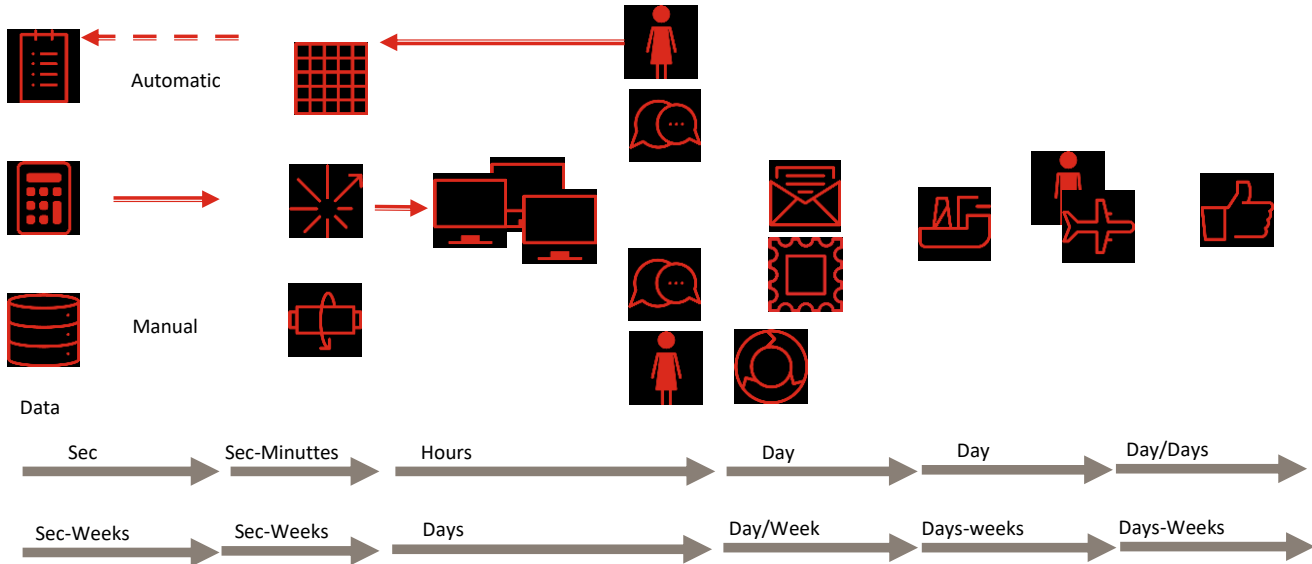
Data Analysis
/ Data
Visualization



FST



Job Done



The Data/Value Journey

Getting
data and
analytics
right

Ability to
interpret and
conclude

Ability to
execute

Information management, IT
infrastructure

Human or AI

Service, Spares, infrastructure

Data quality & Integrity

IT strategy

Analytics- pragmatic quality

Residual knowledge

Quality of Service

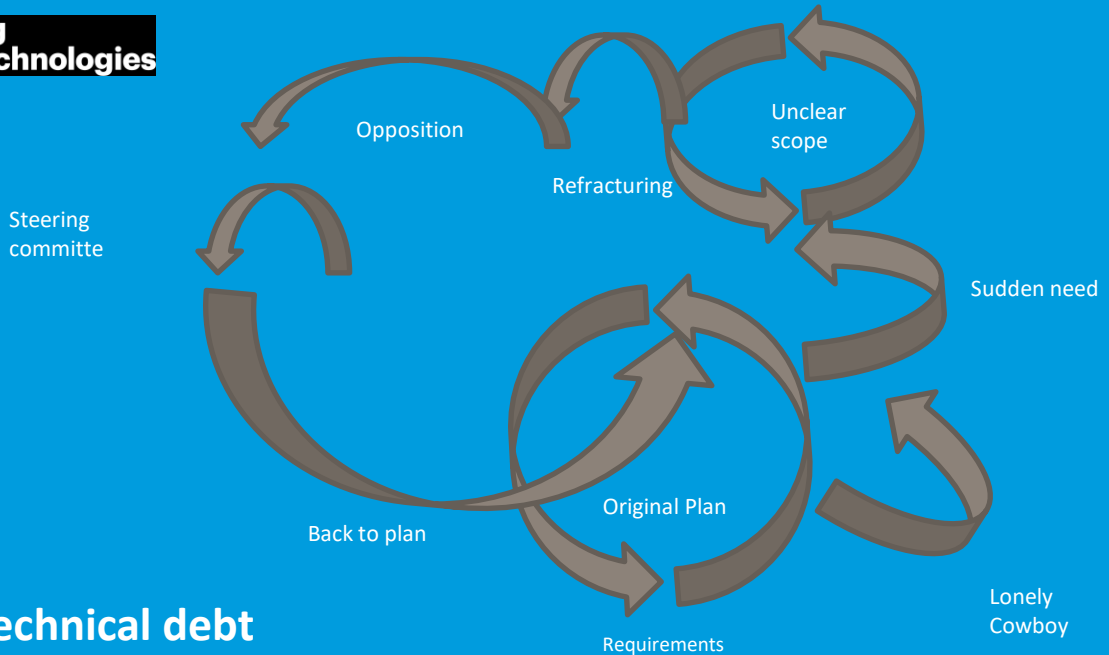
Service Strategy



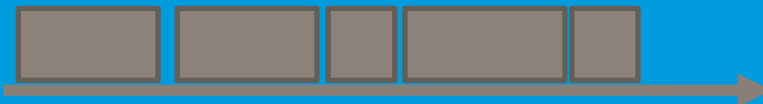
Getting the foundation right



IT strategy- controlling the gates



- **Technical debt**



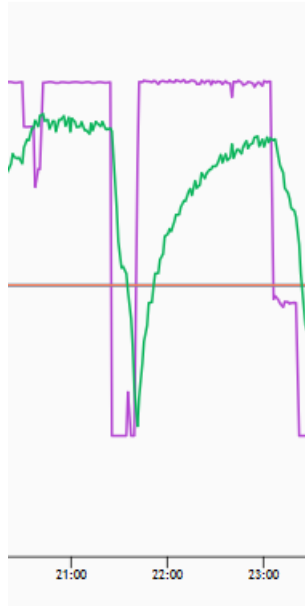
Weeks

Observations

Lack holistic approach



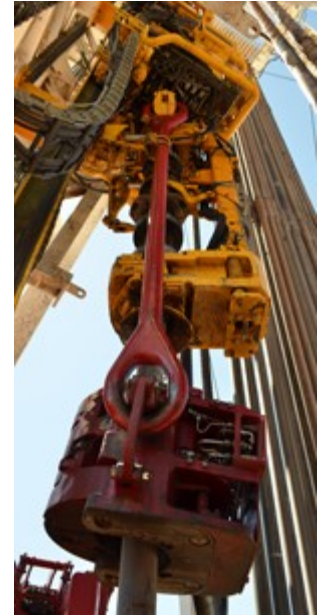
Huge number of solutions on the market, with no real understanding of value chain



Chase for data, lack of proper roadmap or how data potential will be realized



Lack of maintenance and scalability strategy



Piecewise solution with no integration strategy or vertical systems

Analytics



Different kinds of knowledge

**Semantic/ Unconventional
Knowledge**

Heuristical Knowledge

Analytical Knowledge

Coding Human is difficult.

We will not be able to ,make
technology independent from
human knowledge, reflections
and observations for long time.

Empirical Knowledge

Operator
Observations

Measured
Variables

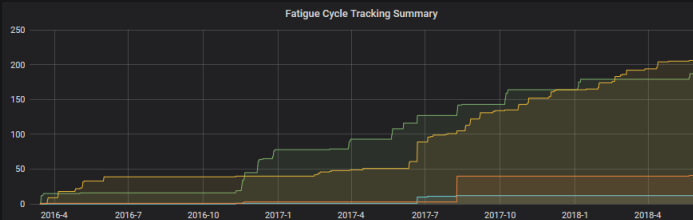
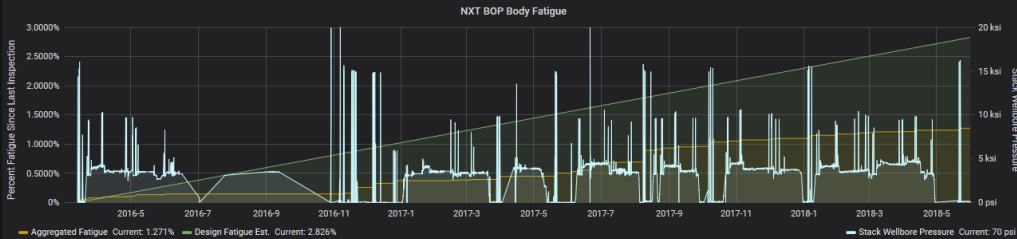


Rolle of analytics is to extract, summarize and present valuable information to be actioned upon.

Presented complex information shall be simplified and focused on necessary processes user is responsible for

Simple, understandable and actionable information

- Daily users are not data scientists
- Time to conclusion is essential



current
187
206
12
41

Calculated Fatigue Percentage

1.27%

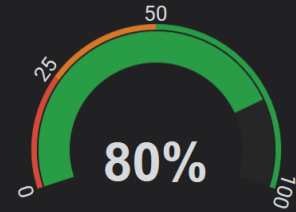
Average WB Pressure Cycle Peak

4.94 ksi

Average WB Pressure Cycle Bottom

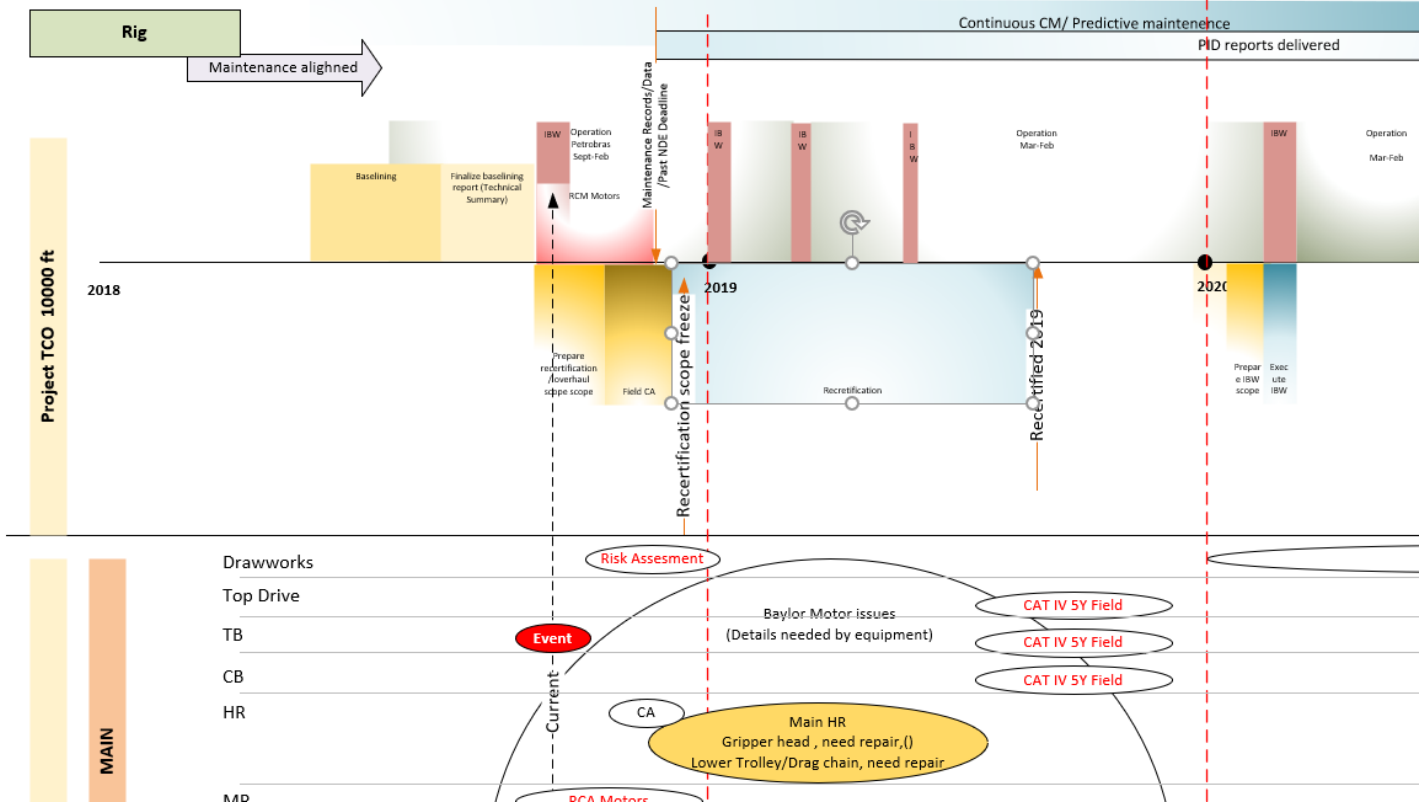
3.77 ksi

Percent Fatigue Remaining Until Next Inspection



Est. Days Until Next Inspection





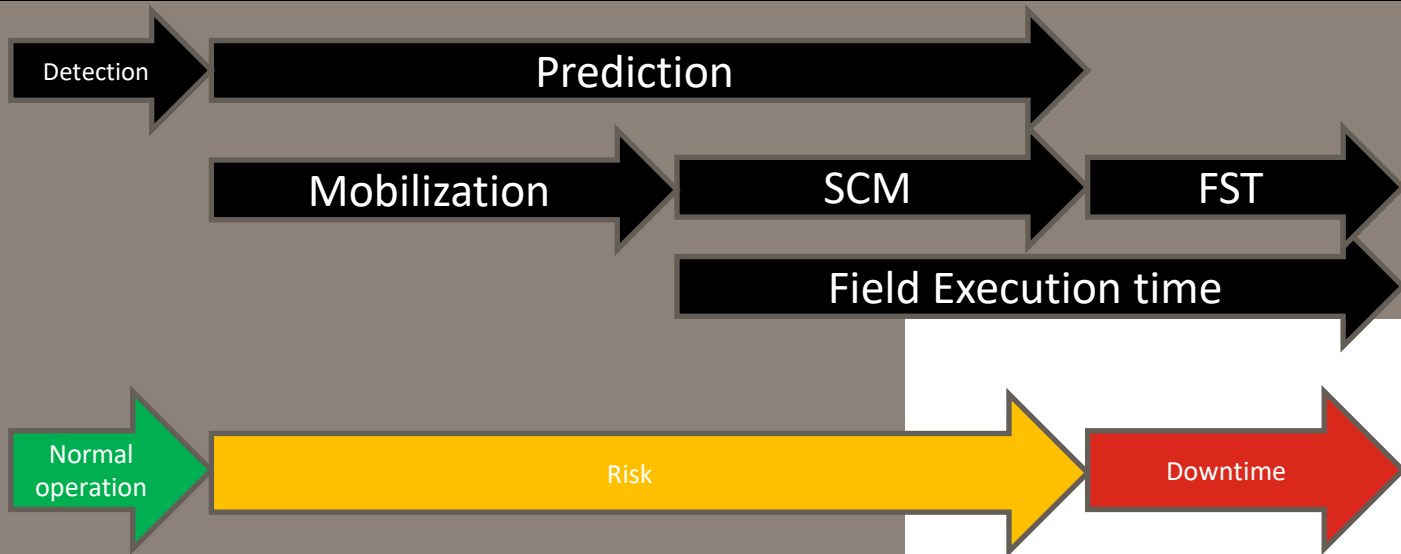
Long term Asset management control and planning



Executing CBM in the field



Action time



- Prediction time shall ideally be longer than
- Predictive technique shall be of right quality
- Or costs may be higher than reactive maintenance

Quality of prediction

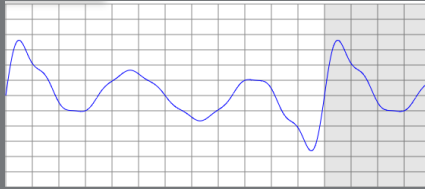
- Information have to be exchangeable and dynamic to be shared between CMMS systems and reliability databases
- Recommendation needs to be spot on topic and executable
- Unnecessary and unclear notifications will confuse organization and weaken product- leading to its abandonment

Strategy- less plan, more swift and organized action

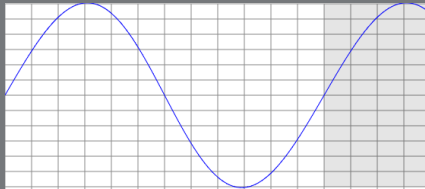
Ideal service organizations are flexible, responsive and adaptable. They possess necessary skills, knowledge, training and capabilities.

Combining strategies with different dynamics

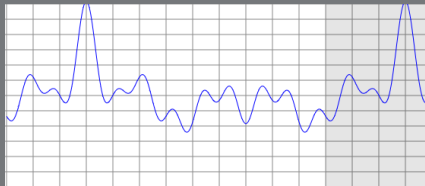
IT



Analytics



Service



Holistic business goals

**Learning to execute
under data driven
management**

Integrated
organization

NOV Vision

The most advanced rigs and equipment
in the world, drilling better than anything
else, with no surprises

