There is an abundance of oil resources...

Global proved oil reserves

Estimates of technically recoverable resources and cumulative oil demand

Trillion barrels

Europe
Asia
Africa
S&C America
N America
CIS
Middle East

Range of cumulative demand from 2015-2050*

Technically recoverable resources
Cumulative demand

2015-2035
2015-2050

*Based on range of outcomes shown on page 88
All this with less people!

Working-age population
% of total

Source: World Bank
Economist.com/graphicdetail
Upstream Engineering Centre
Our Objective:

To get better at spotting problems
Stakeholders

Safety
Key Metrics

Safety          Licence to Operate          Technically Defensible

End to End Mass Balance          Manage Uncertainty          Meet Production Targets

Risk Reduction          Control Reserve Inventory          Traceability

Compliance with Standards          Plant Efficiency          Contractual Obligations
Measurement Scope

- Managing Operational Risk
- Ensuring Compliance
- Limiting Commercial Exposure
- High Availability

Goal

Technically Defensible Measurement Intelligence

Flow Computer
- Daily Reports
- Monthly Reports
- System Status

Maintenance Work Orders
- WO’s Comp.
- WO’s Outstanding
- Pass/Fail Status
- Pending WO’s

Work Order Results Data
- Pass/Fail Criteria
- Test Results
- AF/AL Results
- Auditable Record System
- Results Trending
- Doc Control Log

CBM
- RAG Status
- Real time Degradation / Failure Alerts
- Troubleshooting tools

Diagnostics
- System data validation
- Process stability
- Stream comparisons

“How do I know I can trust this data?”

“Was the work carried out correctly?”

“How do I access this information easily?”

“This is great, but is anyone monitoring this?”

“How do I interpret all this information?”

Upstream Engineering Centre
SMART Measurement Ideal State:

- Managing Operational Risk
- Ensuring Compliance
- Limiting Commercial Exposure
- High Availability

SMART Measurement Management System

Reliable Integration of Data into Dedicated Supervisory Tool

Technically Defensible Measurement Intelligence

Flow Computer
- Daily Reports
- Monthly Reports
- System Status

Maintenance Work Orders
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Diagnostics
- System data validation
- Process stability
- Stream comparisons

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So how do we achieve this???
This document is
Microsoft Big Data Solution

FAMILIAR END USER TOOLS
- Power View
- Excel with PowerPivot
- Predictive Analytics
- Embedded BI

BI PLATFORM
- SSAS
- SSRS
- Hadoop On Windows Azure
- Hadoop On Windows Server

UNSTRUCTURED & STRUCTURED DATA
- Sensors
- Devices
- Bots
- Crawlers
- ERP
- CRM
- LOB
- APPs

This document is...
Big Data – Safeguarding our Future…?
Identifying Emergent Risks

Potential Special Cause Variation

Upper Control Unit

Normal Cause Process Variation

Lower Control Unit
Solving this problem using big data
Solving this problem using big data
A hidden problem…

Anscombe quartet

Upstream Engineering Centre
The Datasaurus dozen
The Datasaurus dozen

This document is
SAFETY NOTE:

Although many of these techniques are intended to improve engineer and technician efficiency, it is essential to ensure that safety systems shall not be compromised by changes made in the way these systems are maintained.
Raw Data

- Process Control Network
- Data Historian
- Data Lakes
- Spreadsheets(!)

Quality Checks

- Risk
- Exposure
- Uncertainty
- Status

Data Analytics

- Process Data
- Maintenance Activities/Results
- CBM

Upstream Engineering Centre

This document is
## Measurement Management System Vision

### Outputs to Business Big Data System

<table>
<thead>
<tr>
<th>Region</th>
<th>Site</th>
<th>System</th>
<th>Fluid Type</th>
<th>Station Total (MBOED)</th>
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<tbody>
<tr>
<td>Region 1</td>
<td>Site A</td>
<td>Sales Gas</td>
<td>Gas</td>
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<tr>
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<tr>
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<td>Export Gas 1</td>
<td>Oil</td>
<td>52</td>
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**Field Inputs**
- Flow Rate
- Pressure
- Temperature
- Gas CV
- HCDP
- Moisture
- Water Cut
- BS&W

**Raw, uncontrolled data**

**High Uncertainty Risk**

**Technically Defensible Measurement Data?**
Measurement Management System Vision

Field Inputs
- Flow Rate
- Pressure
- Temperature
- Gas CV
- HCDP
- Moisture
- Water Cut
- BS&W

Measurement Management System

Raw, uncontrolled data

High Uncertainty Risk

Data Processing & Validation
- Process Data
- Maint. Data
- CBM Data

Outputs to Business Big Data System

<table>
<thead>
<tr>
<th>Region</th>
<th>Site</th>
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<th>Station Total (MBOED)</th>
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<tbody>
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<td>78</td>
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<tr>
<td></td>
<td></td>
<td>Export Gas</td>
<td>Gas</td>
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<td>Site A</td>
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<td>Export Gas 1</td>
<td>Oil</td>
<td>52</td>
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</tbody>
</table>

Technically Defensible Measurement Data
Data Quality Metrics
Where to Start?

Raw Data

How important is this Step to ME?

Quality Checks
- Risk
- Exposure
- Uncertainty
- Status
- Process Data
- Maintenance Activities/Results
- CBM

Data Analytics

This document is

Upstream Engineering Centre
**Process Data**

**Process Data Validation Considerations:**

- Operating within the intended design envelope of the system
- Cross checks between parallel measurement streams
- Range of measurement acceptable (volatility)
Maintenance Data

Confidence in Maintenance Activities:

- Confirming that Maintenance WAS conducted
- Do results make sense compared to last time...?
- Early detection of failing components
Confidence in Maintenance Activities:

- Maintenance WAS conducted
- Results make sense compared to last time...
- Early detection of failing components
**CBM/Diagnostic Data Validation Considerations:**

- Operating within the intended design envelope of the system
- Cross checks between parallel measurement streams
- Aggregate of system diagnostics confirms that signal is good?
How important is this Step to ME?

Where to Start?

- Raw Data
- Quality Checks
  - Risk
  - Exposure
  - Uncertainty
  - Status
  - Process Data
  - Maintenance Activities/Results
  - CBM

Data Analytics

This document is
Pulling it Together

Design

Operation

Accountability

CBM

Process

Maintenance

Process Historian

Forms the basis of the Measurement Master List

Production Values from PI etc

Normalised Data

Quality Metric Reporting

<table>
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<tr>
<th>Region</th>
<th>Site</th>
<th>System/Station</th>
<th>Fluid Type</th>
<th>Total Vol</th>
<th>Total Std Vol</th>
<th>Total Mass</th>
<th>Total BOE</th>
<th>Risk</th>
<th>Exposure</th>
<th>Uncert. %</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region 1</td>
<td>Site 1</td>
<td>Sys 1</td>
<td>Oil</td>
<td>Total Vol</td>
<td>Total Std Vol</td>
<td>Total Mass</td>
<td>Total BOE</td>
<td>Risk</td>
<td>Exposure</td>
<td>Uncert. %</td>
<td>Status</td>
</tr>
</tbody>
</table>
Translating Quality Metrics

- **Status:**

- **Uncertainty**

\[ CU = \sqrt{u_1^2 + u_2^2 + \cdots + u_n^2} \]

- **Risk**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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<td>Minor</td>
<td>Moderate</td>
<td>Significant</td>
<td>Severe</td>
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<tr>
<td>E</td>
<td>Very Likely</td>
<td>Low Med</td>
<td>Medium</td>
<td>Med H</td>
</tr>
<tr>
<td>D</td>
<td>Likely</td>
<td>Low</td>
<td>Low Med</td>
<td>Medium</td>
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<tr>
<td>C</td>
<td>Possible</td>
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<td>Medium</td>
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<td>B</td>
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<td>Low</td>
<td>Low Med</td>
<td>Low Med</td>
</tr>
<tr>
<td>A</td>
<td>Very Unlikely</td>
<td>Low</td>
<td>Low</td>
<td>Low Med</td>
</tr>
</tbody>
</table>
Measurement Management Hierarchy

Global Summary
- Split by Region:
  - MBOE Total
  - O&G Split
  - Quality Metrics
    - Status
    - Exposure
    - Risk

Regional Summary
- Split by Site:
  - MBOE Total
  - O&G Split
  - Quality Metrics
    - Status
    - Exposure
    - Risk

Site Summary
- Split by System:
  - MBOE Total
  - O&G Split
  - Quality Metrics
    - Status
    - Uncertainty
    - Exposure
    - Risk

System Summary
- Split by Stream:
  - MBOE Total
  - O&G Split
  - Quality Metrics
    - Status
    - Uncertainty
    - Exposure
    - Risk

This document is
Where to Start?

Automatic

Manual

1. Field Based → Centrally Available

2. Unstructured Unconnected Data → Centralised Intelligence
### Considerations & Sequencing Options

<table>
<thead>
<tr>
<th>Timescale</th>
<th>Risk</th>
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<td>Measures</td>
<td>Activity Attainment</td>
<td>Results</td>
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<td>Process</td>
<td>Operational envelope</td>
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<td>CM</td>
<td>Configuration</td>
<td>Diagnostics</td>
<td>CBM</td>
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<tr>
<td>Data Needs</td>
<td>Digital Data Mapping</td>
<td>Database Standardisation</td>
<td>Infrastructure/Hardware</td>
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</tr>
</tbody>
</table>
Automating for Efficiency

Field Based

Manual

Automatic

Unstructured Unconnected Data

Stranded Intelligence

Centralised Intelligence

Unprocessed Centrally Available Data

This document is
### Layer of Protection - Controller Overview

<table>
<thead>
<tr>
<th>Controller Name</th>
<th>Mode</th>
<th>SP</th>
<th>OP</th>
<th>PV</th>
<th>% Manual</th>
<th>Variability</th>
<th>Alert</th>
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</tbody>
</table>

*This document is [Upstream Engineering Centre](#)*
Recap
Recap

- **Automatic**: Centralised Intelligence
- **Manual**: Unstructured Unconnected Data

Field Based → Centrally Available

1. Unprocessed Centrally Available Data
2. Stranded Intelligence

This document is
Questions?

Technically Defensible Measurement Intelligence