A Driller's View of the Cross-over between Aviation and Drilling

John Thorogood

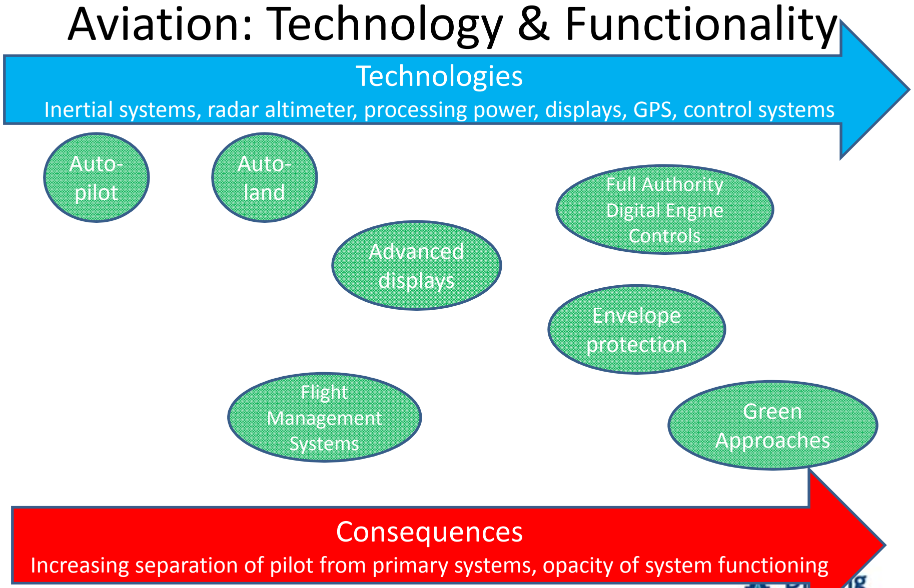
Drilling Global Consultant

Introduction

- Parallels between Aviation and Drilling
  - Evolution of Automation and relevant Principles
  - Three air accident examples and lessons
- Aviation, Process Control and Drilling
  - Drilling decision-making cycle and timescales
  - Examples of existing automation in drilling
  - Emerging Technologies and questions to ask
- Addressing the Human Factor
  - Problems for Drillers: operational discipline
  - Non-technical skills and training

Drilling Global Consultant

Aviation: Technology & Functionality



Drilling Global Consultant

Premises of Automation in Aviation

- The pilot must be actively involved in the process being controlled
- The pilot must be adequately informed about what the system is doing
- Operators must be able to monitor and interrogate the functioning of the automation
- Behaviour of automated systems must be predictable
- Automated systems must monitor the operators by providing alerts if anomalous conditions are detected

Drilling Global Consultant

M1

AA965, Cali, Colombia, Dec 1995

- Sequence of events
  - Approach runway changed midway through the descent
  - Procedure start point already passed, incorrect beacon frequency selected
  - Crew disorientation and breakdown in procedures
  - 159 pax and crew killed, 4 people and a dog survived
- Lessons for Drilling
  - Reactions to unexpected events, sense-making
  - Operating complex systems under stress
  - Situation awareness
  - Discipline in control and communication

Drilling Global Consultant

M2

US1549, Hudson River, Jan 2009

- Sequence of events
  - Collided with flock of geese, near total power loss
  - Automated flight controls prevented major upset
  - Fortuitous decision to start up auxiliary power unit
  - Exemplary crew discipline lead to successful ditching
- Lessons for Drilling
  - Automated controls could not be over-ridden
  - Automation enabled the crew to focus on the problem
  - Skilled improvisation ensured computerised controls continued to function
  - Experience, discipline and adherence to standard procedures

Drilling Global Consultant

AF447: Final Minutes, June 2009

M3

Observations about AF447

- Characteristics of the event:
  - Highly automated flight deck
  - Sudden onset, major surprise
  - Unusual situation
  - Multiple ambiguous signals
- Lessons for Drilling
  - Response of systems to rare events
  - Complexity of interfaces and sense-making
  - Situation awareness and basic understanding of flying

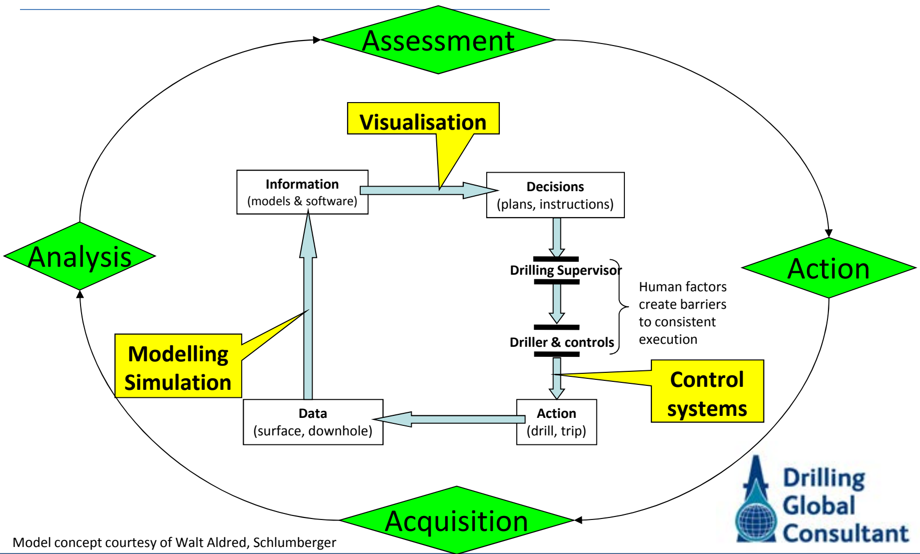
Drilling Global Consultant

Aviation, Process Control & Drilling

- Aviation and Process Control:
  - Processes are comprehensively instrumented
  - Steady state is the norm
  - Systems are designed and behave according to defined laws
  - Systems are fully integrated
  - Operational protocols standardised worldwide (IACO)
- Drilling
  - Downhole and operational environment subject to major uncertainties
  - Operations are dynamic, rarely steady state
  - Limited integration of systems and regular changes in suppliers
  - Wide diversity in management styles, control of work and command protocols

Drilling Global Consultant

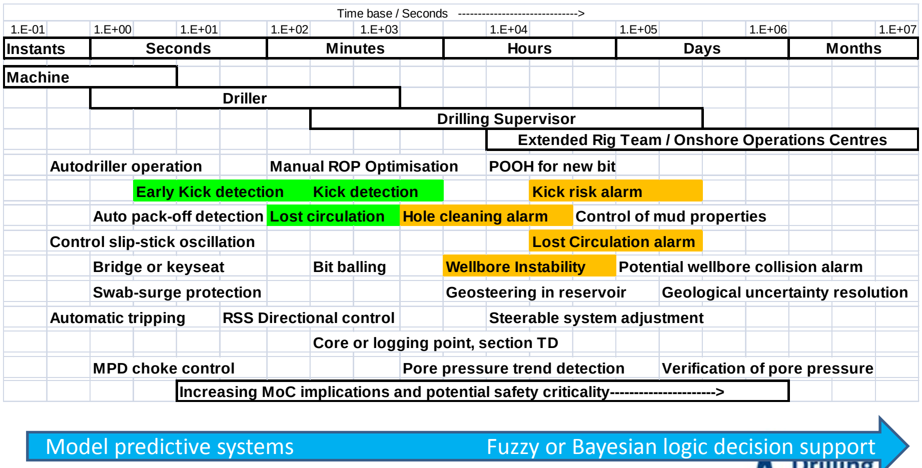
Drilling Operational Decision Cycle



Model concept courtesy of Walt Aldred, Schlumberger

Drilling Global Consultant

Timescales in Decision-making



Drilling Global Consultant

Current Automation in Drilling

- Elementary Systems
  - Auto-drillers, rotary steerable systems
- MPD Choke Control
  - Increased precision, enhanced kick detection
  - Models used as aids, new protocols required
- ROP Optimisation
  - Advanced algorithms, direct control of rig
  - Reduces driller workload, improves oversight
- Dynamic Positioning Systems
  - Considerable complexity, safety-critical, high integrity
  - Internationally formalised protocols, simulators, log books

Drilling Global Consultant

Emerging Technologies?

- Envelope protection
  - Pump start-up & shut down
  - Swab-surge limitations
- Automated choke control in primary well control
- Intelligent Alarms, case based systems
- Automated Decision Support
- Increasing complexity will create different issues:
  - Sensor integrity and redundancy
  - Database initialisation and maintenance
  - Opacity of decision-making
  - Authority / responsibility conflicts

Drilling Global Consultant

Decisions about Automation

- What decision is the function automating?
- Whose responsibility is the decision?
- Safety-critical issues?
- Is delegation to a machine appropriate?
  - Authority vs responsibility

Drilling Global Consultant

Conclusions around Automation

- Automation:
  - brings benefits and complexity
  - is more than just computers, it involves people and organisations
- Automation of critical time-sensitive functions:
  - provides more consistency and reliability than an operator
  - reduces cognitive demands, enables increased situation awareness
- Automated systems for control and decision-support must keep authority and responsibility tightly linked
- Advanced automation and decision support will place increased demands on education, training, assessment and ongoing proficiency
- Automation of safety-critical systems will demand tight control of design, manufacturing, testing and user operation

Drilling Global Consultant

M5

Addressing the Human Factor in Drilling

- Where are we?
  - HF tacitly acknowledged as factor in major incidents
  - Industry focused on application to well control
  - Blinkered approach presents a major risk
- Reality check:
  - Effects of cognitive bias on decision-making not addressed in routine incident analysis
  - Examples can be seen in events in every-day operations
  - "Explanations" involving superficial attributions prevail
  - Lack of awareness of underlying psychological issues, chronic unease and weak signals
  - Non-technical skills must be visible in routine operations in the workplace and chain of command

Drilling Global Consultant

M6

Crew Resource Management in Drilling

- Situation in Aviation:
  - Well established operational protocols
  - Training, licensing and operational oversight impose strict discipline
  - Demonstrated competence in non-technical skills and multi-crew coordination are required skills
- Application to Drilling
  - Drillers will require much greater formality in the way they approach their jobs
  - Development of CRM in Drilling will require deep discipline knowledge
  - Non-technical skills must be examined and assessed as part of competency assurance

Drilling Global Consultant

Slide 18

CRM Requires a Formal Context

1. How Drilling Programmes are written
2. The process for generating Written Work Instructions
3. Procedures for monitoring the operation
4. How deviations and changes are handled
5. Decision-making Procedure
6. The elements of Operational Discipline
7. Operational doctrine and rules
8. Competency, Training and Assessment of the people

Drilling Global Consultant

Non-Technical Skills: what are they?

CATEGORY	DEFINITION
Situation Awareness *What is going on?*	• Gathering information • Interpreting information • Anticipating future states
Decision Making *What shall I do?*	• Defining problem • Considering options • Selecting and implementing option • Reviewing outcome
Communication *Where is the relevant information?*	• Sending information clearly and concisely • Including context and intent during information exchange • Receiving information – especially by listening • Identifying and addressing barriers to communication
Leadership *What directions or orders should I give?*	• Using authority • Maintaining standards • Planning and prioritising • Managing workload and resources
Teamwork *How will the team work together?*	• Supporting others • Solving conflicts • Exchanging information • Co-ordinating activities
Stress Management *How can I cope?*	• Identifying symptoms of stress • Recognising effects of stress • Implementing coping strategies

Drilling Global Consultant

How do you train Non-Technical Skills?

- Teach the basic theoretical concepts:
  - Impact of biases on thinking process and decision making
  - Non-technical skills as a way to counter the biases
  - Threat and Error Management to institutionalise chronic unease
- Practical & theoretical in combination
  - Simulator-based sessions to practise and apply new information
- Assessment of theory and practice
  - Directed feedback and debriefing
- Coaching continued into the workplace (Aviation: LOFT)
  - Supervisors trained in the skills and encouraged to include in briefings and debriefings
- Recurrent training and assessment
  - No 'magic wand'; continuously reinforced throughout the workplace and working life

Drilling Global Consultant

Conclusions around CRM

1. Address psychological and cognitive aspects to detect weak signals and train to respond strongly to them
2. Assure competence in non-technical skills to overcome psychological traps
3. Institutionalise chronic unease with Threat and Error Management techniques in the chain of command
4. Codify procedures for executing and monitoring well operations, making decisions, and managing change within a Standardised Operational framework.
5. Adopt a high level of operational discipline in the execution of workplace activities

Drilling Global Consultant

Questions?

Acknowledgements:

My co-author and collaborator in all of this work: Margaret Crichton of People Factor Consultants Ltd, Aberdeen.

In addition, contributors to the papers we have written:

Charles Cowley, Brian Crichton, George Galloway, John Gidley and Lisa Reed

P Mathieson, B McIntyre, R Smith, P Sproul, S Salter, P Johnson, J Boys, M Ydalus

References:

- SPE 151257: Automation in Drilling
- SPE 163489: Operational Control and Managing Change
- SPE 167967: Threat and Error Management
- SPE 167047: Case Study of Weak Signals

Drilling Global Consultant