

Logistics Technology Investigations project: Data science and AI

Karen Walker, Dstl

Cdr Sue Seagrave, DE&S

Alison Jordan and Paul Earnshaw, CGI

Content includes material subject to © Crown copyright (2020). This material is licensed under the terms of the Open Government Licence except where otherwise stated. To view this licence, visit <http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3> or write to the Information Policy Team, The National Archives, Kew, London TW9 4DU, or email: psi@nationalarchives.gsi.gov.uk



9 July 2020

© Crown copyright 2020 Dstl

OFFICIAL

DSTL reference number:
DSTL/CP124208

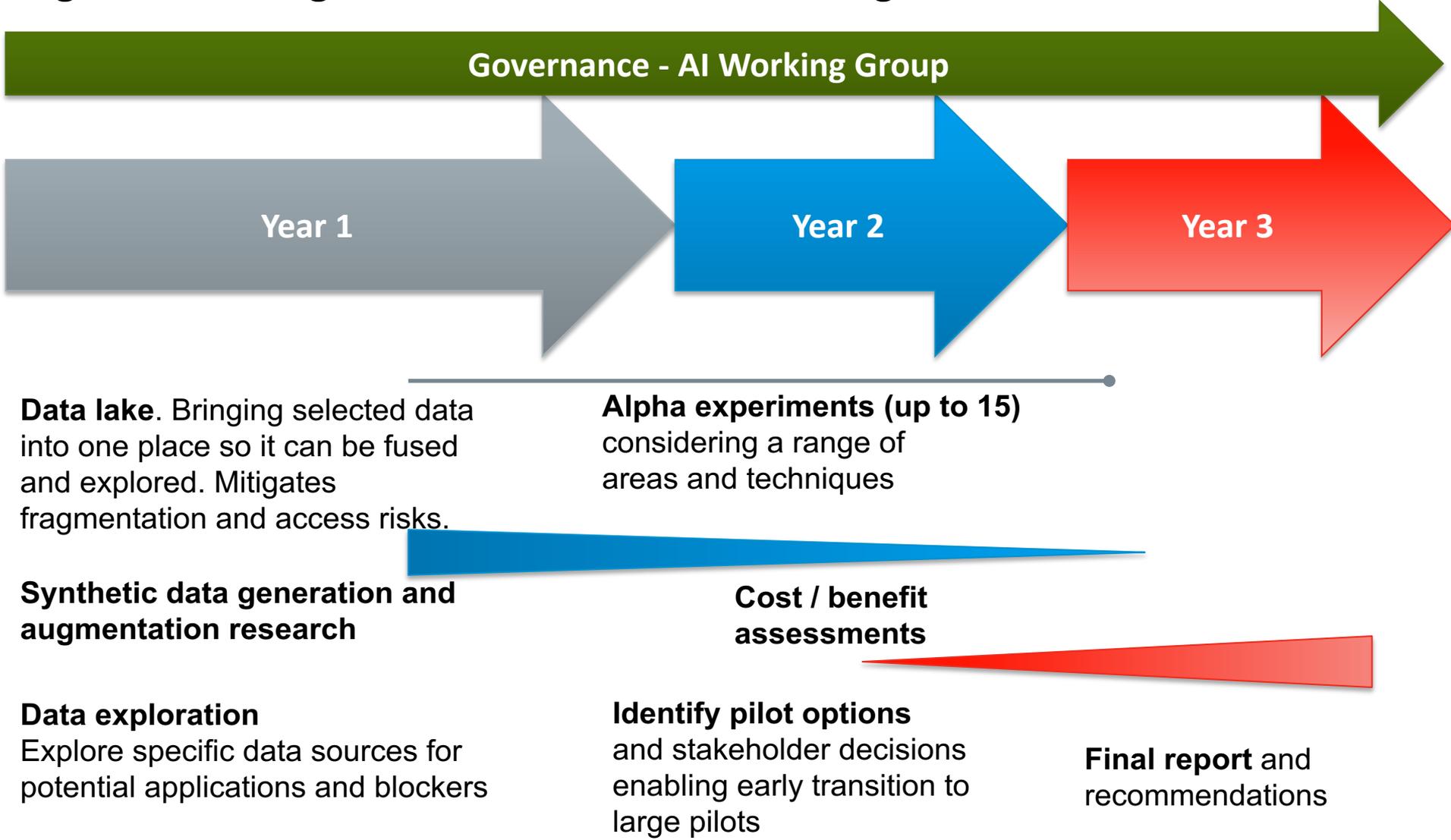


Ministry
of Defence

Aim of overall project

- “Through trials and experimentation it is required to generate objective evidence for where data science and analytics can deliver benefits for logistics, engineering and equipment support”
- Better decisions through:
 - More / better insight
 - Less routine, more value added work
 - Better efficiency / prioritisation, money better spent

Logs Tech Investigations – Data Science & AI – high level schematic





Use Case for Application of Advanced Data Analytics to “S2022s”

(An S2022 is an RN frontline feedback report of ‘deficiency in design, documentation or support’)

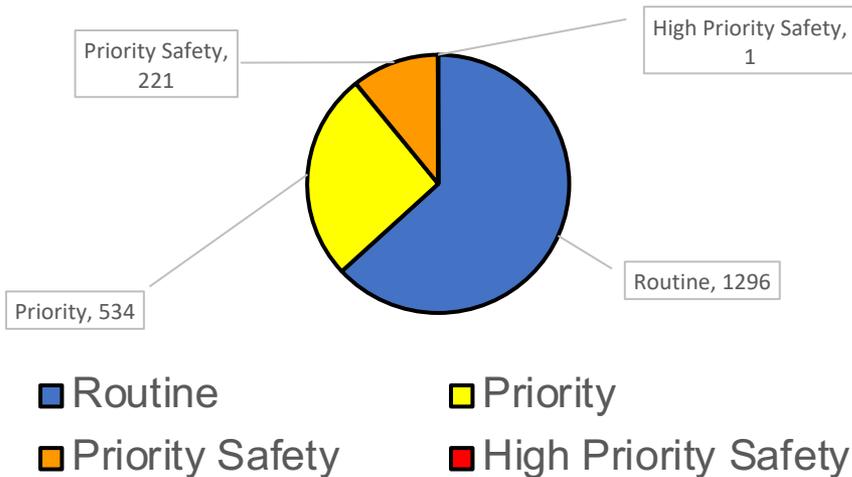
29 Jan 2020

Cdr S J Seagrave MBE RN- MMS GL



How could data science be used to help the 'non-technical' S2022 'front door' in triaging and prioritising finite 'technical subject matter expert' resource better?

Number of Live S2022s



Processed S2022s should ultimately trigger improvements to design, spares, documentation (manuals), maintenance schedules (RCM studies), operating procedures, configuration etc as required to prevent future failures.

Snapshot data size: '48711' full archive (27k fully digitised- remainder metadata only).
1883 'open' (oldest live one Nov 2010)

Of open S2022 1280 'no holding reply'

Volume info exceeds capacity to process and triage let alone action quickly.

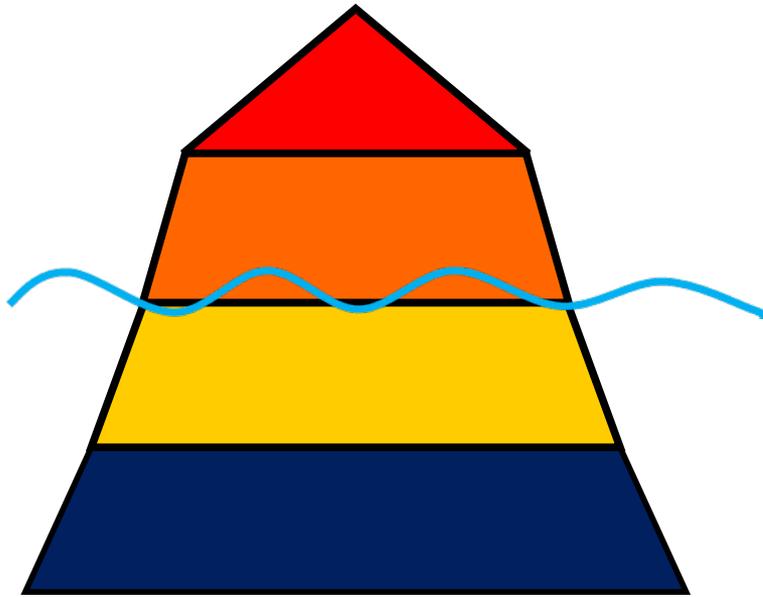
There are roughly 150 'equipment specialists'
2 or 3 have >100, half a dozen >30

Only real sub-prioritisation metric 'time'- FIFO regardless of real importance or cost:benefit.

Prioritise simple but minor 'safety' issues vice complex 'hidden killers'



“Icebergs ahead”

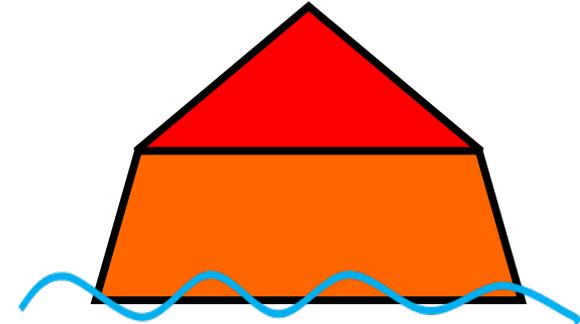


‘Impact layer’- One ‘OPDEF’

‘Proactive Report’= 1- 3 S2022

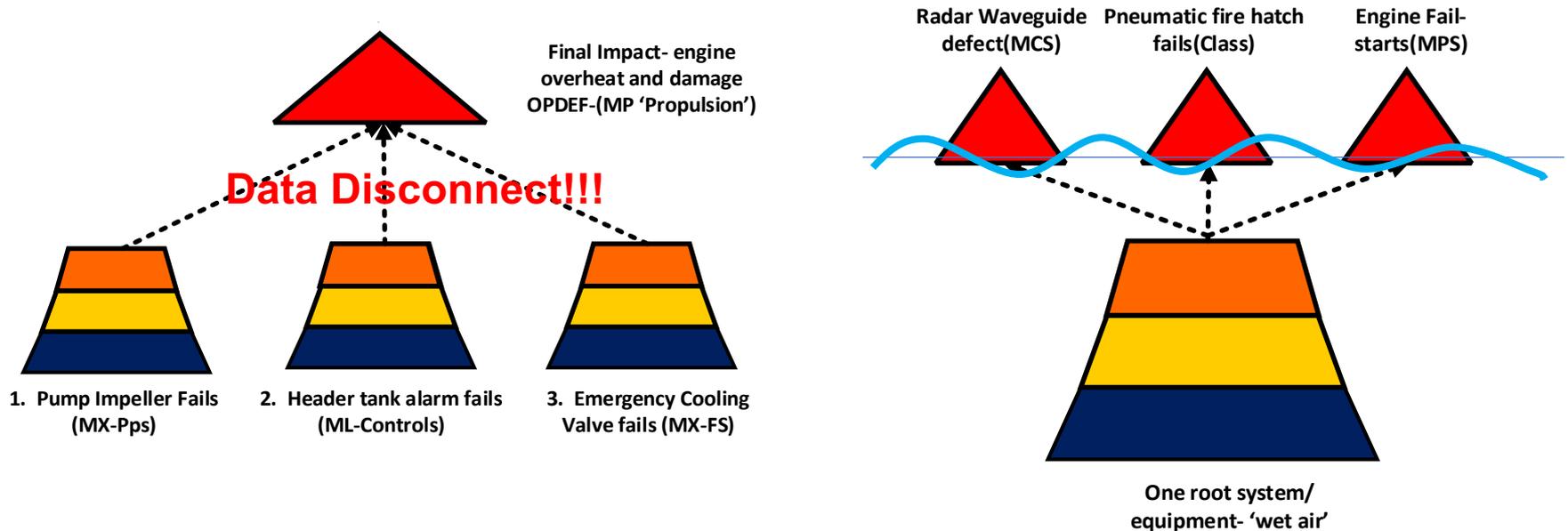
‘Onboard tracking’ = 5-10 defects-
(but prob described differently)

‘Below the waterline activity’-
>50 stores demands for failed
part (or alarm resets etc)



- An ‘OPDEF’ is a loss of Op capability- ultimately aimed at fixing symptom not treating cause
- S2022s have different focus- positive report- quality varies but provide causal analysis or pre-emptive analysis
- Without linking layers below waterline two S2022s at same category appear equal
- Finding and tackling ‘icebergs’ offers big ‘second order’ gains- ‘full’ problem is sum of layers
- 2nd order cost: lost maintainer time/spares etc reducing capacity even if OPDEF prevented.
- Under reporting paradox- the more frequent the problem the less likely it is to be reported every time it occurs

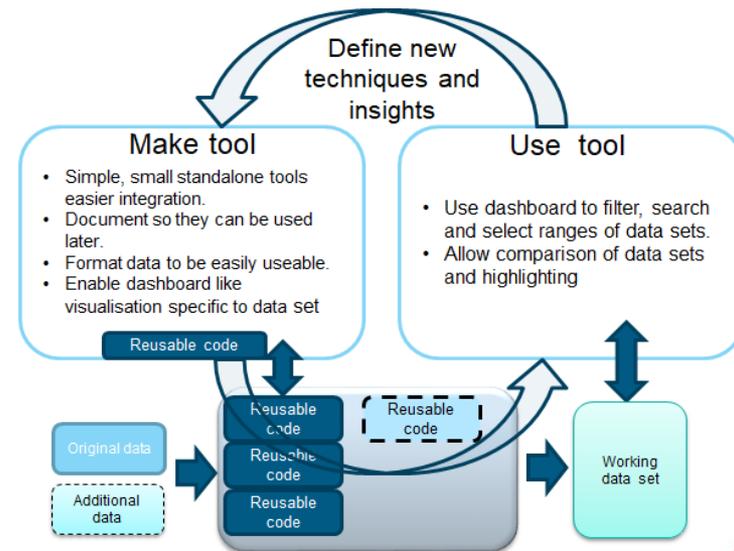
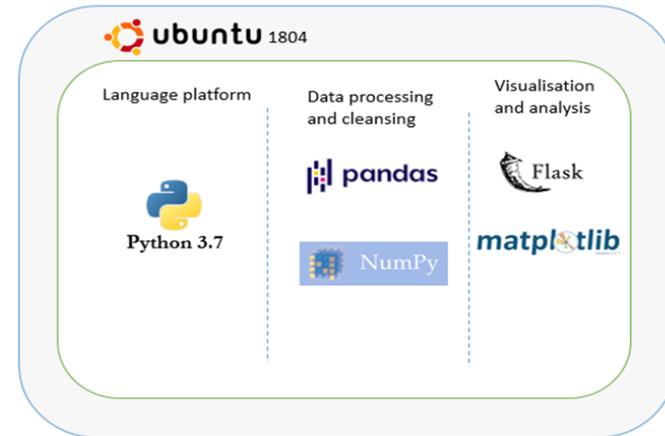
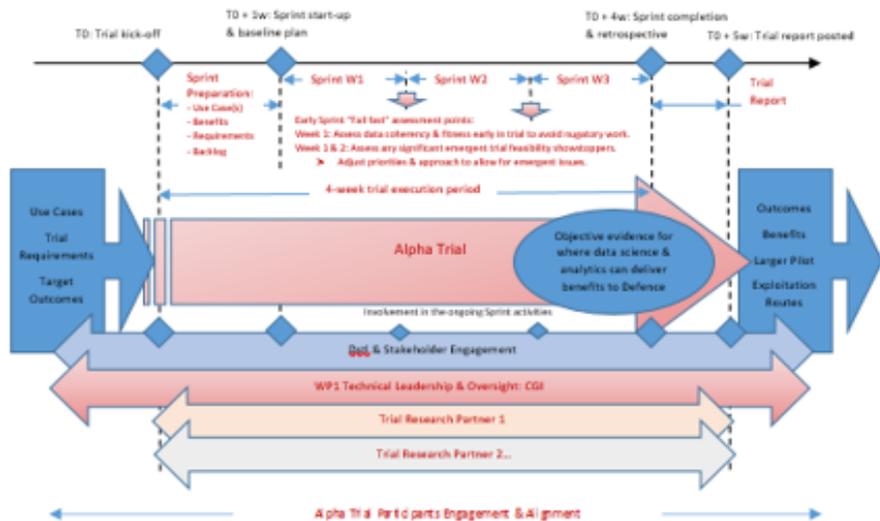
Complex Causation Chains and Stovepipes



- Traditional analysis focussed on symptoms (OPDEF) sub optimal
- Organisational stovepipes prevent accurate identification of single symptom with multiple causes in other 'sections'
- Conversely apparently unrelated OPDEFs with different owners has single cause
- S2022s provide potential data set pivot/node at point of disconnect
- Analogy with medical diagnostics/risk factors

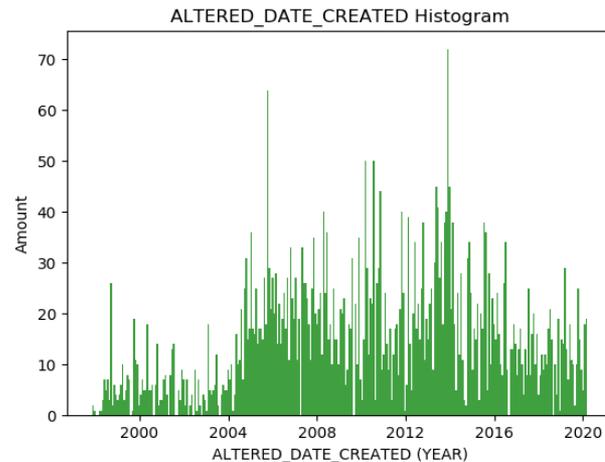
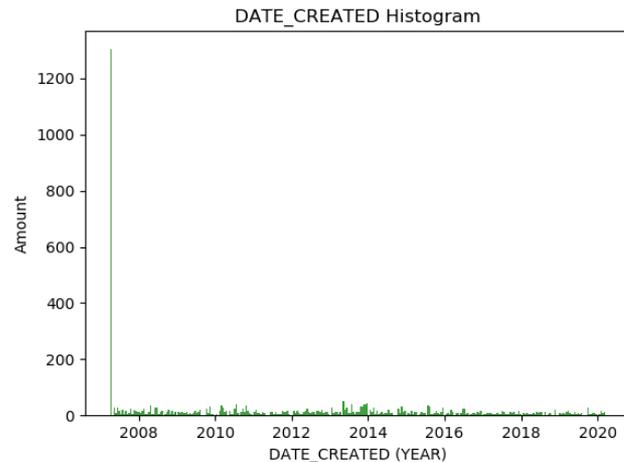
OFFICIAL

LTI Programme: WP1 Alpha Trial



The Process

- Data familiarisation.
- Identified a few data inconsistencies, requiring cleaning data to allow for critical time series analysis to be performed.



- Data expansion and enrichment to enable specific parts of each S2022 to be queried
- Production of an interactive dashboard allowing S2022 data to be queried and filtered dynamically
- Prototype of 'recommender algorithm', defining a 'distance' between S2022s, based on the similarity of S2022 components and natural language processing of the respective descriptions

Findings

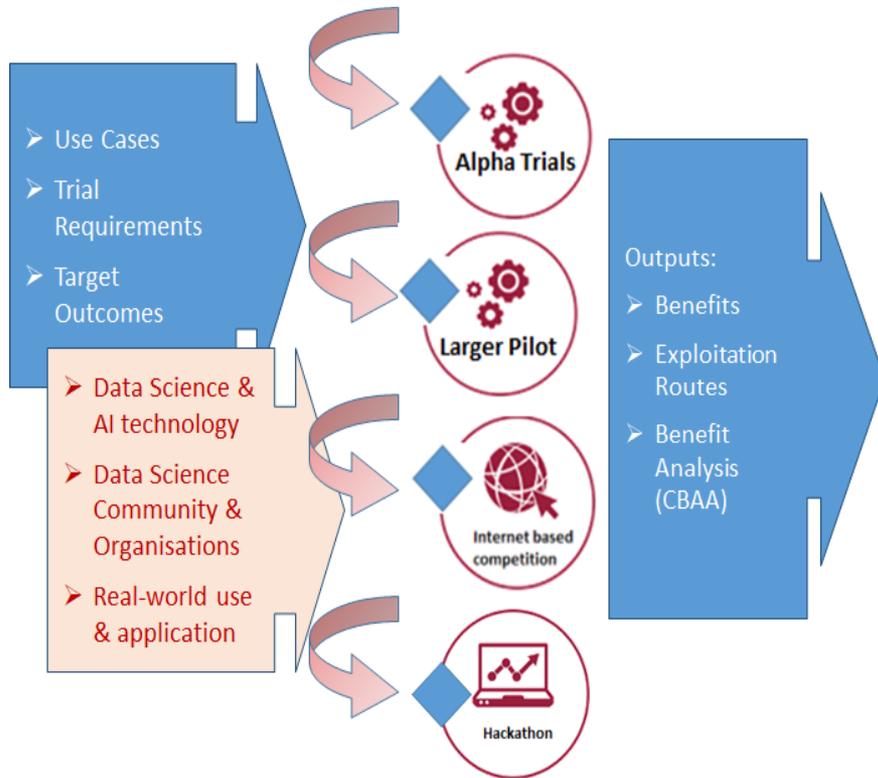
- Insights from Domain expertise key to success
 - Covid-19 travel relaxation enabled face-to-face workshop increasing the DS team knowledge
 - Updates to dashboard to support use by domain experts with less familiarity with data science
- Data spike from 2007 following implementation of a new database
- Adjusted data provided insight into how human factors affected the data, and clear pattern linked to application of KPIs
- The Dashboard enabled:
 - Analysis of individual components over time; periodic nature of the raising and closing of S2022s and how long S2022s are open
 - Analysis across the entire UK surface fleet (those within the data set), a particular type of ship or a specific ship
 - allows for analysis between ships use of S2022 and OpDef reporting
- The recommender algorithm enabled matching S2022s
 - potential to solve/identify S2022 raised in the future more efficiently

These tools combined showed that some S2022s were potentially being reported to the incorrect equipment desk

Future Possibilities

- The dashboard provides ability to rapidly understand trends behind S2022s
- Inclusion and linkage of wider data sets (FMECA, ODMS) will provide for a richer single data source for analysis
- Adaptation of the recommendation algorithm to show the 'distance' between all S2022s, and allow grouping similar S2022s, and use of graph theory techniques.
- Combining common faults/human behaviours with more data sets and time series analysis to allow a Bayesian analysis of component failures eventually leading to identification of predictive maintenance.
 - Support to identify certain component failure modes and provide evidence based reviews of FMECA and RCM
 - Facilitate intelligently direct S2022s to multiple, equipment desks for investigation, rather than the one which corresponds to the component list (current process), allowing for prompt resolution of a problem
- We identified 4 major conclusions and 10 recommendations for further analysis
- Next steps – additional Alpha Trial

What's Next



- 2nd year of the 3-year programme
- Want to be involved?
 - Hackathon on Sea King helicopters towards end of 2020
 - We are looking for candidate Use Cases (& datasets) to be investigated
- Have an idea?
 - Contact Karen Walker
 - kwalker2@dstl.gov.uk
- Want to be involved in delivery of the Alpha Trials?
 - Contact Alison Jordan
 - alison.jordan@cgi.com

Thank you

Questions?

