Brushing off Old Data

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What I'm talking about today

The last 58 years

1961
US drug company Block Drug launches Sensodyne Original, with strontium, the first desensitising toothpaste

1960s
Sensodyne Mint toothpaste launches with improved flavour

1970s
First formulations with potassium nitrate launch with a range of gentle toothbrushes

1970s
Sensodyne F, the first variant containing fluoride launches

1980s
Sensodyne launches Total Care F providing gum protection and sensitivity relief

2008
Sensodyne launches in India & China

2007
Sensodyne Iso-Active, the world's first gel-to-foam sensitivity toothpaste launches

2006
Sensodyne launches Pronamel, with an optimised fluoride formulation to help protect against acid erosion

2004
Sensodyne launches its first dentist testimonial TV advertising

2001
GSK acquires Block Drug and the Sensodyne business

2009
GSK acquires NovaMin®, a next generation active ingredient which helps repair sensitive teeth

2010
Sensodyne Rapid Relief launches offering relief in 60 seconds

2011
Sensodyne celebrates 50 years launching Repair & Protect with NovaMin® and fluoride, a toothpaste that can actually repair sensitive teeth

2013
Sensodyne Complete Protection launches, with 7 specially designed benefits in one sensitivity toothpaste

2014
Sensodyne True White launches, offering a breakthrough in whitening for sensitive teeth

2019
Sensodyne Sensitivity & Gum launches addressing 50% sufferers with both conditions

2018
Sensodyne wins Marketing Society of the Year Grand Prix and Euro Effies awards for advertising effectiveness.

2017
Sensodyne relaunches Rapid Relief, based on a superior stannous fluoride formulation

2016
Sensodyne becomes GSK's 1st
£1 billion
Consumer Healthcare Brand

2015
Sensodyne launches a mouthwash containing potassium, to protect sensitive teeth

Manufacturing Overview

Challenges & Opportunities

– Regulated industry

  – In many markets Sensodyne is regulated akin to a medicine

  – Change and experimentation is difficult

– Batch processes

  – Many isolated data sources

  – Never exactly the same day – day

  – Many interconnected steps
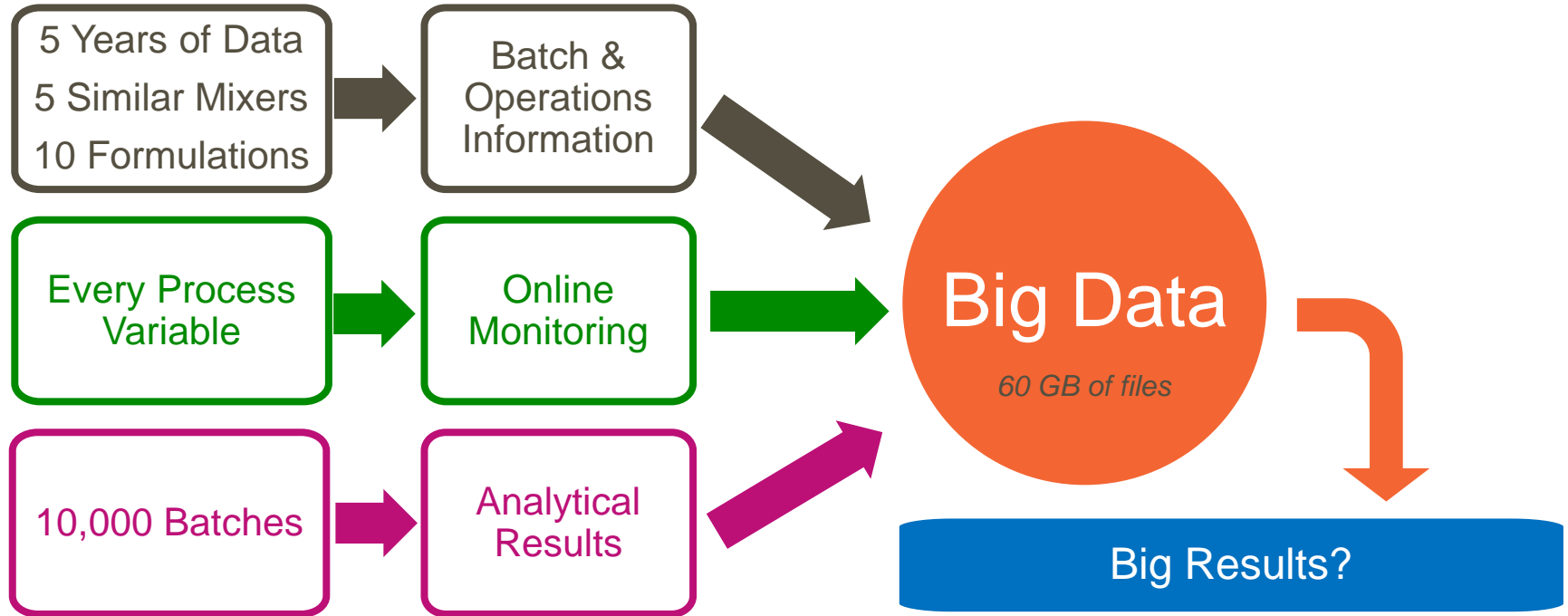
Can we learn from our history to make better products?
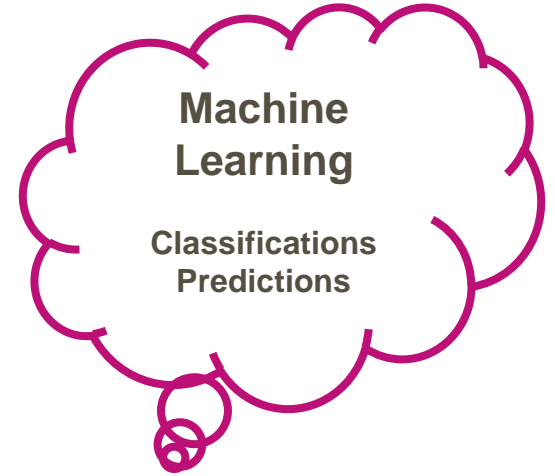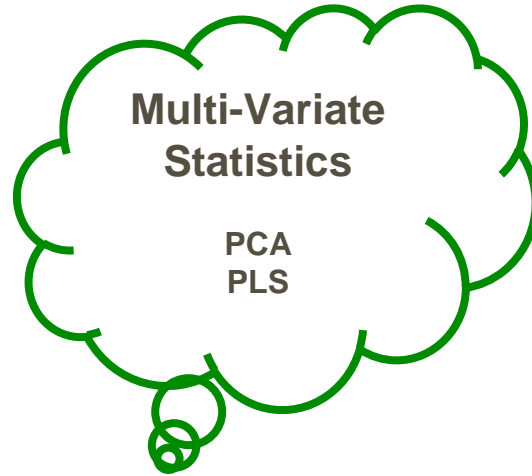
Big Data

What does this mean?

What have we got?

5 Years of Data
5 Similar Mixers
10 Formulations

→

Batch & Operations Information

Every Process Variable

→

Online Monitoring

10,000 Batches

→

Analytical Results

Big Data

60 GB of files

Big Results?

What can we do with all this data?

Univariate Statistics

Long term averages, trending, Production Support

Multi-Variate Statistics

PCA
PLS

Machine Learning

Classifications
Predictions

Process Improvement and Understanding

Improved Manufacturing Efficiency & Reduced Cycle Time

Improved R&D → Factory Product Transfer

Why MATLAB?

– Ability to link different data files & formats together

– Quickly iterate code

– Format / library independence

– Commercially supported / maintained

– Easy consulting support

– Build GUI to enable easy observation of data

Quick & easy code development cycles

Excel

Process Historian

Operations Database

MATLAB

Analytical Archive
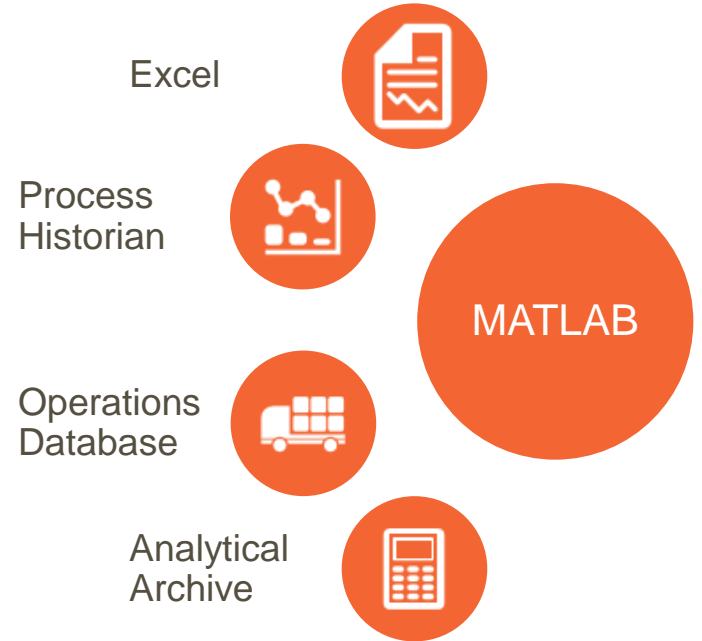
Results

What did we do?

Process Workflow
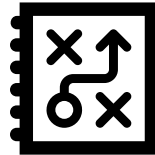
| Cleaning & Context | Phase Separation | Data investigation | Results |

Typical Workflow

Process Workflow

Cleaning & Context

Phase Separation

Data investigation

Results

Data Visualisation

Excel

Process Historian

MATLAB

Operations Database

Analytical Archive

Process Workflow

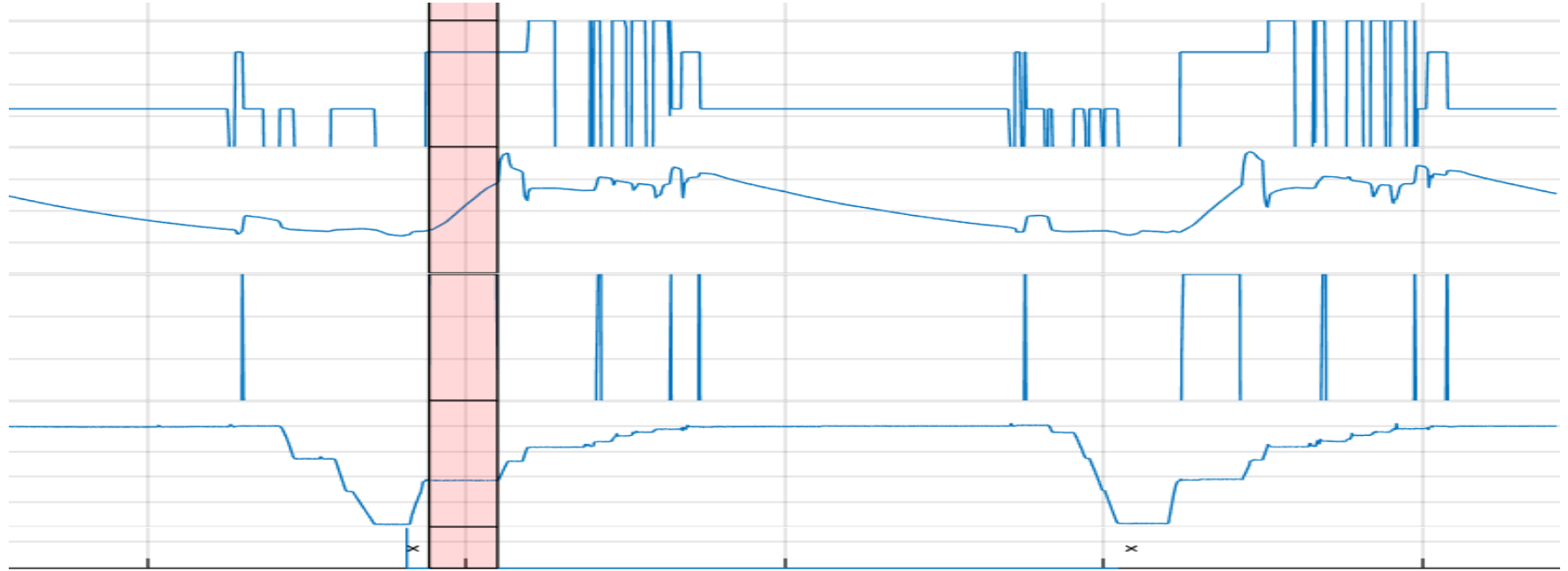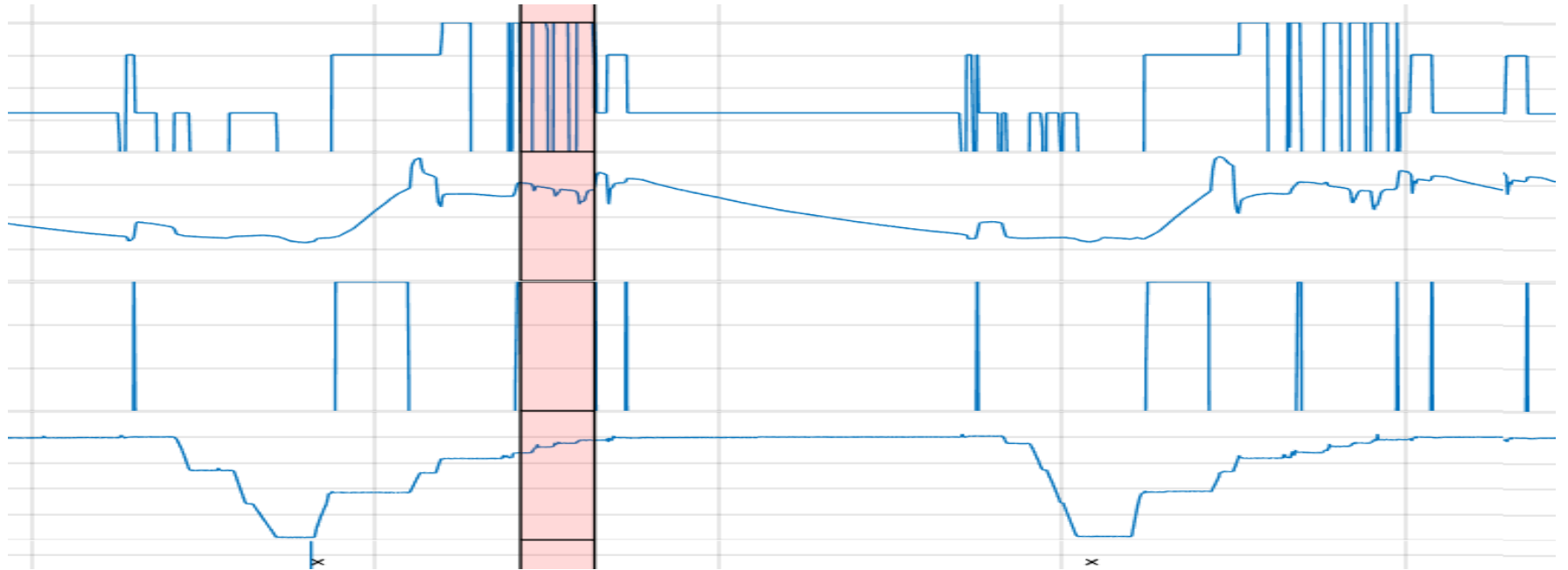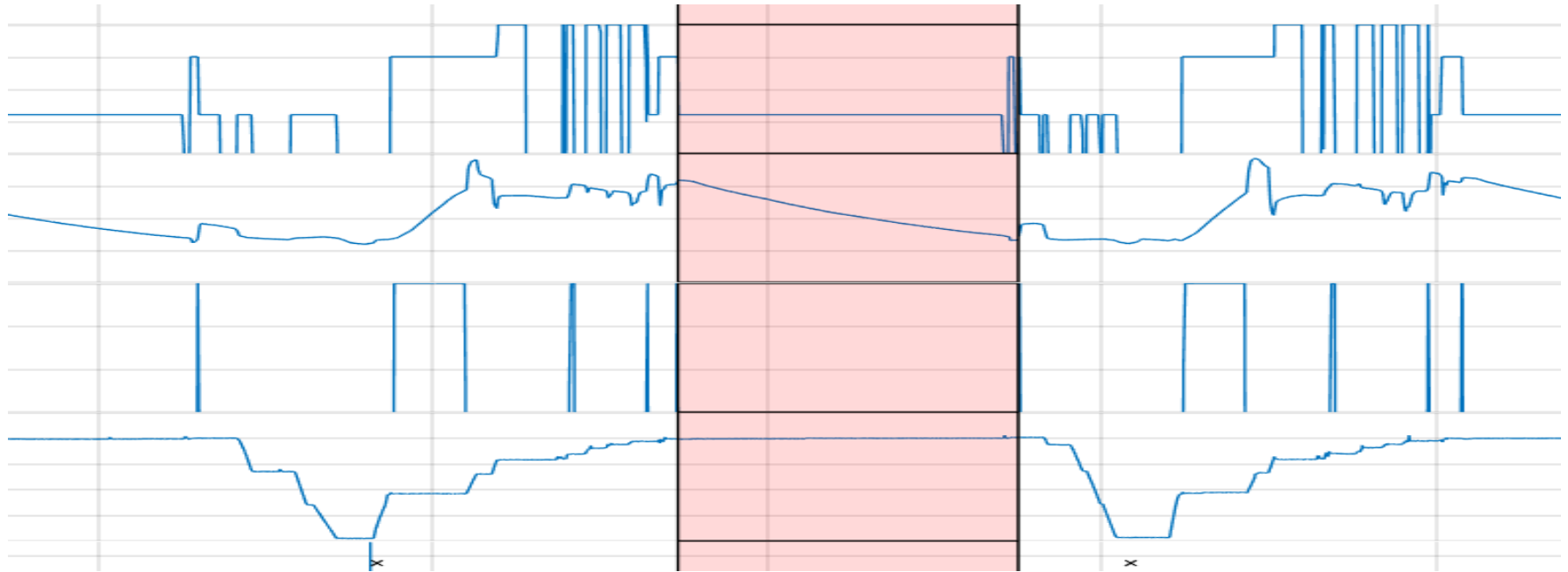| Cleaning & Context	Phase Separation	Data investigation	Results

Typical Batch Trace
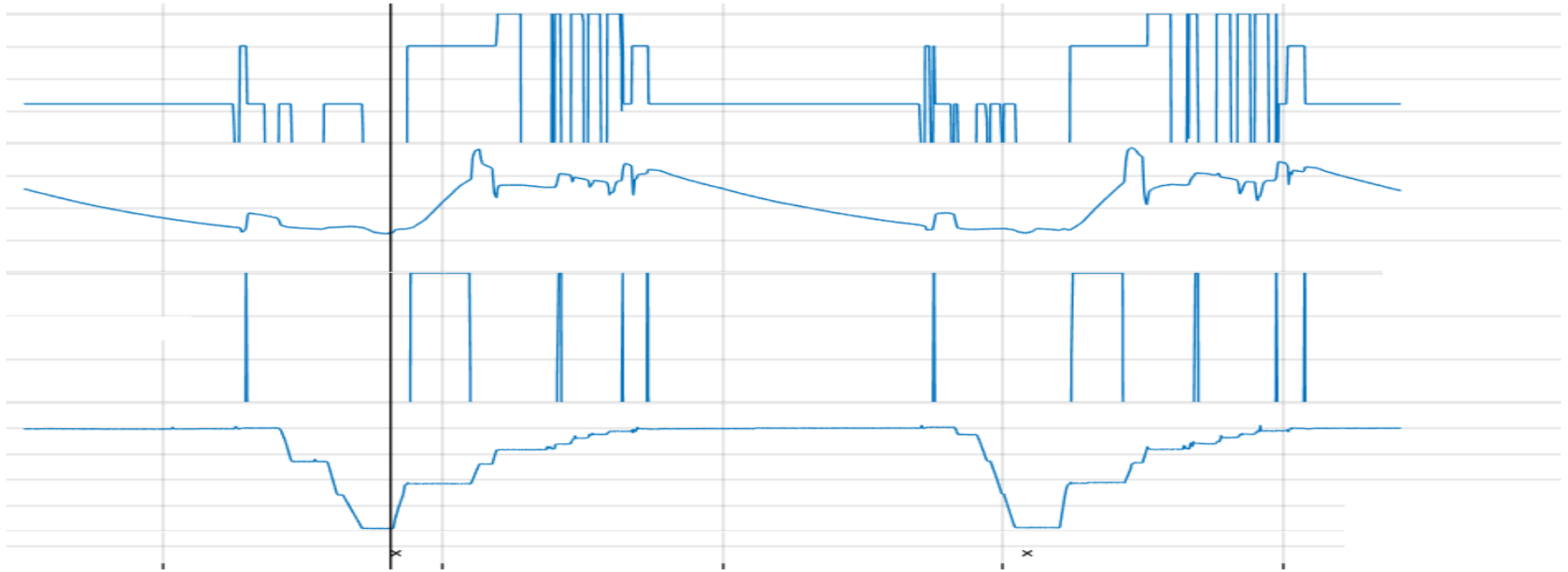
Overall Batch

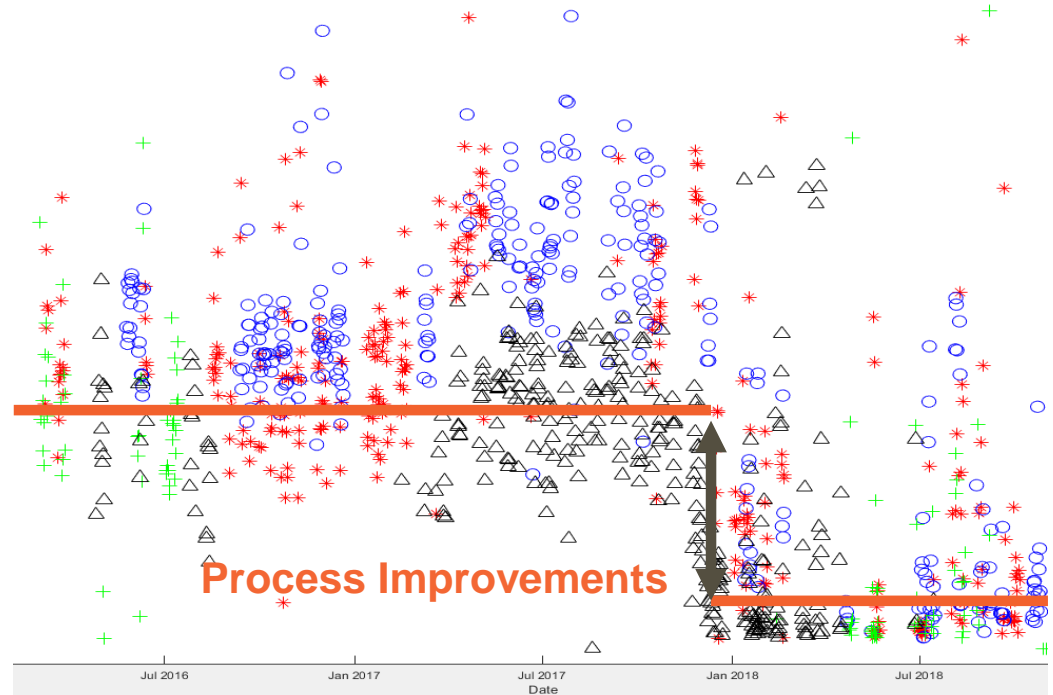# Batch Start-up

Adding Silica

Batch Finishing

Improvements Over Time

Can now **automatically** pick phases out of data and start to ask simple questions:
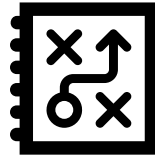
i.e:

  1) Does process time improve over time?

  2) Is processing time mixer dependant?

  3) Do our process improvements work?

Process Improvements

Process Workflow
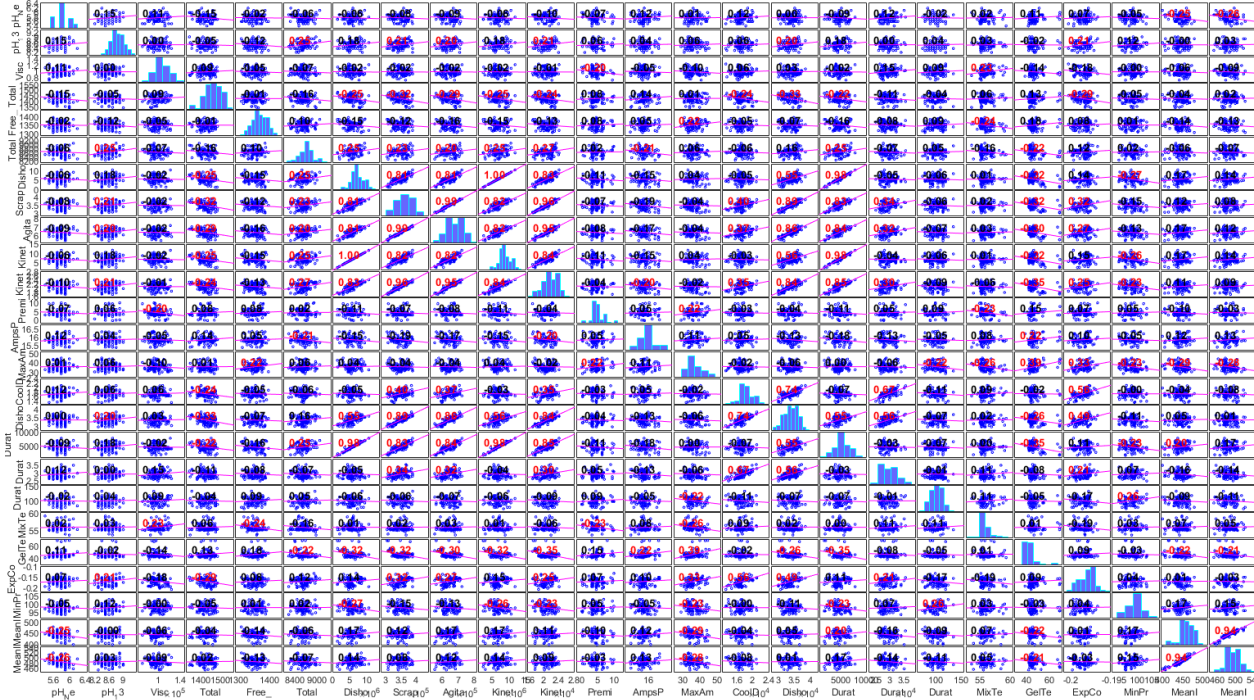

Cleaning & Context

Phase Separation

Data investigation
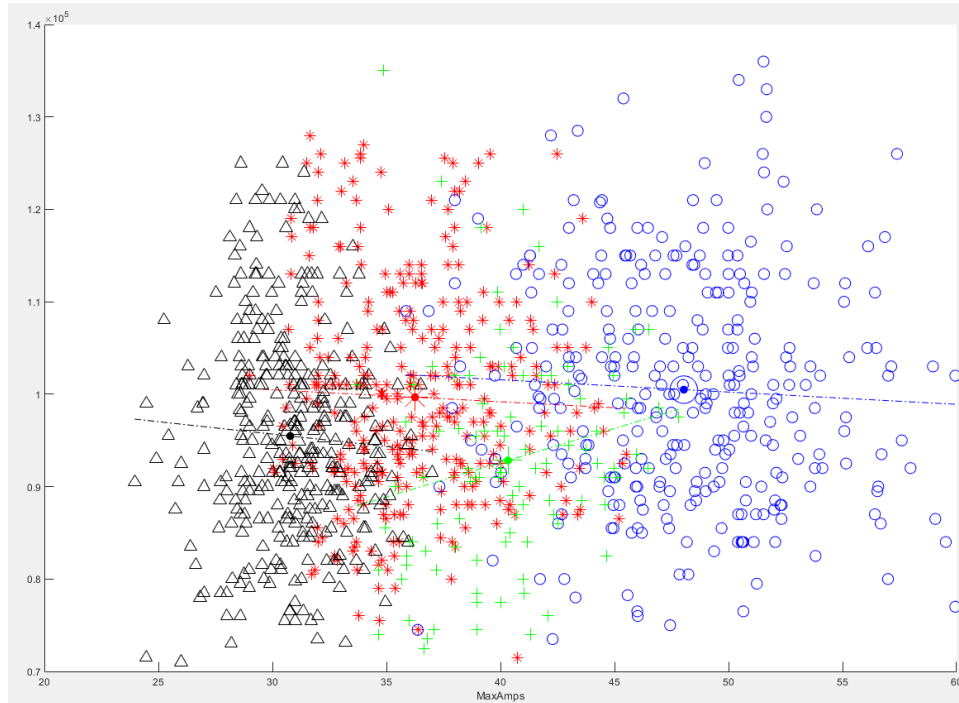
Results

Linear Correlations

Too much Data to easily see!

Can see relationships in the data

Needs further understanding

Linking Manufacturing Phases to Analytical Data

- – Can link final batch properties to the batch to each phase of the data

- – Not all mixers perform the same
  - – Confirms our operator reports

Process Workflow
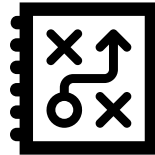
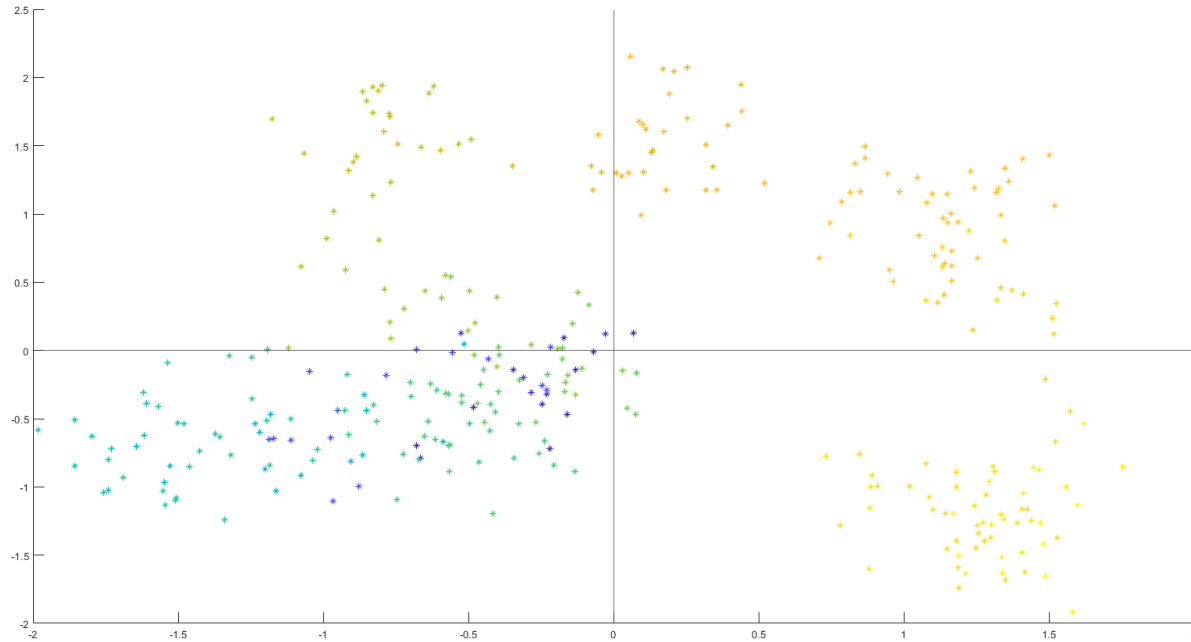Cleaning & Context ✓

Phase Separation ✓

Data investigation ✓

Results

Multivariate Understanding

Process Workflow
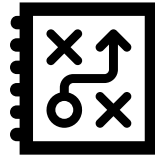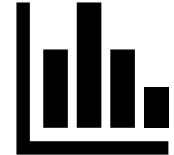
Cleaning & Context	Phase Separation	Data investigation	Results

What have we done?

- We had / have a lot of data that is very siloed, in many different systems

- We finally have a way to match all Batch, Process & Analytical information together.
  - Can only get better as systems progresses in GSK

- We can reliably deduce information about phasing and performance of the mixers, without human intervention.
  - Reduce time and error processing, easier conclusions.
  - Can do this across formulations, mixers (& years)
  - **We can now ask for conclusions in process data – i.e. does "this" effect "that"?**
  - Every growing as our factories make more batches!

What have we learnt?

- **Not all our variability is random**
  - For example different mixers seem more important than different processing times
  - More inputs will likely make better models, but never going to be perfect

- **Big Data is not a panacea!** – It will not immediately solve all our problems

- **We still have to do experiments to generate understanding**
  - Machine Learning / Multivariate Statistics can't replace science.

- **Allows us to guide experiments to examine impacts of input variables.**

Thank You For Listening

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Points to Ponder

However: There are no SIMPLE easy correlations in the data

1. We might not have enough data:

   Is there enough data here? – we only have 200 – 300 data points per batch

2. It might not vary enough to make clear versions of truth

   Because of GMP / Factory nature of data i.e. mixer speeds seem mostly similar between batches

3. We might not be measuring the right thing

   Our test methods don't exactly detect what we're looking for. Viscosity vs Rheology for example