The use of high throughput experimentation to accelerate decorative coatings research

26th April 2017

AkzoNobel

Brief Introduction to AkzoNobel

2008
Akzo Nobel acquired ICI and changed its name to AkzoNobel

1969
Akzo formed following the merger of Dutch companies AKU and KZO

1998
UK company Courtaulds, whose products include hi-tech industrial coatings, acquired by Akzo Nobel

1871
KemaNobel established in Sweden. Later, in 1984, KemaNobel merged with Bofors to form Nobel Industries, which in turn was acquired by Akzo in 1994 to create Akzo Nobel

1895
Alfred Nobel founded Elektrokemiska Aktiebolaget, known as Eka. Today, Eka is part of our Pulp and Performance Chemicals business

1792
Painter and decorator Wiert Willem started making Sikkens lacquers in Dutch town of Groningen

1646
Bofors forge founded in Sweden

AkzoNobel
- Performance Coatings
- Speciality Chemicals
- Decorative Paints

AkzoNobel

Brief Introduction to AkzoNobel

€14.6 billion in revenue

47,000 employees

200+ production sites

80+ countries

Key regions by revenue

North America 15%

Mature Europe 38%

Asia Pacific 25%

Latin America 11%

Emerging Europe 8%

Other countries 3%

Revenue by Business Area

Decorative Paints	28%
Performance Coatings	38%
Specialty Chemicals	34%
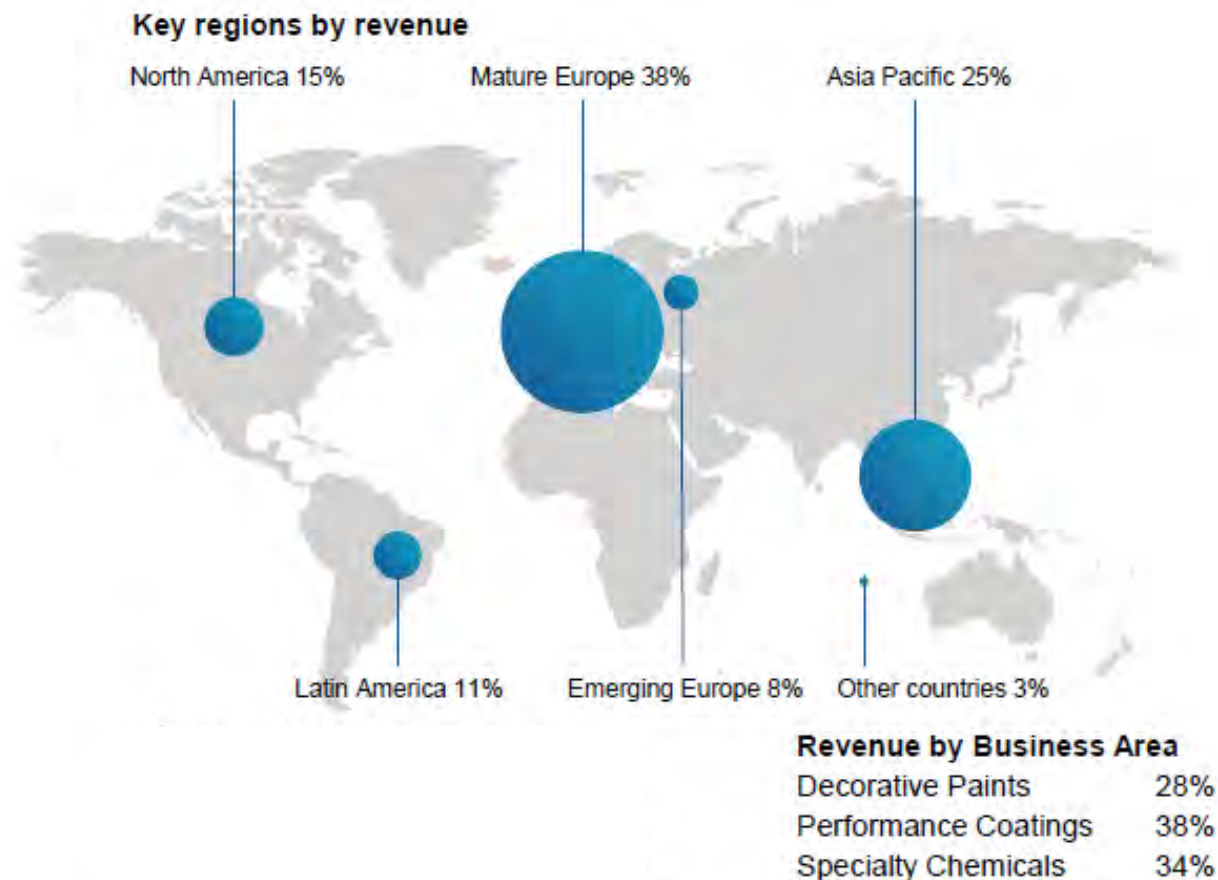
Brief Introduction into AkzoNobel

Decorative Paints
"Essential Color"

Who am I?

- Chris Lampard

- 25 years with the former ICI paints then AkzoNobel

- Originally a polymer research scientist

- 3 and a half years ago opportunity to move to leading the High Throughput Experimentation Team

- Lead a team of scientists and engineers in supporting suite of robotics that prepare and test coatings for Decorative Paints

Our Strategic Ambition & Enabling Pillars

Our Strategic Ambition for HTE and Data & Knowledge Management

AkzoNobel

'To **enable** our global colleagues to identify and implement

value adding formulation and technology solutions,

Ambition

Enabling Pillars

Roadmap
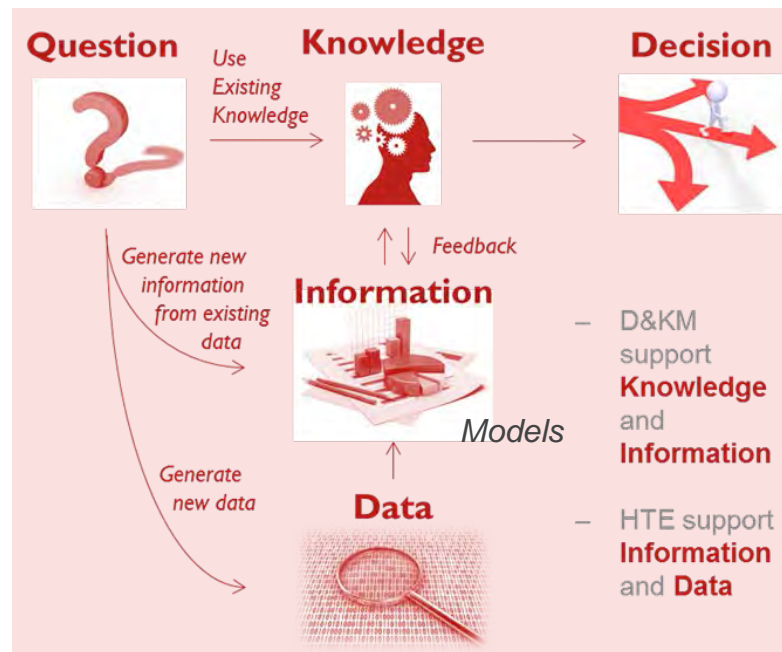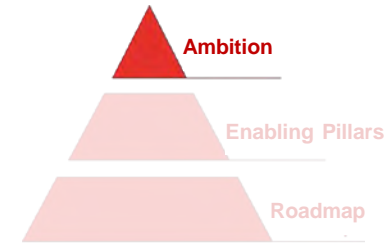
made by our Customers:

Global Technology Programs
Regional PDCs & LTS

facilitated by

industry-leading HTE capability

and

the **(re-)use of collective data & knowledge**

to allow **data-driven decisions** to be made,

fully integrated in & **accelerating** project workflows.

AkzoNobel

Enabling Pillars to deliver our Ambition

High Throughput Experimentation – Paints & Polymers

To establish an industry leading HTE facility by:

- *continuous improvement of existing systems and processes,*
- *enhancing our current capability,*
- *development and implementation of new test methods and*
- *scoping for new system opportunities & implementation.*
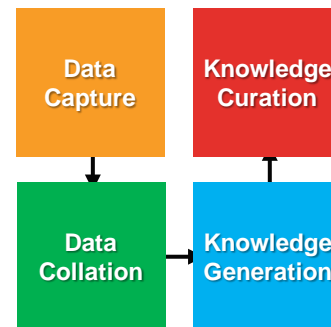
Enabling Pillars for HTE

Continuous improvement	Scoping new systems
Enhancing Capability	Implementing new test methods

Ambition

Enabling Pillars

Roadmap
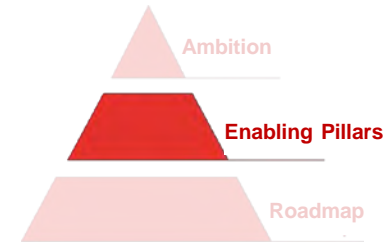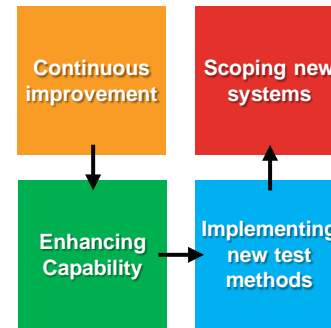
Data & Knowledge Management

To develop tools and software to:

- *capture data as it is generated,*
- *collate data into relevant groupings,*
- *support the generation of knowledge and*
- *promote and facilitate the re-utilisation of data and knowledge.*

which will facilitate the (re-)use of collective data & knowledge.

Enabling Pillars for Data & Knowledge Management

|	
Data Capture	Knowledge Curation
Data Collation	Knowledge Generation

High Throughput & Lab Automation
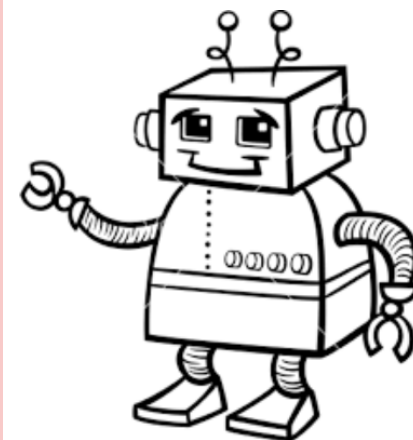## Benefits for our chemists & scientists

Lab Automation to free up creative & analytic brain power of our chemists & scientists

Create innovative ideas, hypothesis and question generation, being creative, design DoEs

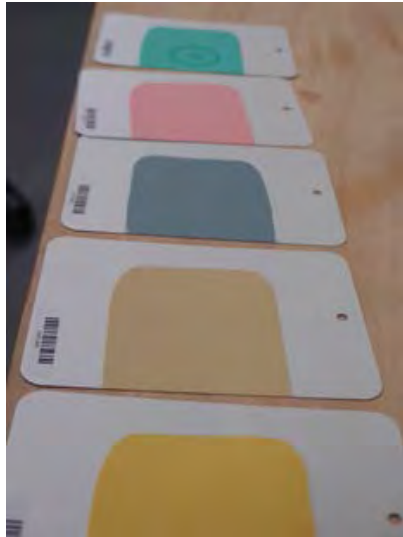**Let automation do the tedious, repetitive, time-consuming & error-prone laboratory tasks**
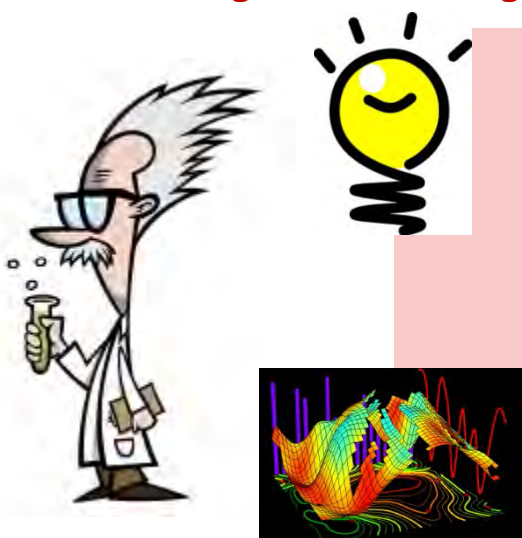
Project workflow

Data analysis, mining & visualisation Identify innovation solutions

Automated formulation & performance data capture

Example 1 – Freeing resources
Experimental project 1

50-100 samples are run in accelerated exposure machines at a time.

Test panels are traditionally handmade in the laboratory and a typical scientist can apply paint to approximately 12 panels per hour. 1 run therefore requires up to 9 (very boring!) hours for a scientist to just make the panels.

By using HTE, 30 mins to 1 hour is spent in preparing the samples and setting the system running, leaving 8 hours of time to do other value-added work.

For this project, approximately 2000 samples have been prepared over a 12 month period. This has saved almost 18 days or nearly 1 working month of a scientist's time.

Our Formulation Science Journey so far

Situation at the start of our journey

R&D groups were...
- Formulating
- Optimising
- Scoping RMs
- Benchmarking
- Innovating

- **Solely focussed on their local market**
- **Lots of repetition across R&D groups**
- **Complex RM & product portfolio**
- **No ability to share & repeat**
- **Not efficient, no scale advantage**
- **Individual stamp on formulations**

R&D — Market
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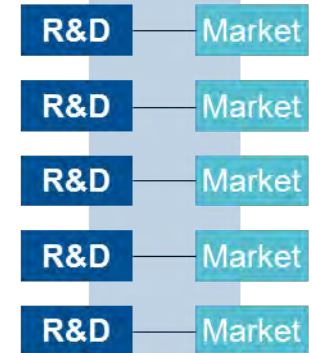
However, our local markets have similar needs.

So, there was a need and a benefit to move

- to a global and sharable approach to formulation design

- from an 'art-driven' to a formulation science & data driven product development approach
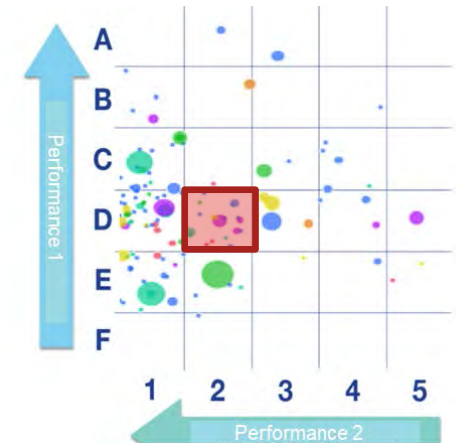
Market (R&D)

Our Formulation Science Journey so far

- To move from **local & 'art-driven'** to a more **global & 'data-driven'** formulation science and product development approach:
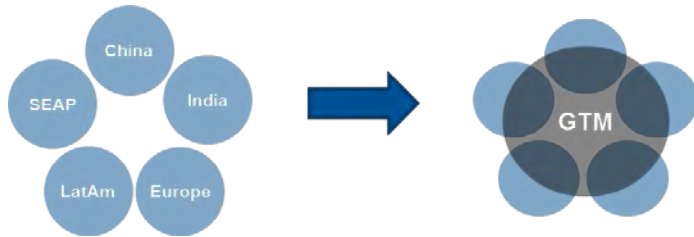
Defined set of standardised tests with global applicability.

Product performance mapping and clustering.
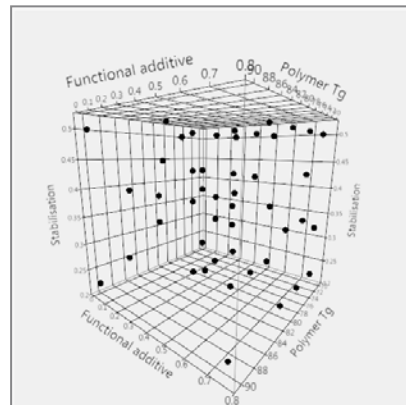
Models:
- defined formulating approaches
- raw material types & ranges

Our Formulation Science Journey so far

Pigment
Binder
Humectant
Extender
Solvent
Additives
Colorant

Structured approach to formulating & mapping formulation space.

Use of Design of Experiment (DoE) to build broad & focus models and optimisation experiments.
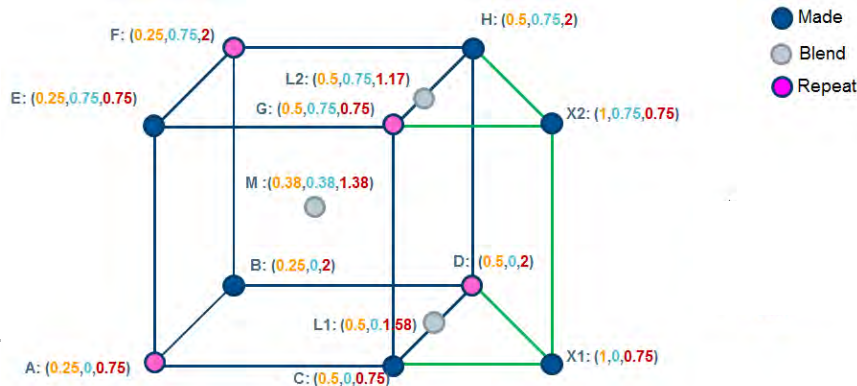
Broad Model	Focus Model	Optimisation
200 +	20 - 100	5 - 20
Understanding technologies	Understanding performance space	Optimising products

Traditional methods to carry out this experimental Programme would have taken years – NEEDS robotics

Our Formulation Science Journey so far

HTE capability to speed up delivery of structured experimentation in consistent manner.
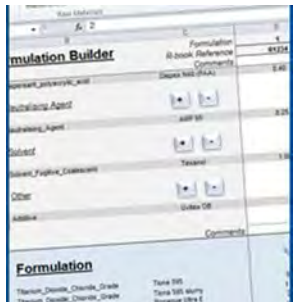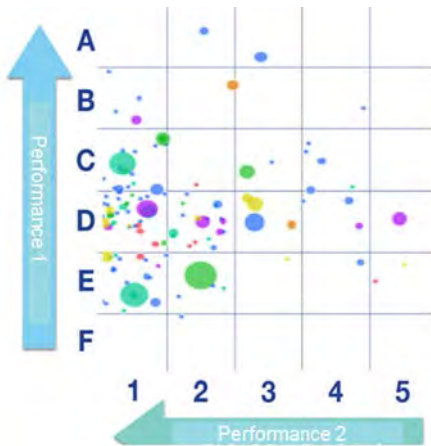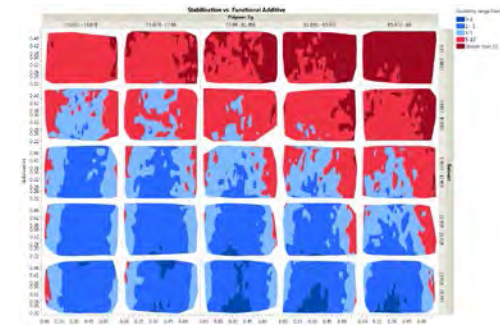
Our Formulation Science Journey so far

Formulating Software to drive consistency in formulation science

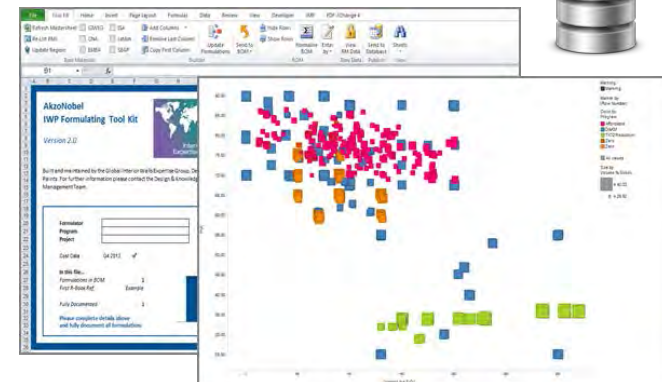Single click from formulation to HTE input file

Visualization tools to turn data into knowledge

Product maps built for 80% of Global Volume

Formulation Database available

Tools to support Share, Adapt, Invent.

SHARE

ADAPT

INVENT

Example 2 – Targeted model development for a specific region

- Model designed with help from UK teams

- Local raw materials sent from China to the UK

- Spent 3 weeks HTE time making ~ 500 model paints followed by 3 additional weeks of automated preparation of ~1500 panels and testing – 6 weeks in total

- By modelling and optimizing formulations, substantial saving in raw materials cost with no performance hit

- Several product upgrade opportunities found

Example 3 – Performance confidence

- New plant being commissioned in Ashington – NE England

- Entire Garden Shades colour palette produced on HTE using actual Ashington intermediates

- 1 week of HTE time in making and measuring paints and panels

- Gave confidence in selecting right recipe to deliver correct color

- Would not have been able to complete in the lab due to timescale

Example 4 –
Model Augmentation

New Raw Materials – For new marketable properties
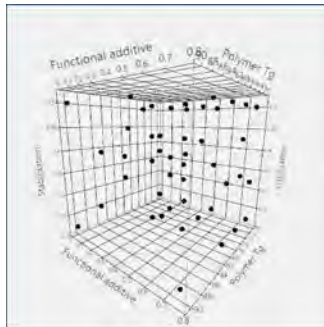
- Suppliers continually innovate to produce new chemicals and intermediates to give new properties

  - Our database now contains many thousands of formulations and associated performance data

  - Full screening of a new raw material previously could take hundreds of formulations to evaluate in a range of product types

- As the data is reliable and captured in a reproducible format, we can now augment existing models and can get the same information in 10s of formulations

Summary & The Future

Summary and the future
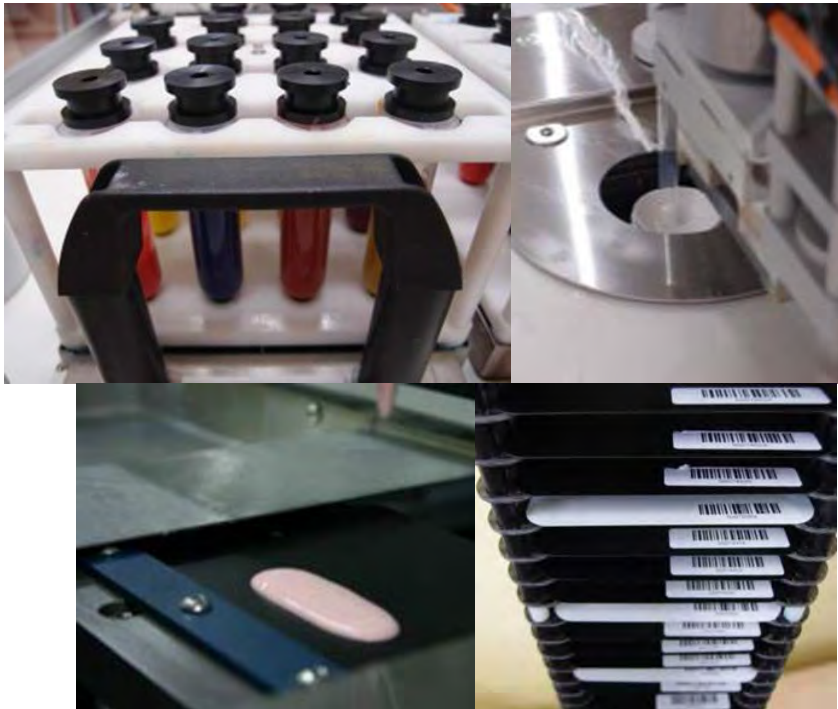
- **Robotics and Automation have transformed the way we work at AkzoNobel**

  - Speed

  - Consistency

  - Culturally

  - Enabled data capture and modelling on scale impossible without robotics

- **The Future**

  - More automation

  - More training and support

  - More tools to interpret data

    – Danger – becomes a black box

  - More reuse of data

Thanks for your attention