



DoE APPROACHED DIFFERENTLY

MAKING EVERY EXPERIMENT COUNT
IN PILOT PLANTS

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“THINKING IS ONE OF THE MOST IMPORTANT WEAPONS IN DEALING WITH PROBLEMS”,
NELSON MANDELA (1918-2013)



Source: <http://www.apartheidmuseum.org>

DESIRE FOR DESIGN OF EXPERIMENTS



Design of Experiments is:

- » Structured
- » Efficient

Design of Experiments

- » Analysis

“The basic idea of Design of Experiments is to ensure that the Research Questions you have can be answered – with a minimum effort – by the results of the experiments you do.”

Design of Experiments desires:

- » Good preparation
- » Good software tool(s)

EXPERIMENTING IN UNILEVER GLOBAL



R&D

Pilot Plant

Factory

Costs per experiment

\$\$

\$\$\$\$\$\$\$

Number of experiments

High

Low

Desire for DoE

High

Low

Statistical knowledge & support

High

Low

INTRODUCING DoE IN PILOT PLANTS



Challenges:

- » 40+ pilot plants, 500+ colleagues
- » Statistics is “not their cup of tea”
- » Possible lack of knowledge
 - Many DoE’s available
 - Analysis techniques
 - Interpretation of results

Possible solutions:

- » Detailed training
- » Increase statistical support
- » Force the use of DoE
- » Simplify the process of applying DoE



SIMPLIFIED PROCESS OF APPLYING DoE IN PILOT PLANTS



Avoid statistically language:

- » About type of DoE
- » About analysis techniques

Focus on what information is required & knowledge they have

Help at every stage of setting up DoE & analysis

Forced decisions:

- » Output of one design
- » Predefined set of analysis techniques

HELPING HAND: “PLYOS” SOFTWARE TOOL



Plyos tool (globally available within Unilever):

- » Runs in JMP
- » Collects known information (responses, factors)
- » Q&A for additional information (context sensitive)
- » Explains every step and communicates decisions
- » Checks input and suggests improvements based on Unilever constraints
- » Supplies efficient DoE
- » Analyses experimental data
- » Helps in interpreting statistical results

FLOW OF PLYOS

Start

Responses

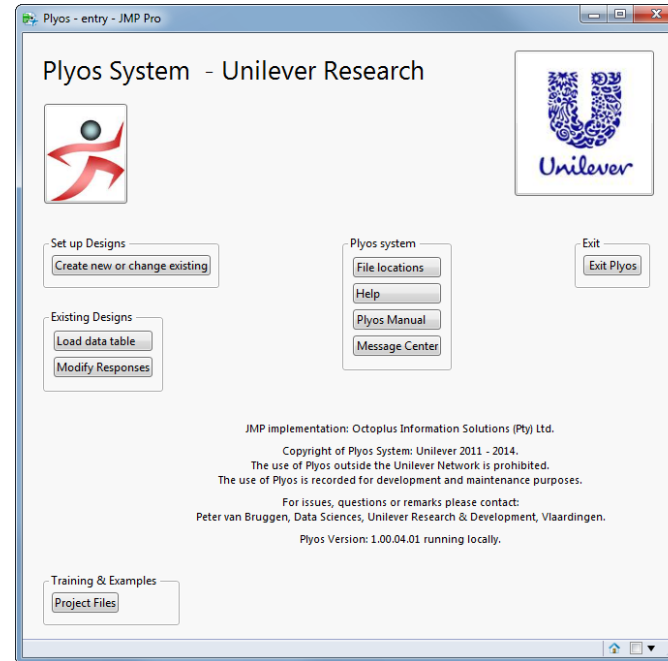
Factors

Q&A

Decisions & consequences

Ready to use design of experiments

Analysis of results



FLOW OF PLYOS



Start

Responses

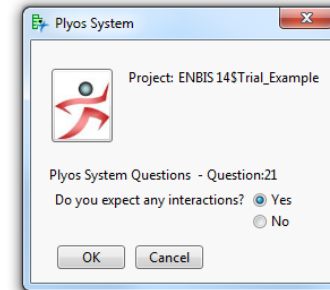
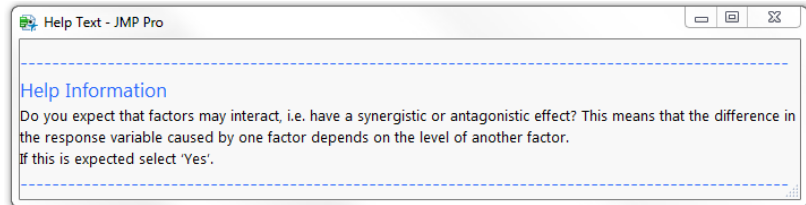
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FLOW OF PLYOS



Start

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Analysis of results

	Ingredient A	Ingredient B	Mixer Type	Mixing speed	Processing speed	Viscosity	Taste#1	Taste#2	Storage Stability#1	Storage Stability#2	Stevens
1	10	20	Mixer P	10000	High						
2	5	30	Mixer P	10000	High						
3	10	30	Mixer P	10000	High						
4	5	30	Mixer P	10000	Slow						
5	10	30	Mixer P	15000	High						
6	5	20	Mixer P	15000	Slow						
7	5	20	Mixer P	10000	Slow						
8	5	20	Mixer P	10000	High						
9	10	20	Mixer P	15000	High						
10	5	30	Mixer P	15000	High						
11	5	30	Mixer P	15000	Slow						
12	10	30	Mixer P	10000	Slow						
13	5	20	Mixer P	15000	High						
14	10	20	Mixer P	15000	Slow						
15	10	30	Mixer Q	10000	High						
16	5	30	Mixer Q	10000	Slow						
17	5	30	Mixer Q	10000	High						
18	5	20	Mixer Q	15000	Slow						
19	10	30	Mixer Q	15000	Slow						
20	5	20	Mixer Q	10000	High						
21	10	20	Mixer Q	15000	High						
22	10	20	Mixer Q	10000	Slow						
23	5	30	Mixer Q	15000	High						
24	5	20	Mixer Q	10000	Slow						

Help Information

This is a modelling design for 5 factors. You have not provided an external estimate for the error. The design uses 24 runs. As you have indicated that interactions may exist, the design offers the possibility to test for interactions. The p-value for statistical analysis is usually set to 0.05, but factors with p-values slightly above might still be interesting for further investigation.

If you have indicated factor(s) being 'Hard' to change than the design has been randomised using blocks of the hard to change factor(s). Only at this moment you are allowed to interchange the order of these blocks. This could be done by changing the order of the ('Hard to change') factors and/or their levels at input of the factors (you need to restart Plyos and redo this design to do so). Within the blocks the order is random. This order should remain. In all other cases the order of the runs is randomised.

You should execute the runs in the given order. Enter the measured response and save the data.

Chose the red triangle next to "Analyse ..." and select "Run Script" to start the statistical analysis of your response data.

With "Create Other Responses" you can create columns for the remainder of the responses that has been filled previously. With "Analyse Other Responses" these columns can be analysed after data has been filled.

FLOW OF PLYOS



Start

Responses

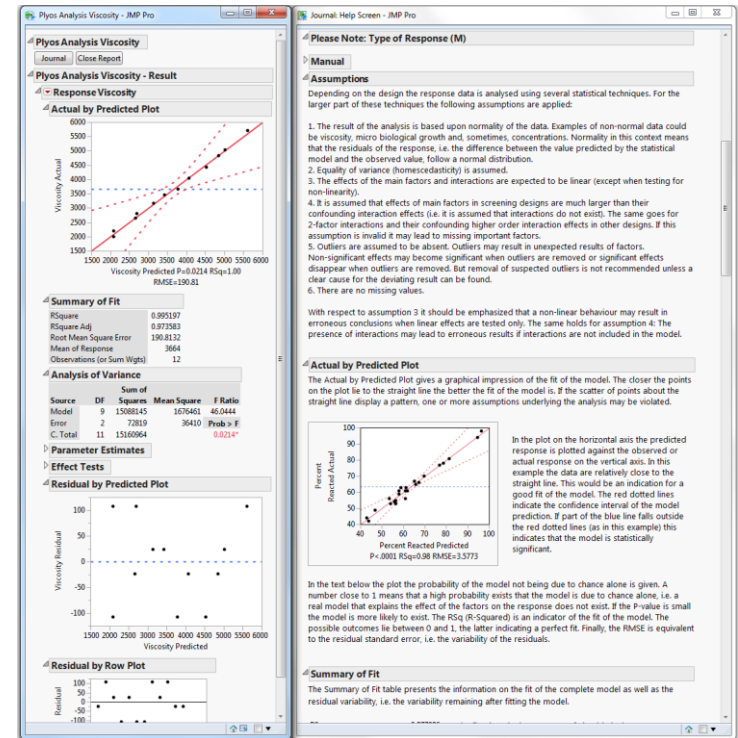
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DEVELOPMENT CHALLENGES



Major challenges/problems during development of Plyos:

- » How to assure the correct design as output?
- » How to create the design?
- » How to present the right help at the right stage?

Some minor challenges:

- » JMP language issues
- » JMP default setting issues
- » JMP version issues

DEVELOPMENT: HOW TO ASSURE THE CORRECT DESIGN



Problem:

- » What design would be needed?
- » Could we describe the constraints?

Decision:

- » Driven by expert knowledge we defined over 280 different situations with specific demands.

Solution:

- » Creation of a table with demands/constraints per design (the “Backbone”).

DEVELOPMENT: HOW TO CREATE THE DESIGN



Problem:

- » Use of classical designs (no Custom Design).
- » Not showing the JMP DoE dialogue panels.

Decision:

- » Create designs manually.

Solution:

- » Use of nested loop procedures.
- » Data table with coded designs for other designs.

DEVELOPMENT: RIGHT HELP AT RIGHT STAGE



Problem:

- » Help for DoE set up process, the use of the tool, (forced) decisions by the tool, design data tables and analysis techniques.
- » Easy maintenance.

Decision:

- » Store help text in different sources.

Solution:

- » Some in scripts, most in data tables, description of analysis techniques in a journal.

DEVELOPMENT: MINOR CHALLENGES



JMP language issues:

- » Test on language at start of Plyos.

JMP default setting issues:

- » No solution found.
- » Warnings in help text.

JMP version issues:

- » Separate subroutines build for JMP9 & JMP11.
- » No longer an issue (all uses JMP11).

ROLL OUT OF PLYOS



Use of Plyos is self-explanatory:

- » Guided manual
- » Additional procedures available

The use of Plyos is also part of a training:

- » Minor background of DoE
- » Practising the use of Plyos
- » Focus on preparation to set up DoE:
 - “Think Hard Before You Start”

USER STATISTICS (2012-2014)



Worldwide availability

- » 20+ countries

500+ registered users

- » ~100 “hard core” users

Creation of DoE for 600+ business cases started in Plyos

- » Plyos delivered DoE in ~95% of the cases
- » ~5% needed input of a statistician

Supported by senior management

CONCLUSION



Simplification of the DoE process seems to be successful.

» First time users react positive:

- “... I found it easy to play with as a beginner even without the manual. The interface is user-friendly. ... I was clearly guided by the system to reach the final step. ...”
(S.Wang, China).

» Questions we receive are primarily on design details not on tool details:

- E.g. about differences between continuous, ordinal, nominal or interactions.

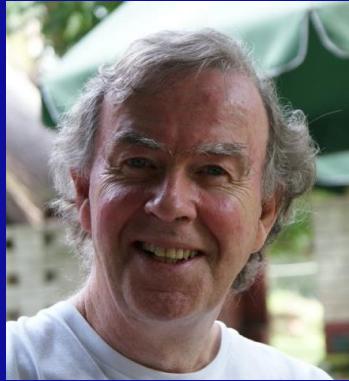
Possible lack of attraction to the DoE technique remains a concern. It is improving in time.

“Think Hard Before You Start” approach is beneficial.

THANKS TO A FANTASTIC TEAM



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**Thank You
Questions?**

Plyos