# Case study
# 3M Deutschland GmbH



## Predictive Analytics and Simulation for Continuous Improvement and Quality Management

Both the digitization of process and quality data as well as their processing for the purpose of process optimization and efficiency of product and process development in the context of "Industry 4.0" or "IoT = Internet of Things" are usually important core elements in every corporate strategy. One aspect of establishing these core elements is the acceptance and the overall data culture in the company.

While the associated technical capabilities, especially machine learning tools (ML) or artificial intelligence-based algorithms (AI), are being introduced and expanded across industries at seemingly breakneck speed, we (the 3M Company) also use both commercial software tools and proprietary self-developed tools with the following goals: On the one hand, we are driving digitization itself forward ("digital transformation"), on the other hand, to increasingly use the data available in digital form to gain the knowledge that is decisive for success, to enrich knowledge and thus to obtain an improved process understanding of supposedly proven and new processes.

We are convinced that every successful data-driven problem solution follows the principles of a structured project roadmap, as described, for example, by the classic QM approach, the PDCA cycle, or the DMAIC method (Six Sigma) or the variant specially developed for data analysis, the CRISP method.

Within such a structured project-oriented approach, we have been using ClearVu Analytics for about 6 years: It supports us in many ways due to the flexible possibilities in EDA (exploratory data analysis), data cleansing as well as in the planning and design of experiments and the extraordinary modeling and simulation possibilities for the investigation of the predicted parameter space.

Data-driven decisions accompanied by risk-based methods are traditionally part of 3M's business processes and, in addition to the continuous optimization of manufacturing processes, also include processes in business planning, inventory management, and of course innovative approaches in product development and application technology. Data science and analytics play an important role at every stage of our value streams to gain a sound, customer-centric understanding of our products and processes in line with the company's strategy.

Our focus of ClearVu Analytics applications is on R&D, process engineering and manufacturing technology. On site, we support the creation and optimization of formulations and experiments on a laboratory scale. On the other hand, we use pre-scaled and controlled multifactorial DOE's to optimize existing manufacturing processes.

Typical applications are often motivated by recurring problem areas that result in rejects or unplanned line downtimes. These include, for example, web breaks in the production of jumbos, disturbances in pumping and processing of viscous media due to raw material influences, or aging effects in chemical plant components, which at some point lead to an interruption of continuous operation or adversely affect the efficiency. Another field of application is the increasing need to save costs in energy-intensive processes. It makes sense to define projects that aim to increase the ratio of output to energy input.

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Statistics Advisor and Coach as independent first contact to support internal multidisciplinary project teams or individual engineers to achieve data driven solutions or improvements for all types of business process steadily driven by Customer Requirements and passion for statistical problem-solving methods. 33 y experience in Quality, and Product Engineering & Development as well development of Quality Management Systems. Study graduation in Physics from the Heinrich-Heine University Düsseldorf.

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In some cases, functional errors in the process can be detected by uncalibrated sensor devices or unfavorable settings within process control limits that are not immediately recognizable on site at shop floor level or on the machine itself. An inestimable value therefore lies in the avoidance or detection of previously undetected deficiencies or weaknesses and thus in the avoidance of waste of money, which is a priori difficult to measure by nature, at best estimable.

In the case of typically existing multivariate structured, mostly historical data, ClearVu Analytics offers very efficient tools to reduce the multidimensional workspace to a clearly manageable set of parameters. These provide the basis for further planned experiments to dive into in the actual mechanisms of the process.

Once a prediction of new target settings is possible after validating the proposed model, we can "play" with the factor settings to evaluate the sensitivity and graphically explore the process or design space (Sensitivity Analysis).

ClearVu Analytics offers us a real advantage with the calculation of a ttheoretical optimum, or in the case of a multi-factorial and competing optimization scenario, a so-called "Pareto frontier". In simple terms, the algorithm provides us with several solution scenarios that best match the previously defined goal.

At this point, it is up to the process experts to decide whether another experiment should verify these predictions, or whether the evidence derived here should be taken up to create a new and improved DOE. Above all, however, the decision is supported by data, which leads to a more efficient approach and thus to reduced experimental and project costs.

One of the main strengths of ClearVu Analytics becomes apparent now: Without the built-in mechanisms of data mining and the automated comparison of several solution approaches (model types), the traditional application of "only" classical regression modeling methods, which are associated with the usual risks of overfitting or bias due to covariances of input factors, would take much more time and experimental costs. In addition, the analysis does not require the deep specialist knowledge of programming languages such as R, Python or similar, a data scientist, to master the model-specific processes of the calculations.

To put it in the words of this data scientist, the model offers a very good bias-variance compromise with correspondingly careful preparation of the data basis using modern ML algorithms.

Regardless of the application, the use of ClearVu Analytics teaches us that a successful data-related improvement project requires a multidisciplinary approach in addition to the methodological knowledge of the data analytics engineer, scientist or statistician involved, which at least includes the stakeholders, the process owner and, above.



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In this context, there is always the demand for financial justification (savings or efficiency or benefits vs. costs) It is not always easy to quantify savings as justification for using external software tools. Such potentials are often hidden as "low-hanging fruits" in an exploratory data analysis, or are revealed by the usual variance analysis methods in statistical quality assurance. Ideally, we consolidate or generate new valuable knowledge in the verification of working hypotheses by conducting and evaluating systematically planned experiments (DOE). The complexity of such potentials can only be grasped and handled by the classic process engineer by using of appropriate software tools. By using the software, we identify these potentials and make them more visible and quantifiable. Thus, due to the results achieved and positive improvements, the software itself also becomes a crucial element in the establishment of a broad data culture in the company.

Finally, we would like to state that ClearVu Analytics occupies a very valuable place in our portfolio of external software tools to enable engineers and teams to handle much more complex tasks even with high data volumes solution-oriented and efficiently, without the need for more specialized programming skills such as in R or Python. This increases our flexibility and enables us to successfully explore and exploit the existing improvement potentials.



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