Increasing innovation through data analytics

Results of a roundtable discussion with scientists and engineers about achieving innovation momentum through data analytics

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WHITE PAPER

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Executive summary

Organisations that demand a high level of product and process innovation are constantly under pressure. They need to uncover hidden insights, drive down costs and get to market faster than the competition, then continually improve products and reduce costs throughout production. With the advent of big data, IoT and Industry 4.0, are organisations taking advantage of the data available to them? Are they using analytics to counteract the challenges they face and drive momentum in a robust and scalable way?

Why change?

According to McKinsey, organizations that lead the way in data analytics are staking out significant advantages – in manufacturing, they achieve up to 50% lower product development costs.[1] So the pressure is on to capitalise on the data that many companies are generating.

Effective R&D and production teams can help increase profit margins, reduce waste, capture market share and outperform the competition. These efforts can also support current strategic initiatives and help businesses meet the demands of customers and shareholders.

What are the challenges?

Embracing data analytics can mean changing how things have always been done and adopting new tools and techniques – which is why transformation is not always a straightforward process. Without best practices in place, there can be ever-increasing stress on the teams responsible for delivering results, especially if those teams are not able to work productively with the data they generate.

Failing to get the right data into the hands of the people who understand it can be a significant barrier to achieving product and process innovation. In some organisations, data scientists are not always experts in the data they are expected to work with. Subject matter experts may not be familiar with the analytics techniques required to investigate the data they generate. This can create tension and inefficiency within a team. Making the cultural shift to embrace data analytics is not always easy.

Even with the right tools and skills for analysis, the next great innovation may be locked in data that is not being investigated. Industry 4.0 means some industries are producing high volumes of data, but many still lack the ability to use it effectively. While this data – the 'hidden factory' – remains inaccessible, organisations may be missing out on the crucial information they need to make developments ahead of the competition.

What can you do?

Having the right tools to connect and analyse large data sets is essential. Data analytics helps to inform the process of data gathering – often highlighting the data you should be collecting – so by starting data analytics sooner and avoiding the paralysis of over-planning, organisations can reap the rewards of analytic insight more rapidly. This approach encourages a culture of 'learning by doing' and motivates scientists and engineers to explore new possibilities.

[1] *McKinsey Global Institute report: The Age of Analytics: Competing in a Data-Driven World*

R&D and production professionals want to improve their personal effectiveness – in short to have the tools and support to do their jobs better. By equipping subject matter experts with the right tools for data analytics, they are more likely to find robust solutions to problems more quickly and be able to communicate these solutions persuasively to colleagues.

Unlocking access to data and providing the tools and support for effective data analysis means innovative industries can empower their R&D and production experts to inform faster decision making, creating the momentum for success.

Introduction

In September 2019, a group of scientists and engineers – business leaders in the world of research and development – gathered to discuss some of the challenges they face in getting to market faster, reducing product costs, and gaining insights more quickly.

The participants shared their experiences working with data to drive innovation and the role of data analytics in delivering value for their organisations.

Despite substantial challenges and internal pressures in their different industries, the members of the discussion group all agreed that data analytics, design of experiments and the ability to visualise and communicate results persuasively are helping them deliver results. By adopting a data-driven, best practice approach, they are helping their organisations to develop a culture of innovation.

This report captures the participants' key discussion points and highlights some of the approaches individuals and organisations can take to improve their ability to harness data-driven insight.

Roundtable participants

- **Gary Finka**, Senior Director at GSK, heading the BioPharm Research Team
- **Victor Guiller**, Chemistry R&D Engineer for FUCHS Lubrifiant
- **Stan Higgins OBE**, a business and technical consultant with decades of experience in process industries
- **Tatjana Könnigsman**, team manager in R&D at Atotech
- **Dan Middleton**, Chief of Digital Manufacturing at Rolls-Royce Turbines
- **Per Vase**, Managing Consultant at NNE
- **Malcolm Moore**, [TITLE] at JMP
- **Anne Milley**, Roundtable Facilitator and [TITLE] at JMP

Driving an innovation culture

People are at the heart of any organization. Data, technology and processes are often the focus of a drive for innovation, but problems can arise when companies overlook the importance of evolving the skills of the talent pool in the push to reduce time to market and lower product costs. People are the ones gathering the data, using the technology and authoring the processes. How do R&D and manufacturing teams adjust to the data-driven world?

Dan Middleton, Chief of Digital Manufacturing at Rolls-Royce Turbines, oversees digital transformation across 14 global sites including one of the world's leading casting and machining centres. The automation at his organisation means that data is generated in high volumes. Middleton explained that there can be a level of fear attached to creating such large quantities of data because people don't always know what to do with it, at least initially. But once that data is connected, you can start to gain insights. In Rolls-Royce Turbines' case, it has improved insight into the supply chain and encouraged better collaboration.

Gary Finka's BioPharm Research Team at GSK is responsible for developing and embedding innovative tools and processes to de-risk the BioPharm portfolio. He described how for some people, the move to automation isn't a comfortable progression.

"It's important that you bring everyone along on the journey, and some people will go further along that path than others. You need to make sure you provide them with the right tools, the right training and the right support." In his experience, when domain experts don't feel they have to solve a problem themselves and are instead recognised for contributing a vital skillset, "they are able to share in the success of driving more value."

> Data analytics supplements what you know and helps you learn faster. There's no substitute for subject matter expertise.
>
> *Malcolm Moore, JMP*

Putting data analytics capabilities in the hands of the people who understand the subject is a valuable step towards developing an innovation culture.

Malcolm Moore from JMP highlighted the importance of enabling subject matter experts: "Some of the promises of big data hype make people feel insecure, because it suggests that inexperienced people can be just as productive as experienced people. Data analytics supplements what you know and helps you learn faster. There's no substitute for subject matter expertise."

By putting the right tools in the hands of domain experts, you can gain insights more rapidly and work more productively with the same resources.

Stan Higgins has decades of experience in the process industries. His opinion is that "these days people are more open to this idea of continuous professional development."

If you enable subject matter experts to understand the importance of data analytics and provide them with the right tools, people can follow that development route themselves – achieving personal success by improving their skill set and helping to drive innovation for their organisations.

The group discussed evolving skill sets and whether today's science and engineering graduates are equipped for the modern workplace with an understanding of data analytics. GSK and Rolls-Royce Turbines both have apprentice programmes and connections with universities to ensure they have the right talent coming into their organisations and can empower their future experts to learn by doing.

"Just as today companies wouldn't recruit people who weren't able to use Microsoft Office packages, maybe in another decade, organisations won't recruit people who can't use analytics tools," Higgins said.

Middleton's view is that companies like his own need to forge strong links with the academic sector so that they can educate and lead universities to produce the right talent for the future. Bringing young graduates in, Rolls-Royce Turbines ensures they are not pigeonholed and receive a broad understanding of what the organisation does.

Moore believes that the era of lengthy training courses is over, and that people are looking for bite-size knowledge. Using data analytics tools specifically designed for scientists and engineers, who don't want to learn a new language or get distracted by syntax – who want to stay focused on the problem they are trying to solve – enables them to use their data to gain insights more rapidly.

Incorporating data analytics into subject matter knowledge means learning is incremental: People can get started quickly, achieve results and experience the motivation to continue developing.

Ensuring data collection efforts fuel innovation

The reality for many R&D teams is that there is more work than time available, resources are stretched, and outcomes and time frames can be unpredictable. Design of experiments (DOE) is critical for realizing the benefits of data analytics quickly. It helps businesses make better decisions faster and meet project milestones more predictably. This in turn helps to reduce stress levels on individuals, leading to more productive, efficient teams.

> The pressure is enormous. You have to do it in very short timescales, and you have to learn a lot quickly.
>
> *Tatjana Könnigsman, Team Manager, R&D, Atotech*

Tatjana Könnigsman is a Team Manager in R&D at Atotech, where she works on new products in surface treatment technology. She described the stresses of delivering results with time and resource constraints: "The pressure is enormous. You have to do it in very short timescales, and you have to learn a lot quickly." DOE is fundamental to her team's ability to deliver results. She described how DOE gives meaningful explanations, explaining the 'why' so you can act on the information and repeat the experiment: "It informs your process understanding."

Victor Guiller, a Chemistry R&D Engineer for FUCHS Lubrifiant, where he is co-leader of an international working group focused on new methodology, is already seeing early success with DOE. Könnigsman and Guiller agreed that DOE is a 'win win' for everyone, allowing you to extract the maximum possible information in the minimum amount of time.

Per Vase described DOE as a way to manage knowledge within an organisation: "You build on the expert knowledge, then you can build a model and share the expert knowledge with the whole organisation. Because you have a mathematical function, everyone agrees on how to act and what is important. It is a very important tool for sharing information, so everyone has the same view on what is critical and how to act."

For Middleton, DOE and data sharing within the supply chain is helping to challenge conventional wisdom. "It challenges your initial thinking … the power of connecting and sharing findings down through the supply chain with your OEMs and being collaborative with your information really supports each other in moving forwards."

In his work as a Managing Consultant at pharmaceutical engineering company NNE, Vase explained how, when his organisation introduces DOE to a customer, they start by brainstorming with the experts to decide which factors to vary: "When we present the results, one person will say 'I knew that up front'. So we turn it around and say 'why didn't you implement it?' They have five or six hypotheses, and one of them is the right one. What we do with design of experiments is kill the other five or so and let the right one survive. I like it when an expert says 'I knew it already', because then I know the model is right. We are confirming hypotheses and are getting the focus right."

> The return on investment keeps coming.
>
> *Victor Guiller, Chemistry R&D Engineer, FUCHS Lubrifiant*

Moore summed it up: "Design of experiments is a stress reliever at an individual level." The group agreed that the predictability ensured by DOE means you can determine the number of experiments you need, the resources you need and the time it will take. Guiller expressed how important it is to be able to reuse the knowledge it delivers in future developments: "The return on investment keeps coming".

At an individual level, DOE provides greater predictability, reduced stress and allows you to get the job done. At an organisational level, this translates to increased innovation rates and more rapid time to market.

Visualizing results in an interactive way

The ability to communicate results effectively and persuasively emerged as a common theme in the group's discussion. Guiller described how DOE can be a strong communication tool: "Even if someone doesn't know the statistics and theory, you can just show them the main significant parameters and how the response evolved depending on the levels of the parameters. It's very visual … It's a great communication tool. We may think of design of experiments as being only for R&D, but it can be seen as a step between R&D and production. It helps different teams to communicate with each other."

The group discussed how important visualization is in communicating the ways data is used within their organisations.

Finka explained how at GSK, there has been significant investment in templating and dashboarding data: "A dashboard that a scientist at the bench might need to make a decision is very different from someone at a different level." For GSK, the ability to tailor and tune reporting for the individual depending on how they want to see the data is powerful: "We've been successful in evolving some of these dashboards where a user might say 'if I could just see this in a slightly different way, or what if this plot had a different axis?'"

For Middleton, interacting with data analytics is essential: "That's where we're starting to see the power: being able to interact with the data means engineers are starting to question their own thinking and say 'actually, I've spotted something here that I wouldn't have seen in a static model.'"

Enabling dynamic, science-driven discussion is far more powerful than providing a set of results on static slides. Interaction with the analysis can happen live during meetings. When data analysis is done in a dynamic way, an organisation speeds up its decision making.

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> *Dan Middleton, Chief of Digital Manufacturing, Rolls-Royce Turbines*

Left to right: Tatjana Könnigsman, Gary Finka, Dan Middleton, Anne Milley, Stan Higgins, Victor Guiller, Per Vase, Malcolm Moore

Using big data in the era of IoT and Industry 4.0

At the end of 2016, McKinsey reported that 'many companies that have begun to deploy data and analytics have not realized the full value. Some have responded to competitive pressure by making large technology investments but have failed to make the organisational changes needed to make the most of them.'[2] The group's discussion seemed to bear this opinion out.

Vase described how many organisations are delaying getting value from their data by focusing so much effort on collecting and combining data and making it available: "Of course that is a pre-requisite for data analytics, but you're not creating any value until you start analysing and visualising that data and the results so that people can make decisions. People have a tendency to wait too long before they start doing the analytics. Do it in parallel with data collection and make it accessible. When you start analysing, it gives you feedback on how to collect and combine and contextualize data. We encourage starting analytics as soon as possible. You create value when you analyse data and make decisions."

> You're not creating any value until you start analysing and visualizing that data and the results so that people can make decisions.
>
> *Per Vase, Managing Consultant, NNE*

Finka explained how the variety of data his organisation generates is the biggest challenge. "We have image data, single time point data, continuous data collected very frequently or less frequently. And as we try to connect that together, especially as we look at it from an end to end perspective – from our earliest development phases in UK to manufacturing in the USA – how you connect that data, how you call data sets the same thing so you can pool them from different sources and connect them together, that has been the biggest challenge that we had to solve before we could start extracting the most value from the data that we're actually generating."

Middleton said that engineers sometimes only look at their own processes and miss factors outside these processes that influence them: "Connecting data is becoming more and more important. We're starting to learn the power of it within our supply chain. We're starting to learn quite a bit of information – for example, understanding which mines we want to go and collect our raw materials from, or how sometimes you might want to pay slightly more for a product because then you'll get better yield and create less scrap, which means less work for the factories."

> Big data needs design of experiments. Learn what you can from your existing data, but there are always new questions. The best way of answering those questions is through design of experiments.
>
> *Gary Finka, Senior Director, GSK*

[2] *McKinsey Global Institute report: The Age of Analytics: Competing in a Data-Driven World*

Finka linked design of experiments to big data. "A lot of our data is quite expensive and hard to generate," he said. "If you only use it once, the value of it is reasonably small." Data reuse – getting the maximum value from data that was quite expensive to generate – is an important factor for GSK. Any opportunity to shorten the time before the data can be reused or identified as useful for another project will help deliver business objectives. "Big data needs design of experiments," Finka said. "Learn what you can from your existing data, but there are always new questions. The best way of answering those questions is through design of experiments."

Vase questioned the way some organisations approach data collection: "All the companies we work for are active in big data, but when we ask them about the value [they] want to create from it, surprisingly we don't always get a clear answer. So they are simply doing it because others are doing it and they're afraid of what happens if they're not doing anything. We need to focus on what value will be created by big data."

> It needs domain experts to say, 'this is what we should be doing with the data,' not management to say, 'what shall we do with all this data?'
>
> *Stan Higgins OBE, business and technical consultant*

Higgins put it succinctly: "It needs domain experts to say, 'this is what we should be doing with the data,' not management to say, 'what shall we do with all this data?'"

Discussing the impact of hype and buzzwords surrounding big data, AI and machine learning, the group agreed that the role of the subject matter expert is key. Moore described how learning from data is a continual process. "One of the myths of big data is that you plug your data into a learning algorithm and it will spit out some magical model that will solve all your problems," he said. "You need to understand the circumstances of your data. It may be that at the current point in time, you're not measuring all the relevant variables. It may be that some of the variable definitions have changed over time, so you have inconsistencies. Learning from data is a continual process. It is only by overlaying subject matter knowledge on top – putting data analytics in the hands of the subject matter expert – that data analytics comes alive and protects you from making wrong decisions that then cost you down the line."

Higgins added that "you don't need a perfect model, just learn enough and be aware that in the future things might change and you need to revisit the situation. Learning through data analysis and statistical modelling is a continual cycle."

Taking the right steps

By avoiding the paralysis of over-planning, organisations can start to reap the rewards of data analytics more rapidly, motivate their scientists and engineers to develop professionally and learn as they go – refining the approach to drive even greater productivity and efficiency.

With a few simple steps, JMP can help scientists and engineers use data for analytics and DOE, equipping R&D and manufacturing teams with the tools they need to gain insights more rapidly.

JMP helps subject matter experts apply powerful statistical and analytic capabilities. From easily accessing data from various sources to using quick, reliable data preparation tools and performing statistical analyses, JMP speeds up the time to insight and enables interactive visualisation to speed up decision making.

The quick-start workflow in the diagram here shows the key stages for developing an analytic workflow. Within 15 minutes or so, most scientists and engineers can make a start and begin to learn incrementally, solving problems as they progress and discovering more about what they can do with their data.

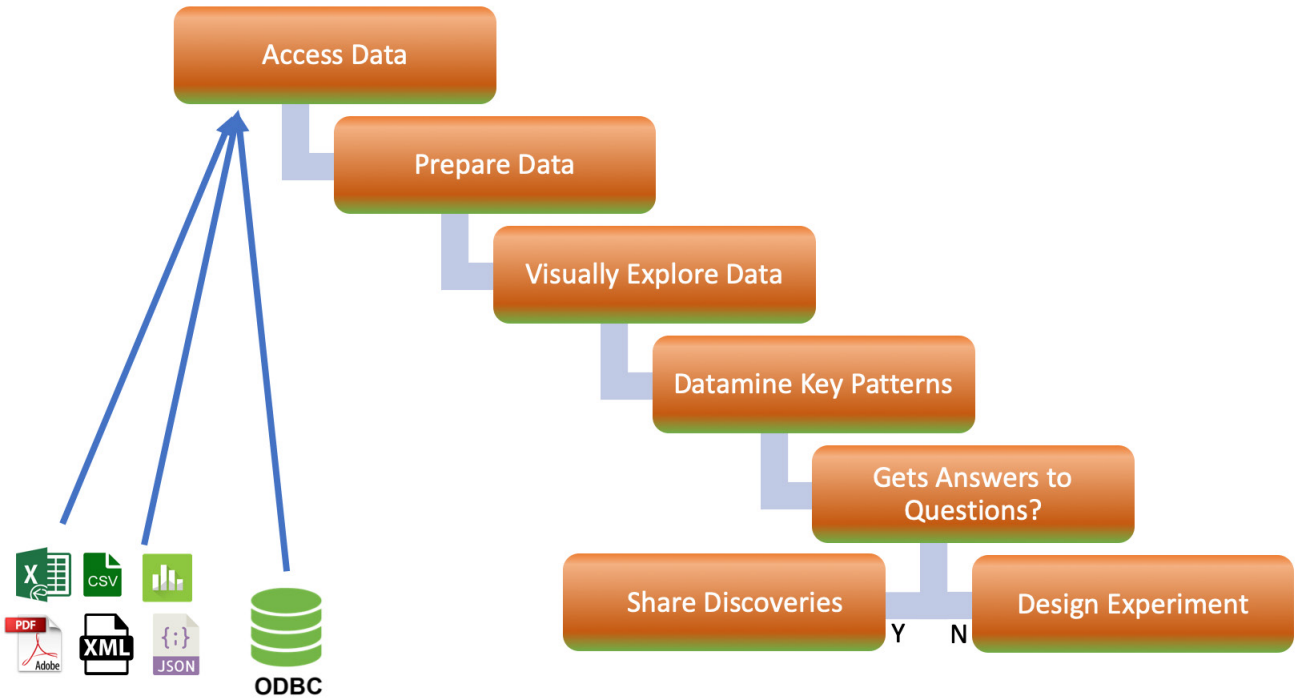
STEP 1
Start by bringing data from various sources into JMP using the inbuilt import capabilities.

STEP 2
Prepare the data using data shaping and preprocessing capabilities.

STEP 3
Visually explore your data to get a feel for the potential relationships.

STEP 4
Determine which combination of features or conditions are associated with a problem or improvement opportunity using robust and simple-to-use methods such as decision trees. If questions remain, then use the knowledge gained to define any new data to be collected.

JMP quick-start analytic workflow



Summary

When subject matter experts have the right tools for data analytics, they are more likely to find robust solutions to problems more quickly and be able to communicate these solutions persuasively to colleagues, speeding up decision making and time to innovation.

Despite substantial challenges and internal pressures in their different industries, the members of the discussion group agreed that data analytics, design of experiments, and the ability to visualise and present results interactively are helping them deliver results.

By adopting a data-driven, best practice approach, they are personally more effective at their jobs and their teams are more productive, helping to drive innovation across their organisations.

Contact JMP to find out more about our quick-start analytic workflow and the benefits of data analytics.

About SAS and JMP

JMP® is a software solution from SAS that was first launched in 1989. John Sall, SAS co-founder and Executive Vice President, is the chief architect of JMP. SAS is the leader in business analytics software and services, and the largest independent vendor in the business intelligence market. Through innovative solutions, SAS helps customers at more than 83,000 sites improve performance and deliver value by making better decisions faster. Since 1976 SAS has been giving customers around the world THE POWER TO KNOW®.

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