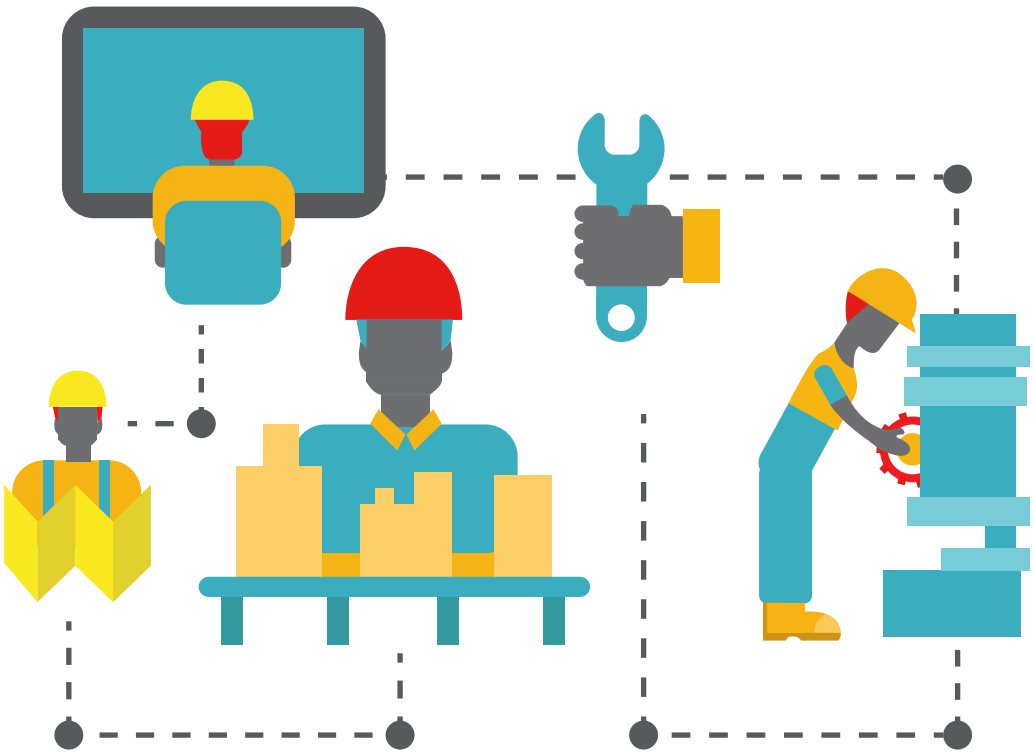

Data Visualization in Manufacturing Domain — Why and How

With immense volume of data getting generated every day, one way enterprises are coping with the situation is by making extensive use of data visualization techniques. Know how data visualization influences the manufacturing domain.

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01 Introduction to data visualization

Data is growing at a phenomenal pace, and it is physically impossible for anyone to keep abreast with all the data that comes up. Production machinery and equipment especially generate vast quantities of data in today's data-driven age, and the rise of ***Internet of Things (IoT)*** is going to increase data volumes even further.

The need for analytics or data crunching to present data in a processed and meaningful form to decision makers has never been so important before.

Aggregating generated data may appear easy, but the real challenge lies in making sense of such humongous quantity of data, and drawing insights from it. Companies that rise up to the challenge are able to design the next-generation data-driven manufacturing systems that would provide them with competitive advantage. One way enterprises are coping with the situation is by making increasing use of data visualization.

What is Data Visualization?

Data visualization, in its simplest form, is the presentation of any data in the form of a graph, chart, image, map, or any kind of visual representation.

Today's data visualization techniques have come a long way from simple pie charts, bar graphs, and other visual images that were once associated with visualization. ***Interactive data visualization*** goes beyond the display of static graphics and spreadsheets, and makes it possible to drill down into the charts and graphs for added details, change the data used for the analysis, and even change the processing rules in the middle of an analysis. The advancement of technology and the spread of computing make it possible to undertake such processes in real time as well, supporting hyper-active analysis of data.

02

The Need for Data Visualization

"A picture is worth a thousand words."

Visualized representations, such as images, are a natural form of expression. The way human brain processes information makes visual representations, such as charts and graphs ideally suited over spreadsheets, to grasp the meaning of large sets of data.

The human brain processes visuals 60,000X faster compared to text. In fact ***95% of marketers,*** based on their experience, swear that images are more powerful than plain text to communicate the message.

Presenting analysis in an easy-to-use format:

In today's age of big data, just about any data crunching exercise invariably involves huge quantities of data, running into several, often thousands, of rows and columns. Traditional electronic spreadsheets are inadequate to represent such information, for it would involve enormous heaps of A4 sheets; and someone seeking insights will be forced to spend hours on such spreadsheets.

- Data visualization delivers analytical results, and communicates concepts, hypothesis and other important insights with ease, regardless of the quantity of data. A single pane or sheet can represent huge quantities of analyzed data, making it not just convenient, but also easy to understand, comprehend, and interpret.
- Trends and patterns become easy to discern, and many trends not evident in ordinary spreadsheets or data sets show up.
- It becomes easy to isolate issues and outliers that inhibit production, spot correlations that may be hindering efficiency, and join data objects to engineer processes for maximum productivity and profit.

The representations in a bar graph may, for instance, make it very easy to unearth trouble-spots or under-performers that need attention or improvements, key factors that increase customer acceptance, know the conditions and configurations that maximize sales, and even predict sales volumes. Such insights may not be readily visible in a spreadsheet consisting numerals and other raw data.

Data visualization also offers a consistent format for analysis, cutting across languages. It is possible to transform data into standardized and commonly visualized format from a variety of sources into rich visualizations.

Improved Productivity:

The ability to present data in an easy to understand output improves the quality of decision making, and saves considerable amount of time and energy.

For instance, improved data visualizations dramatically reduce error detection time. Looking for solutions amid complex data relationships, what hitherto took expert engineers at Fujitsu about six hours, was done in one hour. By applying their intuition and experience, along with new data visualization techniques, these engineers uncovered complex data relationships, and exposed the solutions even to lay users, all in an hour. ***Fujitsu has attained about 30% improvement in productivity*** through better data visualization.

High Motivation Levels:

High end data visualization tools improve transparency, and identify status or progress, thereby motivating the workforce better. By figuring out how errors have occurred, and analyzing the impact of errors on the production line, or how processes may be modified for better results; the rank and file employees are able to appreciate the production line as a whole rather than staying confined within their vision to their own tasks.

Improves Quality of Decision Making:

The latest cutting edge solutions that offer interactive and real time visualization of data, deliver deep insights, such as real time visibility into supply chain, inventory, processing, production, purchasing, and other data. Using such insights, manufacturers may identify available resources, streamline the supply chain, and acquire greater control over their processes, thereby improving operational effectiveness and productivity at every step in the process. They may also take better business decisions, considering inventory levels, production capacity, and workforce productivity, over time and other key factors.

The benefits of improved decision making are realized by lower operating costs, lesser downtime through improved predictive analysis, increased revenue by improved customer satisfaction and better quality product, improved efficiency by improved time to market, and more.

Successful application of smart real time data visualization allows manufacturing companies and their channel partners, such as suppliers, to take a major leap from descriptive analytics to predictive and prescriptive analytics.

For instance, instead of doing a post-mortem on "what happened, or why did it happen," we can move towards predictive analytics (what will happen?) and prescriptive analytics (how can we make it happen?).

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Data Visualization in Manufacturing: The Present Scenario

The obvious aim of applying data visualization, or even analytics in the first place, is to maximize revenue in production, subject to the applicable resource constraints. For instance, a manager would seek to optimize effectiveness and productivity with the available tools, or deliver maximum output with the available components.

In this, there are ***several variables*** at play:

A typical manufacturer usually has hundreds of different products and thousands of different components. Some of them are "common components," used by multiple products.

A production plan usually extends over weeks and months, and the scheduling is often dynamic, depending on inventory levels, availability of components and demand.

The onus is on the planner to ensure the availability of all components, especially "common components," prioritize the order of components, and plan production schedule efficiently. The planner takes several actions to overcome problems, and specific sub-problems.

For instance, they move products to different assembly lines to optimize the production schedule. They may allocate scarce "common components" to products in higher demands, or converse products with other components available, so as not to disrupt production. They may even adjust an assembly line capacity, or change the quantity of products as per demand and material availability.

Inadequacy of Tools

All the discussions on advanced analytics leveraging the power of big data notwithstanding, visualization of large-scale multi-dimensional data, to aid decision makers, is virtually nonexistent in the ***manufacturing*** sector.

There are several visualization tools in the marketplace, and many of them, such as IBM Data Explorer, AVS, and IRIS Explorer, are popular, and are used widely. However, most of these tools are designed for scientific visualization purposes, and it might not be easy to apply such tools for visualizing managerial data in the manufacturing space.

Two Dimensional Visualizations

Traditional one or two-dimensional graphs, such as line graphs, bar charts, or pie charts, are inadequate for today's dynamic environment, for the data they can provide are basically in tabular format - limited to the size that a computer screen can handle, or on a printed report that may be extensively long.

Even existing production planning systems such as MRP II and simulation systems, while having friendly user interfaces, remain inadequate to handle complicated relationships among data in a dynamic decision-making environment, and are unable to provide solutions in an environment where constraints change rapidly.

Using such solutions, the decision makers still need to apply their cognitive powers to discern the underlying "stories." For instance, a chart may provide actual component level, but it is up to the decision maker or planner to predict which component would be in shortfall, after factoring in the proposed planning schedule.

Computer Generated Visualizations

Computer generated visualization, with all the different variables interlinked, gives a clear vision and makes the task of decision makers or planners easier. However, there is still a challenge in how to output large volumes of multidimensional data, with complicated relationships among them.

Non-technical and business users always remain in a quandary while deciding which visual should be used to represent the data accurately. Automated solutions leverage ***intelligent autocharting*** to create the best possible visual based on the selected data. But autocharting has its limitations, and may not always create the exact or the most appropriate visualization.

A key challenge relates to the nature of today's data. Today's data is not geometric by nature, and the relationship between such data is neither linear nor hierarchical, neither network nor geographical oriented. The absence of geometry especially makes visual representation very challenging, for there is no obvious geometry indicating the relationships among the data objects.

04 Generating best data visualization

There is no one specific or perfect way of generating visualizations to adequately represent non-geometric data. The key consideration is to ensure that:

- The design is meaningful to the recipients
- It can be replicated on a computer screen

One good approach is to design "visual abstracts" for each data object involved in each of the decision-making processes, and then link such data objects as images, using the rules developed for a specific problem domain. A visual abstract basically provides geometry for a data object, for 2-D presentations.

A visual image depends on the dependency relationship between the two data objects in question, and the following broad rules ensure geometric connection of data objects:

Rule 1: Dependency Dimensions: When one data object is determined or partially determined by B, data objects A and B create a 2D pane with the same origin. For example, when a data object related to demand satisfaction is partly determined by data object related to component availability, then both data sets are dependency dimensions, and a 2D pane is sufficient to represent the relationship effectively.

Rule 2: Time-Space Dimensions: If datasets A and B are time series data and one dimensional location data, and they both determine other data objects at the same time, then A and B make a 2D plane, sharing the same origin.

Rule 3: Parallel Dimensions: When datasets A and B have no dependency relationship, but both partly determine C, then A and B could be in a parallel position sharing the same origin. A case in point is when data objects relating to component availability and capacity availability have no dependency relationship between them, but both determine data object relating to demand satisfaction.

Rule 4: Overlap Dimensions: When data objects A and B have a dependency relationship, based on either time-space dimensions or another data object C, then A and B overlap each other, while sharing the same dimensions.

Rule 5: All the basic graphing techniques and rules, if not conflicting with the above rules, can be applied up to 3 data objects.

Rule 6: Combinations of the above rules may be used to geometrically connect all the data objects involved in one image.

Have a good grasp of the following key considerations to generate the best visuals:

- Understand the data, especially the size, and the unique nature of data values.
- Determine the intended output or the nature of information to be communicated.
- Know the audience and understand how they process visual information.
- Use a visual that conveys the information in the best and simplest form to the audience.

Most Effective Types of Visualizations

To keep the final visual representations simple so that non-technical users can also make sense of it, it is a good idea to continue using the traditional bar charts for the entire visualization system, with values provided in areas or lines within the bars.

However, there are many ***other innovative ways,*** which are just as effective, and may be even more relevant, depending on the context:

- A mix of line, bar, radar, polar, pie and doughnut type of charts, rendered in HTML5 canvas element
- Interactive maps, with heat spots or other forms of representation
- Fusion charts, which amalgamate maps and bars

Data visualization is both an art and science, and the selection of the best graphical techniques, among the many available, is subjective to the conditions and industry needs. Success depends on following the best strategies keeping the end user in mind.

05 Author Bio

S. Karthikeyan, or SK as he is better known, has 19 years of experience in designing, leading and delivering world-class software solutions. His specialties include Product Ideation, Innovation & Strategy, Enterprise & Solution Consulting, Data Science Solutions, and Digital Transformation. As Chief Innovation Officer, SK ensures that experimentation and innovation continues unfettered at Suyati Technologies. He leads the Mekanate team that is developing a Digital Transformation platform using AI, ML, IoT and Big Data technologies. He holds a Masters Degree in Computer Application, and Advanced Certificate in Information Technology Management from IIM, Kozhikode. The opportunity to build technically complex solutions is what runs through his mind all day, and probably keeps him awake at night! Connect with him on LinkedIn.

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About Suyati

Suyati provides marketing technology and integration services for companies that wish to combine the best of breed solutions and create a unified approach to customer acquisition. This unified digital marketing approach requires system integration between various CMS and CRM platforms, and a slew of ecommerce, Marketing Automation, Social Media Listening, email and social marketing, and customer service systems. Our specialized knowledge in Salesforce, open source and .Net based systems enables us to build effective custom integrated solutions for our clients.

Suyati's custom technology solutions have been deployed in companies in the US, Western Europe and Australia, and have helped many enterprises leverage the web/-cloud/mobile technologies to acquire customers through integrated digital marketing. Suyati is based in Chicago with product engineering capability out of the US and India.

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