

sandman[®]

Green Sand - *Art to Analytics*



Reduce
Repetitive Rejections

Optimize
System Sand

Reclaim
Lost Profits

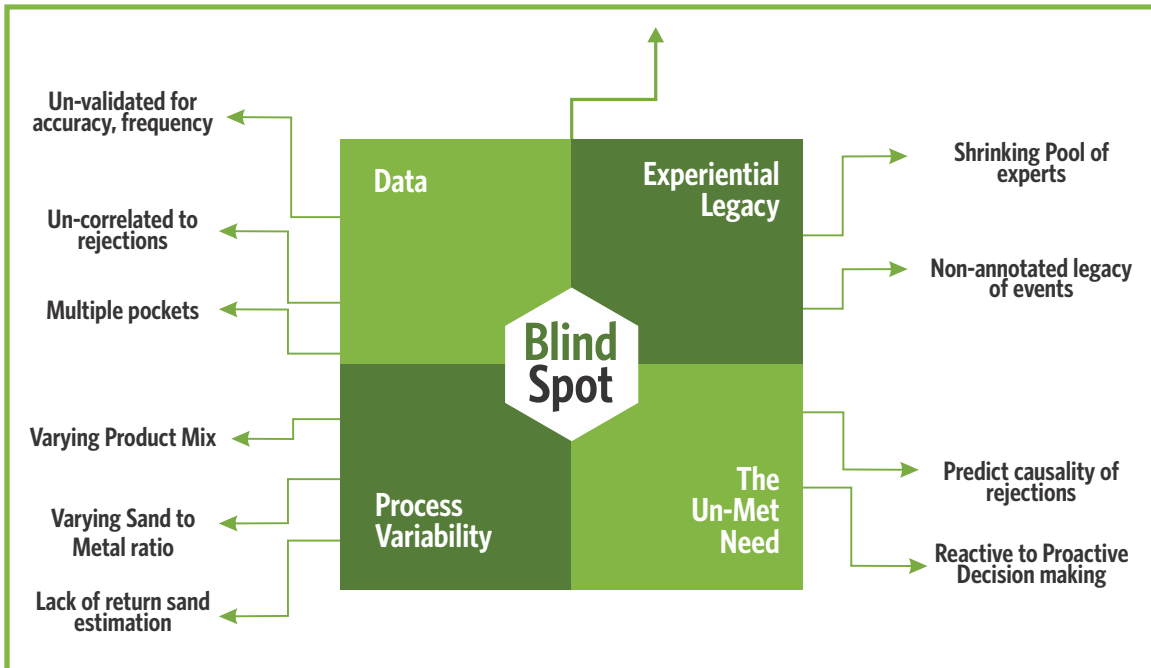
By **Data Analytics Decision Support**

“SANDMAN® organizes, stores, validates, analyzes, and leverages the foundry’s molding-sand data legacy for molding process optimization, using prescriptive and predictive data analytics. This enables the user foundry to move from reactive to proactive green sand control and management, and by corollary, reduce sand related repetitive casting rejections & additives consumption.”

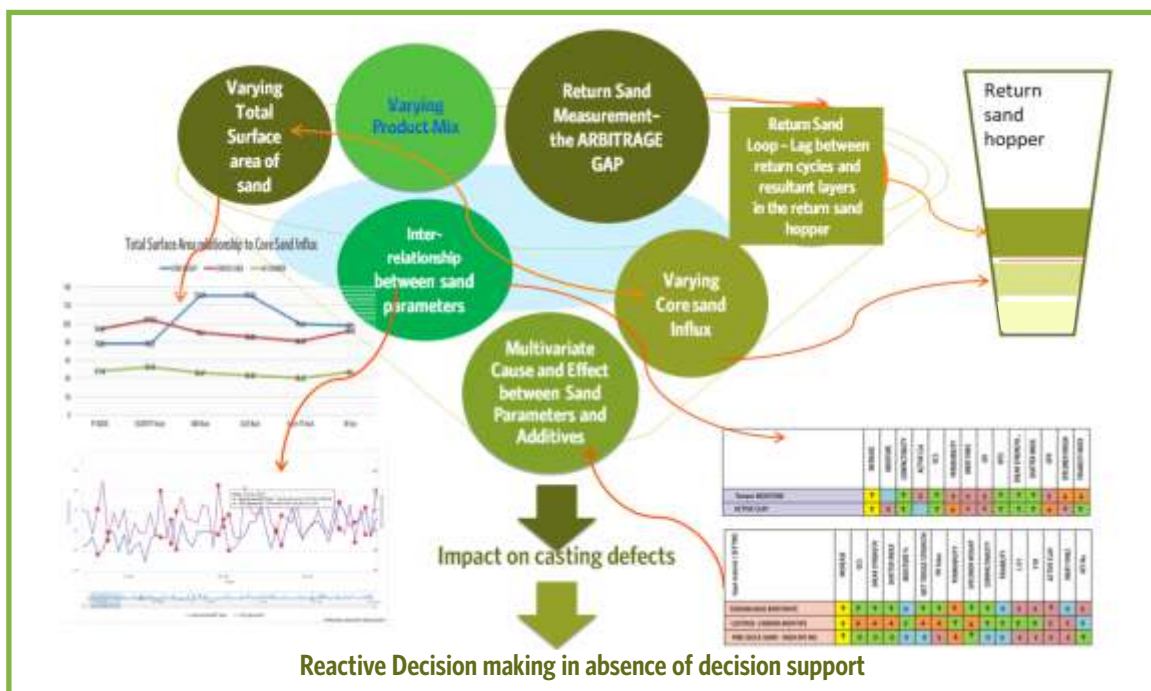
MOLDING ► CHALLENGES IN SAND CONTROL

The 'Blind' Spot

The 'Why' of Repetitive Rejections → Reactive Decision Making



The Challenge - Variable, Validated and Co-related Data



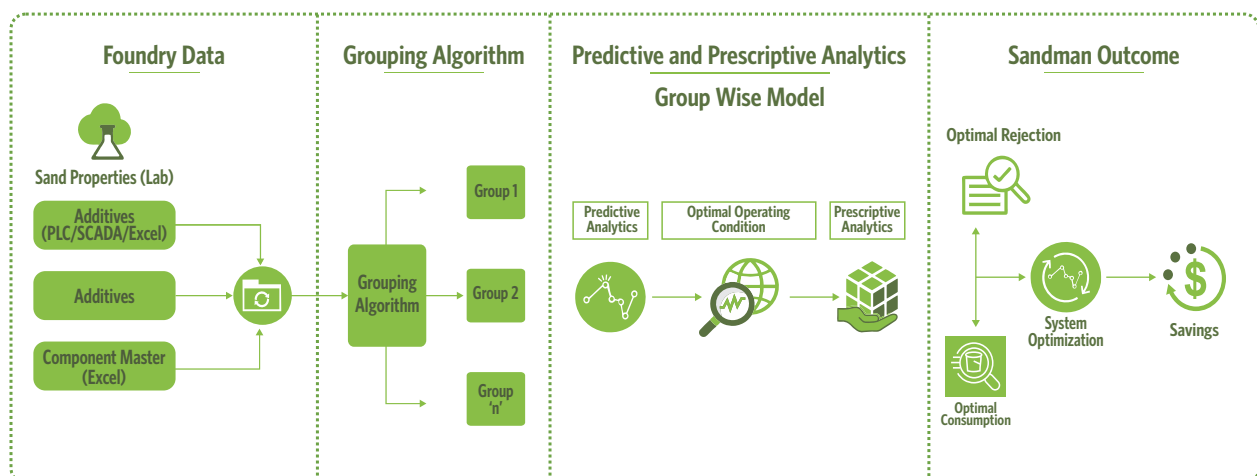
sandman[®] THE SOLUTION

SANDMAN[®] is a pioneering cloud-based, software-as-a-service (SaaS), predictive, and prescriptive data analytics solution for optimizing foundry green sand system. Using its proprietary **SANDMIX** algorithm, **SANDMAN[®]** facilitates variable, "dose-by-need" dosing of additives rather than relying on fixed dosing across casting patterns/jobs.

Powered by machine learning, **SANDMAN[®]** leverages data analytics to eliminate the need for experiential fixed sand conditioning and enable precise control of the system sand through a system-driven decision support. This minimizes casting rejection due to over dosing or under dosing of additives while obviating the need to alter man, material, or machine.

SANDMAN[®] is patented in **India, USA, Europe, China, Brazil, Korea and Japan**. Its multivariate analysis correlates green sand properties with casting defects, offering predictive and prescriptive recommendations for process control of system sand properties and additives. As the world's first of its kind software, designed for Iron foundries, **SANDMAN[®]** sets the bar for optimized foundry green sand management through advanced machine learning driven data analytics.

sandman[®] WORKING PRINCIPLE



sandman[®]

ANALYTICS

A HIGH INFLUENCE

“Predictive Analytics”

By employing advanced machine learning algorithms and sophisticated mathematical models, **SANDMAN's** High Influence algorithm analyses and forms multivariate correlation of the sand properties, identifies the most influential parameters on the casting rejections at a point in time of user choosing, and provides actionable control guidance to minimize rejections. With its predictive capabilities and advanced ML features, **SANDMAN[®]** High Influence enables foundries to take proactive measures, enhance operational efficiency, and enhance product quality.

HIGH INFLUENCE PARAMETERS



Sandman High Influence also offers a user-friendly interface, allowing foundry professionals to easily navigate and interpret the insights generated. The software presents the influential properties in a clear and intuitive manner, empowering users to make data-driven decisions confidently.

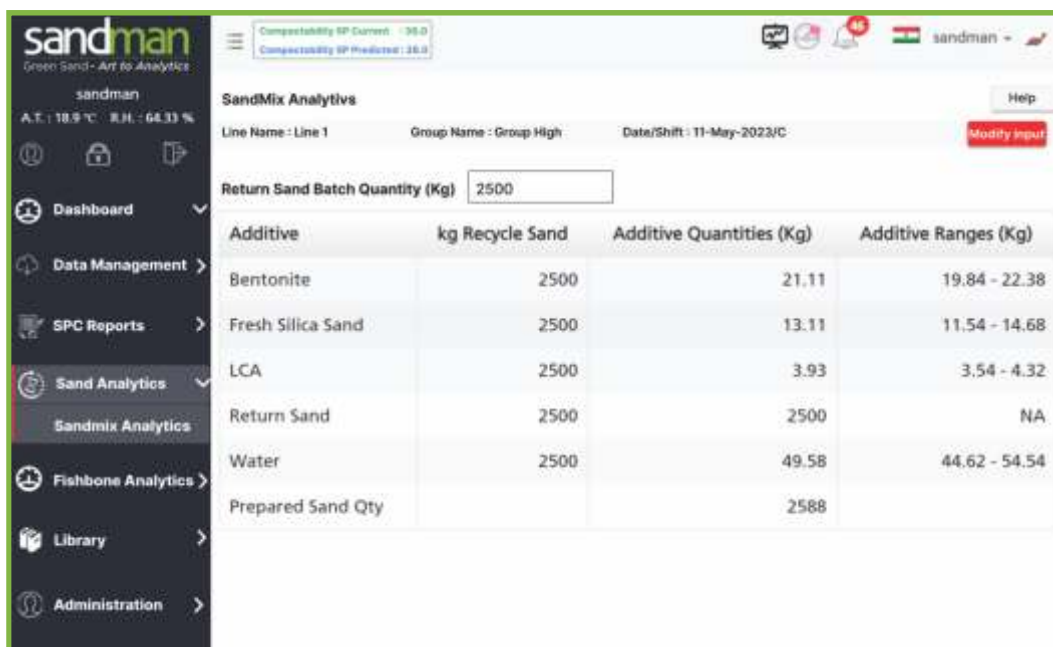
“Dose-by-Need” Prescriptive Analytics

This addresses the global foundry process owners’ unmet need to target variable, 'dose-by-need' additions of sand additives instead of the fixed dose additions based on pattern changes and consequently significantly reduce return sand variability. The variable, multi-variate analytics using our unique **SANDMIX algorithm**, translates the optimal sand properties and prescribes a sand recipe for each new group of patterns correlated to the rejections.

Variable, dose-by-need prescriptive analytics also helps reduce the consumption of costly additives such as coal dust, bentonite and raw silica sand by optimisation of the sand loop.

“**SANDMAN**[®] uses cutting-edge Prescriptive Analytics to prescribe near-precise quantity of additives to be mixed/manipulated to realize consistent and optimum moulding sand process control with a view to achieve consistently, good casting outcomes”

SANDMIX ANALYTICS



Additive	kg Recycle Sand	Additive Quantities (Kg)	Additive Ranges (Kg)
Bentonite	2500	21.11	19.84 - 22.38
Fresh Silica Sand	2500	13.11	11.54 - 14.68
LCA	2500	3.93	3.54 - 4.32
Return Sand	2500	2500	NA
Water	2500	49.58	44.62 - 54.54
Prepared Sand Qty		2588	

- ▶ At its core, it leverages information of the sand plant mixing operation and the sand loops’ historical additive consumption trends, to arrive at the additive prescriptions that best achieves the target sand properties, for the casting group/s and production planning of each shift or day; depending on the granularity of data made available.
- ▶ The sand mix prescriptions are based on the relationship between the make-up additives and the corresponding current and past prepared sand properties, advised under the constraints imposed by the foundry infrastructure, operational capabilities and processes.

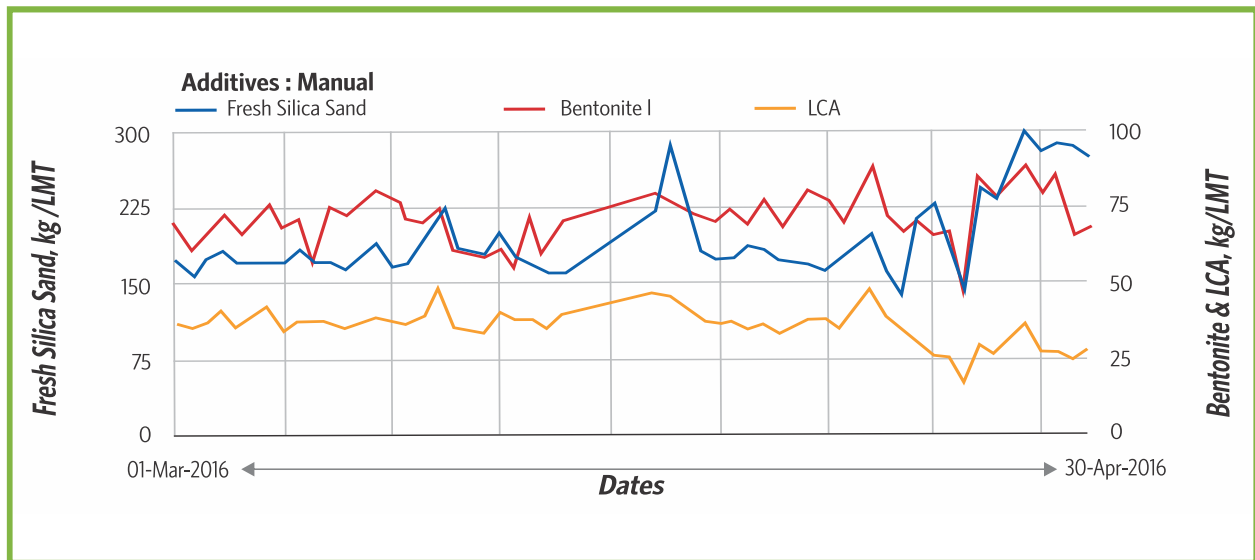
VARIABLE

"DOSE-BY-NEED"

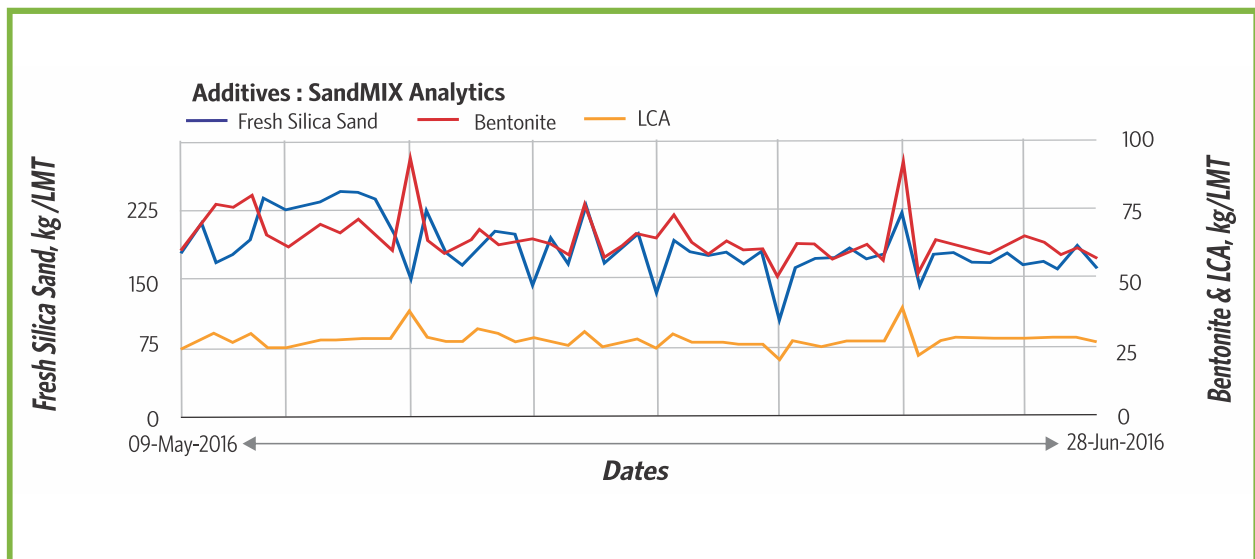
advantage of prescriptive analytics

Case Study: Reduction of additives consumption by variable dosage using prescriptive analytics based on the requirement of sand to achieve target/optimal properties.

MANUAL OPERATION : BEFORE



SANDMIX ANALYTICS ADVISED OPERATION : AFTER



Salient FEATURES

1. DATA MANAGEMENT



SANDMAN® offers comprehensive digitization and digitalization capabilities for foundries, providing a simple and straightforward way to manage sand, casting pattern, and process data throughout its life cycle. It's Desktop and Mobile Data management applications, along with the PLC via SCADA integration, enable the capture and integration of data from various machines in the sand loop, including the mixer, compactability controller, moulding machine, sand, moisture and ambient humidity and temperature sensors, and more. This allows for data to be updated in **SANDMAN®** in near real-time, ensuring accuracy and accessibility.

"The availability of real-time data enables foundries to make informed decisions based on insights derived from their data, leading to improved efficiency, reduced variability, and enhanced quality control."

KEY ASPECTS OF DATA MANAGEMENT:

1. **Data Storage** - store data in an easy, comprehensive, secure, and scalable way using cloud-based storage solutions. Data can be directly stored in the software or via our mobile app.
2. **Accessibility** - The data is easy to store, access and analyse, infinitely across time periods.

DATA STORAGE

The image displays two views of the SANDMAN Data Storage interface. The desktop view on the left shows a sidebar menu with options like Dashboard, Data Management, SPC Reports, Sand Analytics, and Fichrome Analytics. The main content area is titled 'Data Storage' and includes a 'Modify Filter' section with fields for 'Date' (10 May 2023), 'Time' (22:24), and 'Shift' (C). Below this are input fields for 'Test No.' and 'Component I.D.'. There are also fields for 'Active Clay (%)', 'DCS (g/cm²)', 'Moisture (%)', 'LD (%)', 'Total Clay (%)', and 'WTS (N/cm²)'. At the bottom, there are three buttons: 'Save & Add New', 'Save & Close', and 'Cancel'. The mobile app view on the right shows a similar form with a 'Sample ID' field and a 'Component I.D.' dropdown menu.

2. DASHBOARD



SANDMAN's Business Intelligence dashboard is a powerful tool that provides users with an up-to-date, near real-time view of their system sand status, derived from various sources such as PLC/SCADA, mobile and desktop apps.

It presents insights and analysis in a user-friendly and comprehensive way that facilitates better-informed and actionable decision-making.

Using advanced data analytics and visualization techniques, the dashboard offers detailed insights into key performance metrics, enabling users to track and improve their processes and reduce variability.

“With SANDMAN's Business Intelligence dashboard, users can gain a deeper understanding of their foundry operations, improve efficiency, and ultimately achieve better quality outcomes.”

DASHBOARD



SOME SALIENT DASHBOARD FEATURES:

- ▶▶ Quick metrics of production, rejections, etc. for selected period.
- ▶▶ Rejection percentage Chart at Foundry/Machining stage (Sand, Metal, core, other).
- ▶▶ Add powerful filters such as date, component, defect, Pareto (component, defect) for a day/week/month or another time period.
- ▶▶ Pie Charts - Rejections (type and component).
- ▶▶ Download these graphs in high quality JPEG, PNG, PDF formats for management reports and presentations.
- ▶▶ The dashboard is designed to enable users to recall, analyse, view and interpret their data over unlimited time periods of their choosing.

3. ANNOTATIONS



As managers age, change and move on, their shop floor experience often moves out with them or is available in limited formats. To overcome this inevitability, a UNIQUE feature of ANNOTATIONS is offered by Sandman which enables you to record shop floor, System-Sand related experiences and events so as to assist you in future situations for informed and legacy data-based decision making.

SYSTEM CHANGES

The screenshot shows the 'System Changes' form in the Sandman application. The interface includes a sidebar with navigation options like Dashboard, Data Management, Process Changes, System Changes, SPC Reports, Sand Analytics, Fishbone Analytics, Library, and Administration. The main content area is titled 'System Changes' and features a search bar and a 'View System Changes' button. Below this is the 'New System Changes' section with the following fields: 'Line Name' (Line 1), 'System Change Type' (Change in Bentonite Supplier), 'Component' (Change in Bentonite Quality), 'Date of Change' (Change in LCA Quality), 'Enter Details' (Trial of new supplier's Bentonite), and 'Authorized by' (XYZ). There are 'Save' and 'Cancel' buttons at the bottom.

PROCESS CHANGES

The screenshot shows the 'Process Changes' form in the Sandman application. The interface is similar to the System Changes form, with a sidebar and a main content area titled 'Process Changes'. It includes a search bar and a 'View Process Changes' button. The 'New Process Changes' section contains the following fields: 'Line Name' (Line 1), 'Date of Change' (22-05-2022), 'Shift' (A), 'Enter Details' (LCA Addition increased 2Kg/Batch due to Sand Sticking Observed High at Knockout area), and 'Authorized by' (XYZ). 'Save' and 'Cancel' buttons are located at the bottom.

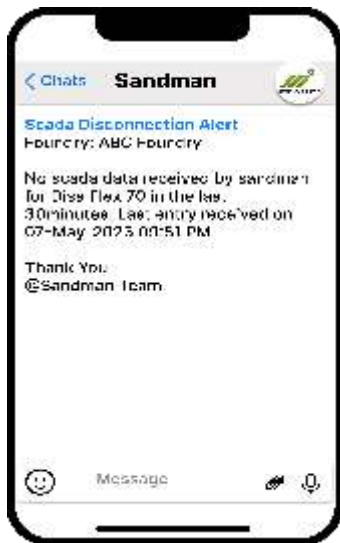
4. SMART ALERTS



SANDMAN's smart alerts are generated using a complex system of pre-defined rules and algorithms that employ data analytics techniques such as anomaly detection and pattern recognition to analyse data and identify any deviations from user-defined process control boundaries. These alerts are triggered when specific conditions are met, allowing for timely intervention and corrective action. The alerts can be delivered via multiple channels, including email, WhatsApp, SMS and in-app notifications, ensuring that users stay informed, alert and can take timely corrective measures.

Common examples:

1. **Security/User behaviour** alerts
2. **Process, sand properties, additive addition and quality deviations**, and many more system alerts
3. **Performance alerts** - These alerts notify users of performance issues or outages.
4. **Analytics alerts** - These alerts notify users of trends or changes in key metrics.



5. SPC Tools (Statistical Process Control)



SANDMAN® incorporates a comprehensive suite of Statistical Process Control (SPC) tools, designed to enhance quality control, optimize efficiency, and minimize variability in foundry green sand process control.

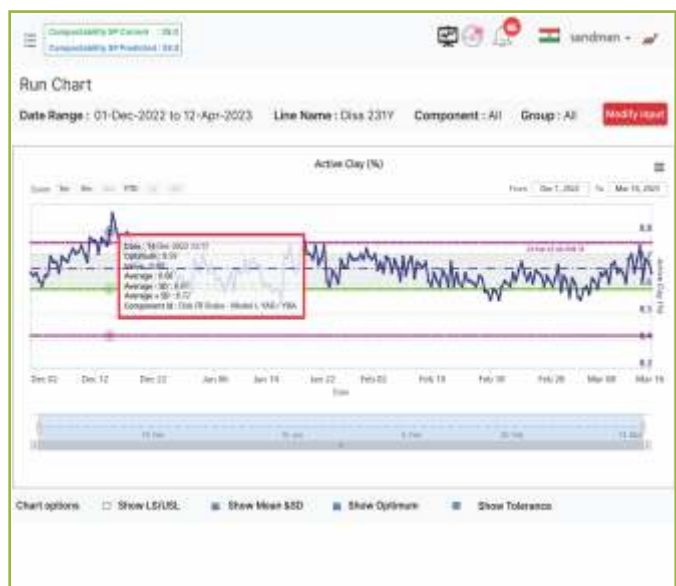
These tools enable real-time statistical analysis of sand parameters against rejections by type, component, or group, across unlimited time-frames. These features are fully integrated with the alert management system, ensuring timely and actionable notifications when specific conditions are met.

Some SPC tools available in SANDMAN® include:

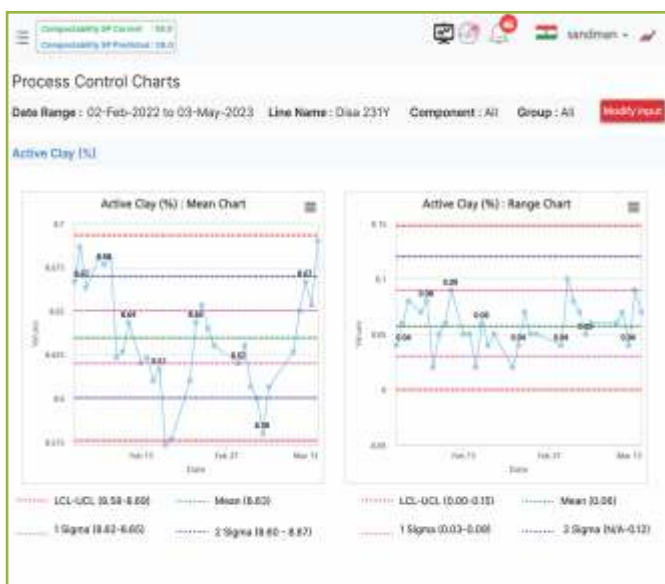
1. LINE CHART



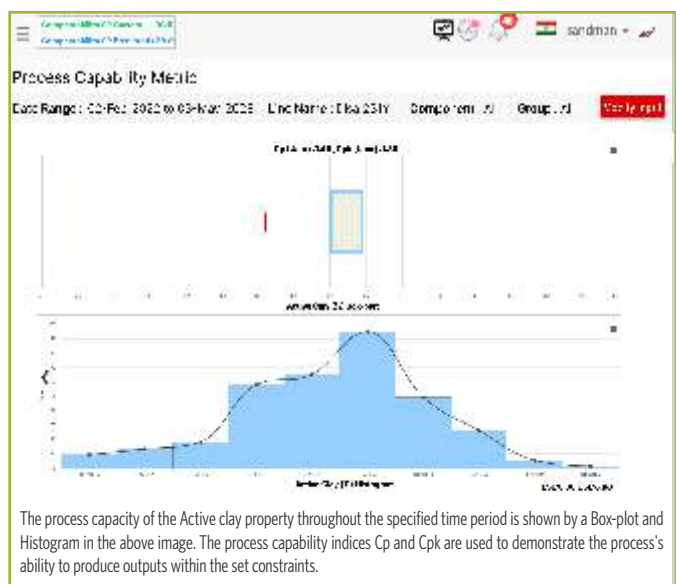
2. RUN CHART



3. PROCESS CONTROL CHART



4. PROCESS CAPABILITY METRICS



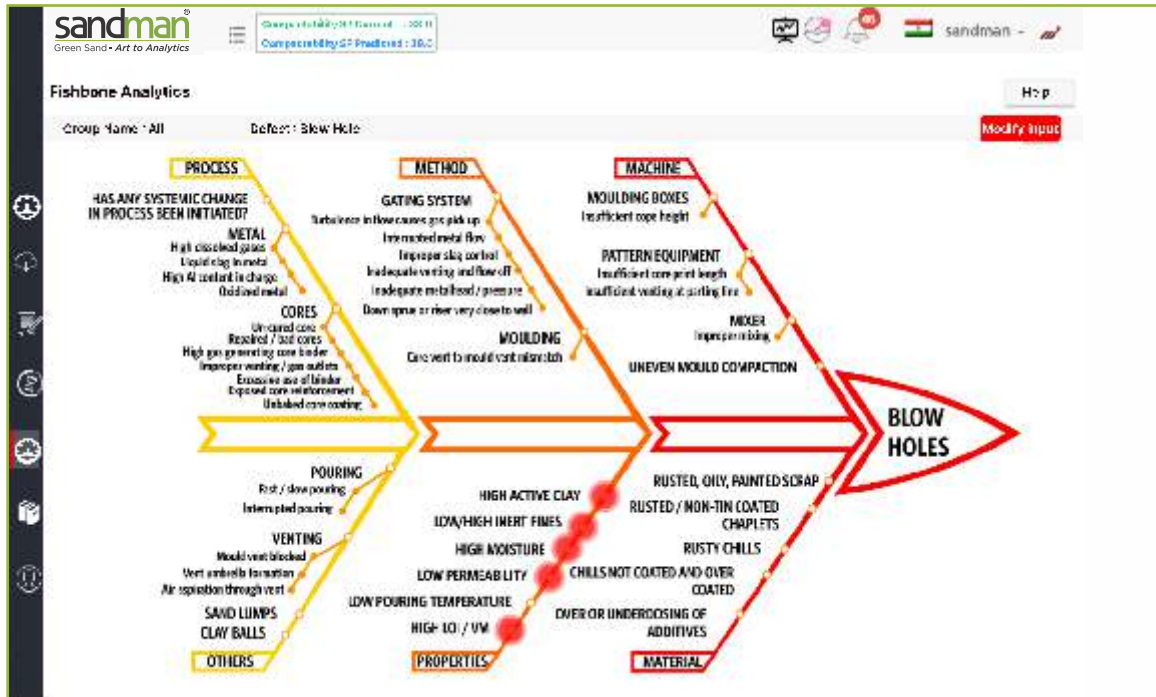
The process capacity of the Active clay property throughout the specified time period is shown by a Box-plot and Histogram in the above image. The process capability indices Cp and Cpk are used to demonstrate the process's ability to produce outputs within the set constraints.

6. Root Cause Analysis/Fishbone Diagrams by Analytics



SANDMAN® leverages advanced statistical tools and techniques to provide a faster and more efficient Root Cause Analysis based on Fishbone/Ishikawa diagrams. By analysing deviations in sand properties between good and poor performance periods in virtual real-time, our solution helps process-owners make informed decisions about their green sand processes.

FISHBONE CHART



FISHBONE ANALYTICS



IloT (Industrial Internet of Things)

“The Internet of Things is fast transforming the way of interlinking of data from various devices that can add huge value by bringing near real-time information to the analytics process, reducing human intervention and increasing the precision of decision support and execution.”

Establishing IloT in Foundry Green Sand Process management is now possible!

Molding Eco system integration



- ▶ The moulding line SCADA - enables the collection of near real-time data and will facilitate optimization modelling. Imagine the capability to be able to co-relate each sand-mix to additive consumption, each casting component/part and predict probable causality of rejection with highest possible accuracy and traceability.

Ambient Temperature and humidity sensor and Return sand monitoring



- ▶ Enables co-relation of ambient conditions at different times of the day and also the changing seasons. The historical impact of these variations on moulding sand properties moisture and sand temperature is harnessed to predict the change of compactability settings for better mould integrity and moisture control.
- ▶ Return sand moisture and temperature captured in real time by sensors, enables system sand control by predictive analytics

Integration with lab machines with a digital output:



- ▶ Integrating lab testing machines with **SANDMAN**[®] automates the data collection process, reducing the likelihood of errors and improving efficiency. Mobile data entry eliminates paperwork and error possibilities in the laboratory for all time.

Integration with ERP systems to push and pull data directly in near real time.



- ▶ It is possible to integrate **SANDMAN**[®] into various ERP systems to push and pull data provided compatible patches are available. This enables data synchronization across all systems, thereby eliminating the need for duplicate work, risk of errors due to manual data entry, automating workflows, reducing the time and effort required to complete tasks and improving productivity.

Auto dosing – subject to capabilities of the machines

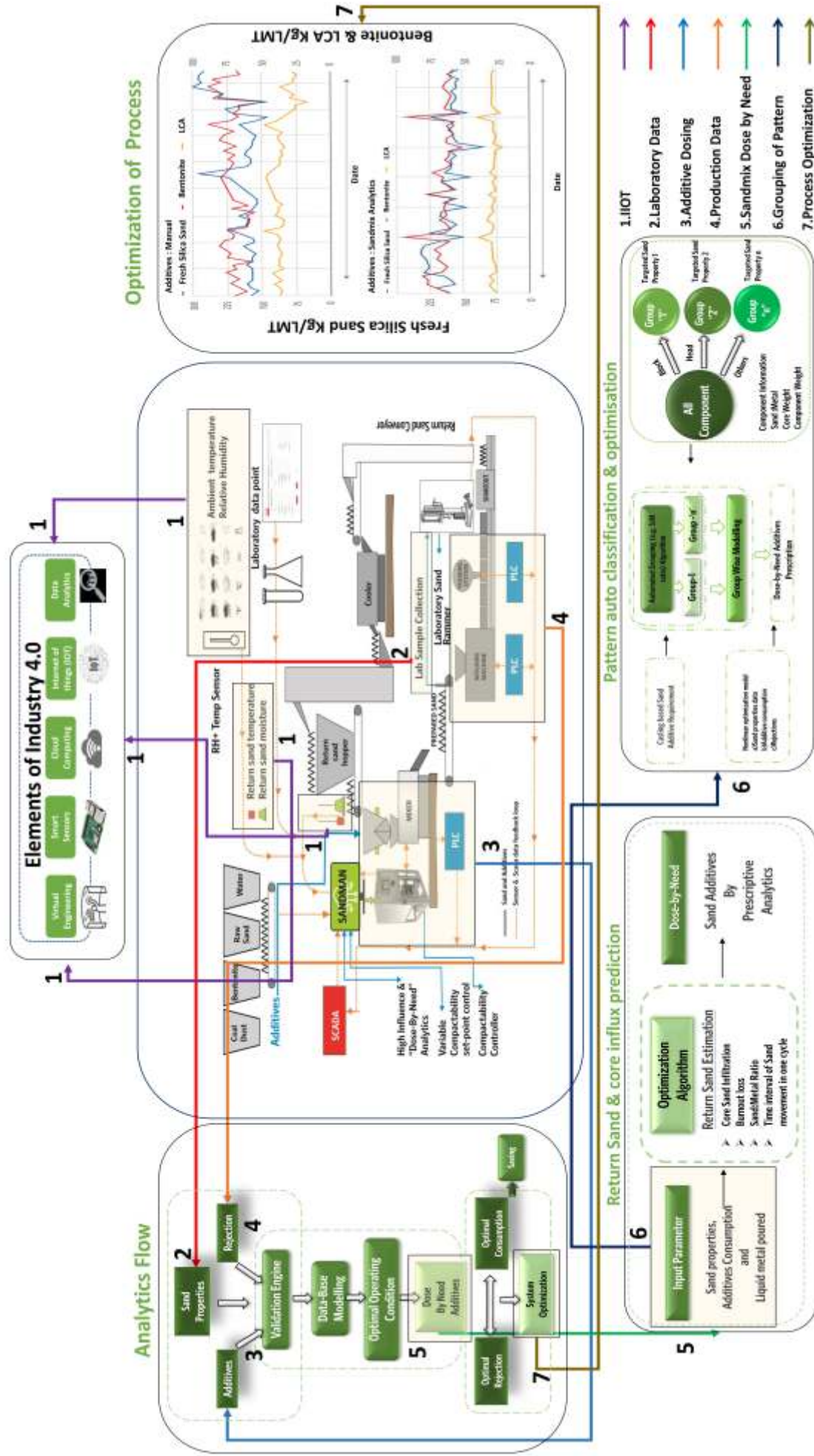


- ▶ **SANDMAN**[®] can be integrated with the moulding machine and its supporting systems like the sand mixer and additive dosing systems of the foundry. The software would be able to send a direct signal to the machines to control the dosing of various materials.
- ▶ For example, **SANDMAN**[®] could monitor the active clay levels in the sand and automatically adjust the amount of bentonite to be added to the sand-mix, in near real-time based on specific formulas and recipes also derived from **SANDMAN**'s unique **SANDMIX** Analytics, to ensure that the sand targets and meets the required properties. By automating the dosing process using predictive and prescriptive analytics, the accuracy and consistency of each and every sand mix improves and so does good casting outcomes.

SANDMAN[®] team is ready and waiting to work together for establishing true IIoT based analytics in the foundry.

SANDMAN Green Sand Digitalization & Machine Learning Analytics Schema

MPM Infosoft has ability to digitize and digitalise the system sand loop



SANDMAN saves more than INR 17mil. in costs by reducing sand rejection by 72%

🔍 CASE STUDY

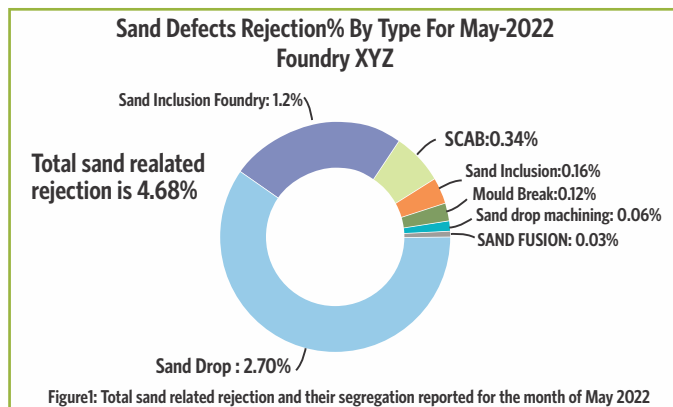


GOALS :

To reduce the sand related rejections and estimate the savings that can be achieved by controlling the rejections.

BACKGROUND

Before **SANDMAN**[®], one of our foundry clients, with a production capacity of approximately 26,000 tonnes yearly, experienced sand defects rejections of 4.68%. They are experts in producing iron castings, mostly nodular iron. Their average bunch weight and sand to metal ratio are 83kg and 9.03 respectively. Additionally, their average core weight is 2.4kg. The detailed segregation of the types of defects is mentioned in the Figure 1.



After implementing **SANDMAN**[®], the foundry was able to monitor, analyse, and by using **SANDMIX** "dose-by-need" prescription of sand additives; succeeded in reducing their sand-related rejections and achieve cost savings.

Rejection
Before
Sandman
implementation
4.86%

Rejection
After
Sandman
implementation
1.33%



ACHIEVEMENTS

A) REDUCED SAND-RELATED REJECTIONS

A sample instance is presented in which the impact of adopting Sandman software on sand-related rejections for one of our clients is discussed. For this purpose, the rejection trend over a period of 10 months is analysed after implementing **SANDMAN®** in the foundry.

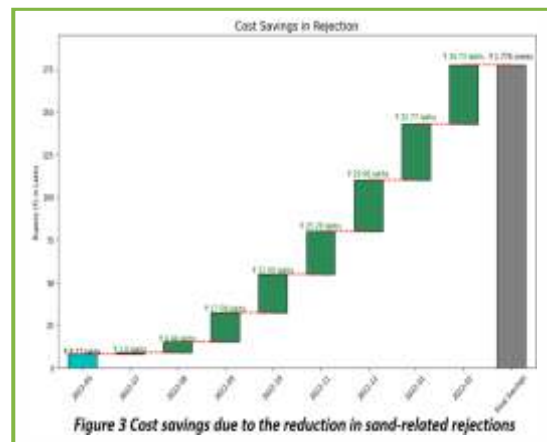


Figure 2 shows the rejection trend starting from May 2022 to February 2023. In this analysis, May 2023 is considered as Baseline period. The term '**Baseline period**' represents the period from where the data is taken for comparison for subsequent months. On comparing rejection from May 2022 to Feb 2023, it was observed that rejection decreased by approximately **72%**.

Cost Savings
after Sandman implementation
INR 17.76 mil.

B) COST SAVINGS

- ▶ An estimated saving is reported in terms of reduced rejection as compared to the baseline period (June 2022 to Feb 2023). In the present analysis, only the savings that can be achieved and quantified due to the reduced sand-related rejection are considered.
- ▶ The total savings of **INR 17.76 mil.** has been achieved by monitoring and controlling the sand-related rejections using **SANDMAN®** (Figure 3).



KEY TAKE AWAY

- ▶ **SANDMAN®**, with its powerful data analytics tools, has the potential to revolutionize the foundry and sand-casting industry, enabling foundries to optimize production, reduce waste, and improve quality.
- ▶ By controlling the sand related rejections, a considerable amount of monetary savings can be achieved that will increase the profit margin for the foundries.

$U_m \leftarrow I_n, i \leftarrow 0.$

1. Let $(x, \alpha) = \arg \max_{x, \alpha} \sum_n^M \max_{\Delta x, \Delta \alpha \in A} h(U_m, B_{x, \Delta x, s, \alpha, \Delta \alpha})$

Let $(\Delta x_m, \Delta \alpha_m) = \arg \max_{\Delta x, \Delta \alpha \in A} U_m, B_{x, \Delta x, s, \alpha, \Delta \alpha}$

Update $U_m \leftarrow U_m - c_m$

n , else go back to 1.

$\arg \max_{x, \alpha} \sum_n^M \max_{\Delta x, \Delta \alpha \in A} h(U_m, B_{x, \Delta x, s, \alpha, \Delta \alpha})$

“What gets measured gets managed”
- Peter Drucker

Update $U_m \leftarrow U_m - c_m$

Initialize $U_m \leftarrow I_n, i \leftarrow 0.$

Let $i \leftarrow i + 1$. Let $(x, \alpha) = \arg \max_{x, \alpha} \sum_n^M \max_{\Delta x, \Delta \alpha \in A} h(U_m, B_{x, \Delta x, s, \alpha, \Delta \alpha})$

Let $(\Delta x_m, \Delta \alpha_m) = \arg \max_{\Delta x, \Delta \alpha \in A} U_m, B_{x, \Delta x, s, \alpha, \Delta \alpha}$

Let $c_m = U_m, B_{x, \Delta x, s, \alpha, \Delta \alpha}$. Update $U_m \leftarrow U_m - c_m$

Stop if $i = n$, else go back to 1.



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Disclaimer:

Rejection can occur due to variations in input raw material quality and/or changes made the process/machinery which are not captured by the foundry either as a test, or as annotations, and can vary from periods to periods in time. Therefore the software Sandman does not claim nor proposes that it can solve rejection issues on a stand-alone basis.

Casting rejections arising from metallurgical issues, tooling issues, methoding and more non-sand related issues, are not addressed in the current version of the application.