IMPLEMENTATION OF INDUSTRY 4.0 IN TESTING & CONTROL OF SAND

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ARTICLE TAKEAWAYS:

- Understanding the equipment needed to translate data to establish meaningful conclusions
- Repetitive actions such as testing and registering data can be mechanized, reducing costs and increasing quality

THE BAND WAGON

We've been hearing and learning about it for quite a while now... Industry 4.0, IOT, haven't we? Opinions are split with respect to whether there is anything new. Many also claim that it's a farce created by electronics and software conglomerates since there haven't been many break throughs to sell, the advent of Internet, e-mails, Amazon, the evolution of humans, and everything in between.

We know it for a very long time that; Machines can communicate with each other. PLCs communicate with each other, PLCs communicate with PCs, and embedded systems communicate with PCs and PLCs. Essentially many digital testing devices or production devices and equipment have been communicating with each other since panel call indicators of the 1920s and automatic number identification of the 1940s. Even today when we are synching or uploading it to cloud simply means uploading it to a server (which is essentially a machine) sitting somewhere, through the Internet. So, IOT & 4.0, is it a 'band wagon' that we shouldn't miss to hop on—or just another jargon?

WHAT'S DIFFERENT NOW

The Internet of Things (IOT) essentially lays the foundation for Industry 4.0 to come into reality. The critical piece that converts a simple machine to machine communicating to an IOT enabled and Industry 4.0 ready device network, is the network's ability to converse with servers which are capable of AI & ML (Artificial Intelligence and

Fig 1: Evolution of Humans

Machine Learning) by crunching large amounts of data. When Google suggests a restaurant to you with a 'match rating in %' obviously it's not some guy who in an instant analyzed your past data, likes, dislikes, reviews and ratings and in real time suggested you a restaurant for a quick lunch. In this instance, AI and ML are at work and your cell phone is the IOT enabled device. The difference in today's world and the past is; earlier intelligence and learning capabilities came along with pairs of hands and feet—now AI & ML comes without it as rental services.

WHAT IS IN IT FOR A FOUNDRY

A foundry probably has more variables to control to produce a good casting than variables involved in face recognition of a slogan shouting mob. If only we could deploy simple technology to acquire data from all fronts and variables to use the tremendous power of AI and ML to control processes, additions, compositions, temperatures and suggest gating related changes—things would be much simpler for the foundry manager.

WHERE DO WE START

To move forward with 4.0, the keystone is the almighty data. For data to be usable for any kind of inference, its integrity and reliability is of utmost importance, as we all know the GIGO rule. That is, computers are only as good as the data that is input. When you train AI on biased data, you obviously get biased outputs. Put very simply, you cannot perform deep learning, machine learning or leverage artificial intelligence on data that is either non-existent or incorrect.

If you want to go ahead with AI and ML or just would like to take more informed decisions without much manual errors, the most important task is to collect correct, un-biased, reliable data that can be fed to AI and ML or analyzed to draw conclusions. In the future, this could lead foundries to run on their own.

Let's classify devices & equipment that we interact with every day from an IOT perspective:

1. Completely analogue
2. Digital with no communication interface
3. Digital with legacy communication interface
4. Digital with industrial grade communication interface (e.g., Modbus over RS485, RS232, TCP/IP)
5. IOT enabled

If we want to have meaningful conclusion, we must acquire data from all fronts and variables and that can be accomplished by a small device like V-Sync and little low cost DYI modifications to completely analogue systems. All of the above equipment can be enabled to upload data to a cloud-based database or to a local server with increasingly lesser difficulty from top of the list to the bottom.

V-SYNC

A data acquisition and sync module can help in this regard for equipment 2 to 5. This module on one side can communicate with industrial equipment in various protocols such as Modbus, Profinet, Canbus and on other side it can communicate to a server over TCP/IP (typically called Ethernet) or GSM (typically called cellular) network. One such module can collect data from many connected equipment on the same protocol, acquire data and further synchronize it with database on server real-time.

Once data is logged in a secure database hosted may be on Google Cloud, AWS or Azure. Dashboards can be configured to have real-time analytics with Qlik, Microsoft Power BI or Tableau.

Configuring dashboard does involve domain knowledge and establishing causality of data is the key factor.

Example of making a simple analytical connection in a green sand high pressure moulding foundry.

A molding machine fitted with squeeze pressure sensor is transmitting:

- Squeeze pressure for a particular mold
- Running pattern number
- Mold number for the pattern

An automated testing apparatus such as a VCAT Mark II sitting

Continued on next page

above the molding machine is transmitting following parameters as sand is pulled in for each mold:

- Compactability for that particular mold
- Moisture for that particular mold
- Permeability for that particular mold
- Green strength for that particular mold
- Temperature of sand at the time of molding
- Running pattern number (acquired from molding machine)
- Mold number for the pattern (acquired from molding machine)

The database created on the server would connect this data based on common values such as pattern number and mold number and when casting rejection data is available a control plan can be established by an online analytical services (shown in fig 2).

A typical analysis may look like the following example.

For Pattern No: XYZ1123

When:

- Squeeze pressure is between: 14-15 Bar
- Compactability range is: 36-38%
- Moisture range is: 3.7-3.9%
- Permeability range is: 280-300
- Green strength range is: 1.8-2.2 kg/cm2
- Temperature range is: 82-89 F

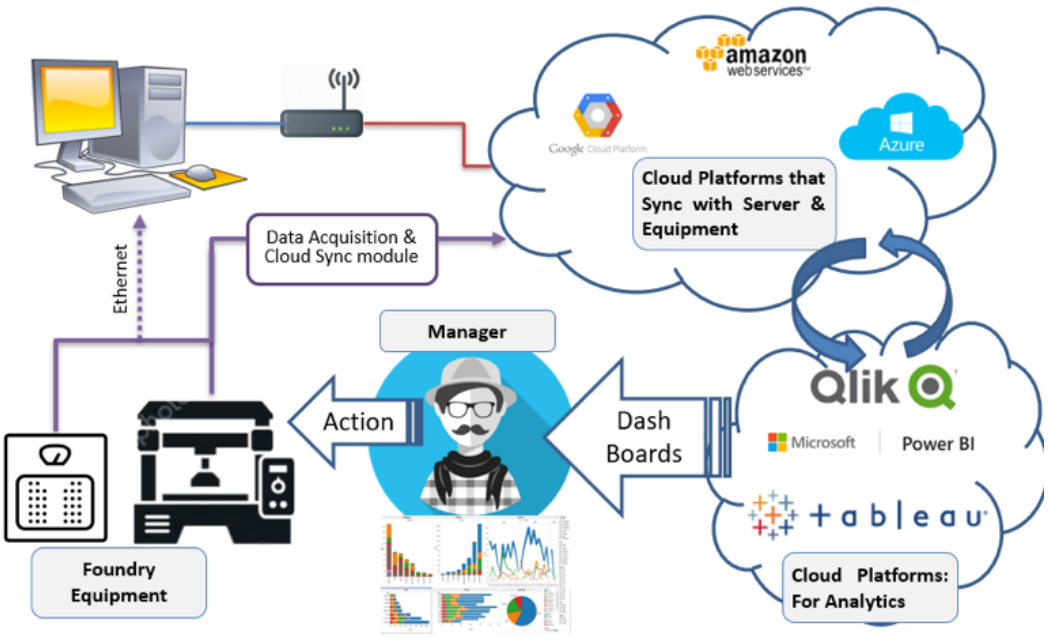


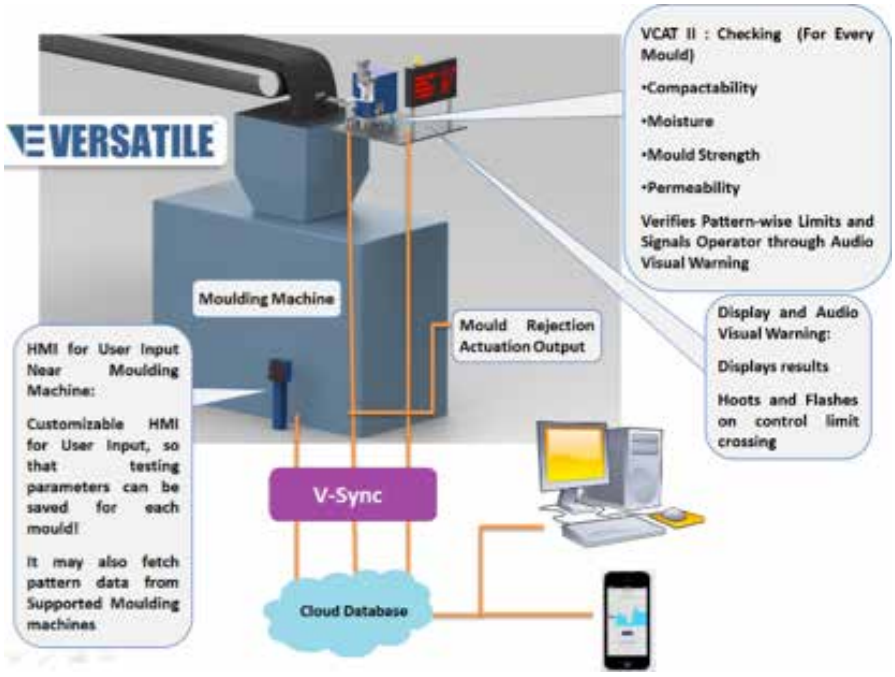
Fig 2: Preparing for 4.0

Casting defects on account of sand shall be < 0.3 %.

This can be taken as a control plan for that pattern by the foundry and can be followed by the online testing system (VCAT-II) as acceptance criteria for a mold to be poured.

V-CAT-II: THOU SHALT TEST EACH MOULD

One such effort from Versatile enables users to progress towards 4.0. A testing system that can test sand as it falls in the molding machine to make a mold, record readings and do much more.



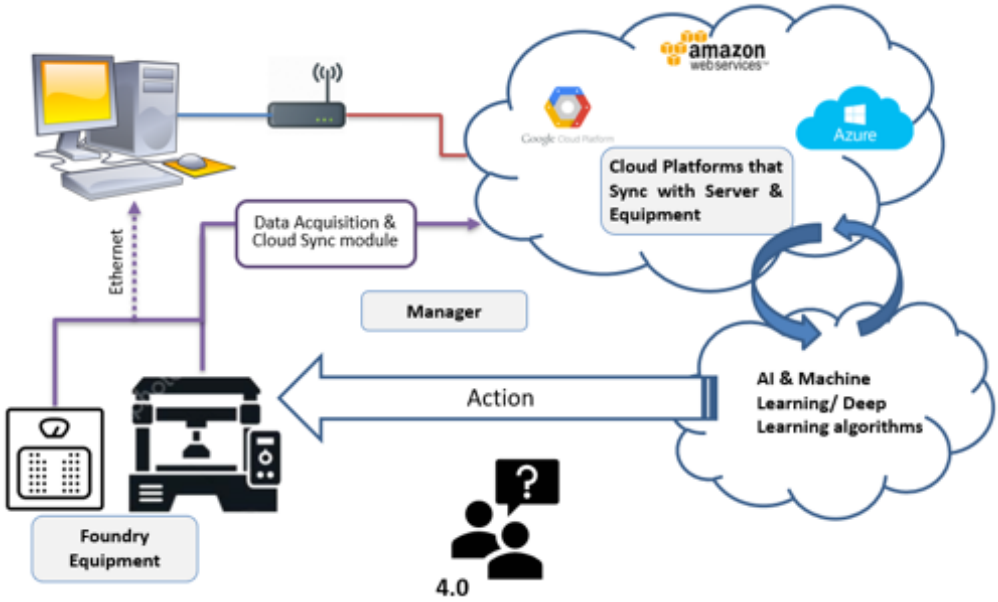
A VCAT-II installed right above the molding machine can serve following functions:

1. It can check compactability, moisture, permeability and green strength of sand when the sand in falling in the molding machine hopper to make the mold.
2. It can acquire pattern/ tooling number from supported molding machine PLCs or by user input through an HMI provided near molding machine.
3. It can send data to cloud with V-Sync data acquisition and cloud sync module and can also work with standard SCADA systems.
4. It can retain control parameters for each pattern/tooling and raise an alarm if the measured quality parameters of the sand falling in to the molding box deviate from control plan at the same time it also activates an output which can potentially destroy or mark/ identify mold for not pouring.
5. It can communicate with supported green sand testing and control systems (such as VCAT-II) working at mixer and automatically increase or decrease compactability set-point, in order to achieve correct parameters at the testing station VCAT-II installed above the molding machine. This indeed completes a feed-back loop makes way for a possibility that, varying moisture loss due to temperature variations is automatically taken care of by adjusting water addition at the mixer itself and sand strength can be automatically adjusted by adjusting bentonite addition at the mixer.

When automatically captured data from apparatus like this and other analogue devices such as energy meters for mixer, current monitoring devices on sand plant, simple manual core production machines fitted with counters, temperature monitors, come on one common platform on cloud, with powerful analytical and machine learning capabilities available at a small cost would make it fun for a foundry manager to establish causality and predict when something good or bad is going to happen.

CONCLUSION

Repetitive actions like testing and registering data can be completely mechanized, drastically reducing need for skilled man-power. With devices like V-Sync, data can be acquired even from very old devices and they can be made internet ready. With the help of connected devices, when cross-functional data, right from production, melting, sand plant and other departments is available on a single platform, automated analytics and in due course direct action on process through AI and ML is a near future possibility. All this, assuming we provide the machine learning platforms with credible data – remember GIGO. Monitoring and improving productivity with IOT & 4.0, without monitoring and improving quality with IOT & 4.0, is like racing with a horse without bearing rein.



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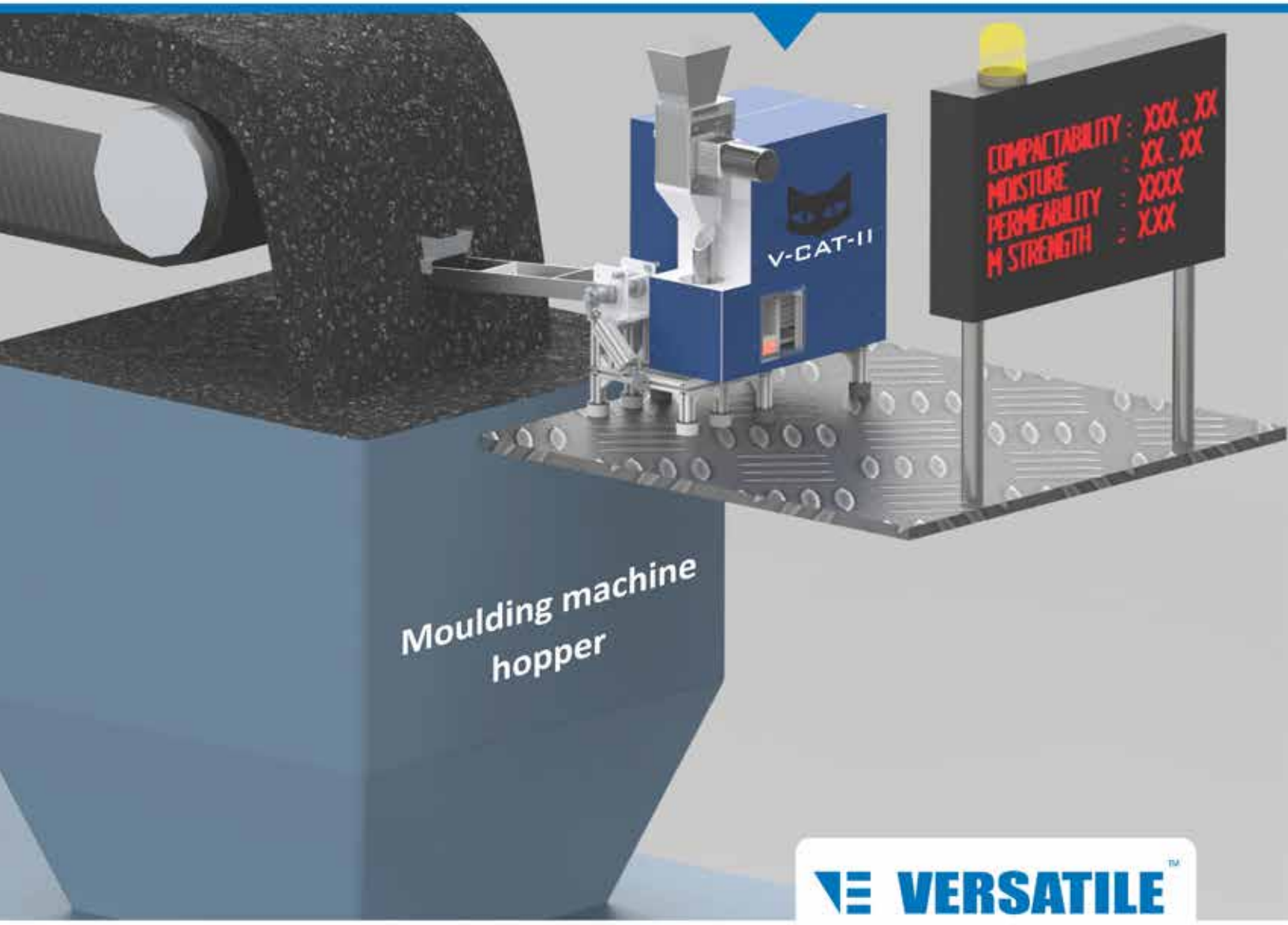
Eliminate the Sand Lab

Have a V-CAT near the Moulding Machine



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A typical installation of V-CAT testing system can be seen above. The V-CAT is commissioned above the hopper of the Molding machine where the machine receives sand from a belt for every mold & the V-CAT tests the sand as it falls. Which simply means, known parameters for each mold!

V-CAT VERSATILE CONTROLLER & TESTER

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http://sandtesting.com