Although inventory, production and financial managers may all agree to the above statement, this does not always mean all parties have the same priorities. Even though they all have the same end goal in mind, there are certain recurring challenges across most industries when it comes to silo monitoring, that causes conflict between the aforementioned managers. The most common and costly conflict is that of “what safety stock levels” to keep? This challenge occurs simply because current technologies and methods being employed for silo stock monitoring, were never specifically designed for the application and resulted in unreliable stock level reporting. This left managers with the task of predicting delivery and production schedules with misinformation.

Traditional methods such as ultrasonic, radar and laser level transmitters only measure a single sample point across the entire uneven surface of the stored material. Therefore readings will differ drastically depending on where the instrument is installed on top of the silo. This is true for “dip testing” as well. Also, these traditional methods cannot penetrate the dust cloud present in this application and many cannot measure during filling or emptying. In other words, until recently, the “wrong tool for the job” scenario had been taking place.

This lead to extremely unreliable stock level reports being sent to management, causing a tendency to stock high levels of safety stock material to avoid shortages that halt production. This ultimately leads to higher production costs and less profits due to the cost of carrying excess stock. And other extreme, losing out on production from lack of material, because higher “stock on hand” levels are reported than what is actually in the silo. This is true for organisations mining, trading and or manufacturing bulk solids and utilising large, medium or small silos.

Let us ask and answer two important questions to better understand the application and to move towards more profitable safety stock levels for accurate and predictable inventory control.

What are the essential requirements for useful silo monitoring?

- High accuracy
- Continuous measurement
- Open communication system with less possibility of human error
- Calculated mass, volume & level measurement values

To answer the second question let us describe four of the most important requirements to satisfy the first question. We understand that there are more since each application is unique in some way or another. Generally though, the most important requirements for silo stock monitoring as described by our clients across Southern Africa are:

**Suspended dust**

In your typical silo, storing granules,
there is an inherent amount of dust particles present in the space between the maximum stock level and the top of the silo. The finer the stored granules, the finer and denser the dust cloud. This dust cloud can become quite severe during filling and emptying of the silo and can take hours to settle. Advanced laser technology is now widely available and able to accurately scan large uneven surfaces, however lasers cannot penetrate dust whatsoever and readings often require human manipulation or “cleaning up”. Therefore they are not reliable for bulk solids monitoring. Traditional ultrasonic level transmitters installed at the top of silos use a sound frequency (normally ranging between 20 – 50 kHz) which cannot penetrate the dust cloud sufficiently to measure the stock level accurately, in some cases not at all. Ideally you need an instrument that operates in the range of 3 – 10 kHz. The 3D level scanner II from APM in Israel has electronic transducers that operate dynamically within this optimal frequency range. Adjusting automatically within that range to suite the particular application and installation. Ensuring penetration to the stored solid’s actual surface profile.

Various silo shapes.

Each industry and most individual businesses within those industries utilize unique silo shapes, in order to meet their particular process requirements. There are even multiple silo shapes and sizes per site. Also silos that are the same in geometry may store products of different mass properties, different dust cloud density etc. These differences, although only subtle at times, creates the necessity for plant managers to utilise various measuring techniques on the same plant, for the same purpose, which is to acquire accurate level, volume and mass readings. Control and automation managers agree that this type of ad-hock system is problematic to say the least. It reduces reliability of measurements, increases labour costs, increases instrumentation costs, increases points of failure in the production process etc.

The maintenance of this type of silo monitoring system is very difficult and expensive to manage. For instance, on one site you might find the following to be true. One large 50 m tall silo with a radar level transmitter being used. Then a medium 30 m silo with an ultrasonic level transmitter installed. Then lastly a small 10 m tall silo which has a manual dip test performed at certain times of the day (a rope with a weight on the end) also referred to by others as a “rope test”. All these methods require separate technology knowhow, separate instrumentation and separate calculations to acquire the desired level, volume or mass measurements. Done manually these calculations take up valuable skilled man hours. Done via a PLC will increase your system costs, increase the network...
load, increase programming time. Training must also be provided on multiple makes and models of instrumentation. The 3D level scanner, has on-board silo/bunker manipulation firmware as well as versatile management software. The user can “teach” each unit, once off, the specific application properties of each different silo that requires monitoring. Such as: The specific silo geometry (i.e. shape, height, diameter, filling point, emptying point, bottom cone geometry etc.); Specific material density for mass measurement; Mapping of small obstructions etc. One instrument for practically every silo shapes up to 70m tall and for all bulk materials. This means less training and programming time, less instrumentation costs, less network resources and less skilled man hours. Most importantly, a universal uncomplicated Windows based system means accurate inventory control. Typical plant setup with multiple silo sizes and shapes is shown in Fig. 1

Uneven measuring surface
A hugely underestimated challenge is the nature of stored bulk solids to form randomly which creates an extremely uneven measuring surfaces. Vastly different from measuring the level of a stored liquid which is dead even/flat. This is not to say that silo users are not aware that this occurs, rather that this fact merely hasn’t aroused enough importance. It is critical to accurate bulk solids measurement.

Absolutely critical. Since traditional measuring methods only measure a single point across the entire uneven surface of materials inside the silo, the readings are unreliable at best. Dip testing, single horn radar/ultrasonic and capacitance probes all only read the level at one single sample point. So depending on where the instrument is mounted, that will determine the level that is transmitted to the control centre.

Because of the random accumulation of product inside the silo, the level on the right side could be vastly different from that on the left side and again different in middle. The larger the silo the larger this difference will be and the more inaccurate the volume, mass and level readings will be. In order to accurately measure an uneven surface you must install an instrument that can read as many different points across the entire surface profile within the container/silo and then gives one combined, un-manipulated reading. This will ensure very high accuracy. The 3D level scanner has 3 integral transmitting horns. They transmit very wide pulses, up to 70 degrees wide, to cover a larger surface area. The multi horn technology enables the instrument to measure samples from approximately every 20 cm² of the entire surface profile. Then produces a combined reading of the uneven surface with an accuracy of 1 – 3% (i.e. multipoint measurement with a combined reading).

Further more, converting the RS485 to EtherNet is extremely easy and will allow the user to transmit and communicate with the instrument via TCP/IP over 10/100 EtherNet networks or even Wi-Fi. Having continuous accurate silo stock readings allows the management team to reduce safety stock levels. Thus reliably plan and predict production, forecast costs, accurately measure material usage in recipes, this list goes on.

Case study: Botswana Ash, Arole

- Project: Accurate volume measurement of silica ash stored in silos
- Initial application challenge: Accurate measurement of very dusty soda ash in a large silo. Dip test measurements were very problematic and unreliable.
- Client’s required outcome: Customer required an automated measuring system for reporting accurate volume measurements of very dusty soda ash to Botswana
- Products installed: The APM MV 3D Volume Scanner on 3 Silos for accurate and continuous volume and mass measurement. The AirLive AirMax2 outdoor CPE units to transmit the data from the silos to the control room via Wi-Fi.

Contact: Dylan Swartz,
Allpronix, Tel 011 795-9500,
sales@allpronix.com