Seeding Knowledge

Optimizing your cannabis grow by understanding your data

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About the topic:

The cannabis industry is growing fast. There is increasing demand from growers for solutions that provide complete control over every aspect of their growing operation, integrate with many peripheral systems from sensors to robotics to cameras – and manage large amounts of data in the process. How can you make sense of it all to understand the dynamics of your growing operation and deliver consistent quality, batch to batch for your brand? We asked our expert these questions and more:

- What is the right data to collect?
- How do you get all your data in one place?
- How do you use your data to your advantage?
- Should you be using data to optimize what you control, how you grow or both?
- At what point does learning occur and how do you record and repeat best practices?
- How do you improve when you are not getting the results you want?
- Do you have zone relative data or batch relative data and how does each impact your grow?
- How do you move from being reactive to proactive to predict outcomes with your crop?

About the expert:

Geoff Crocker, M. Eng, P. Eng; Geoff Crocker joined Argus Controls in January 2021 as Chief Technology Officer. He joined Argus at a dynamic time as new technologies and data applications are emerging at a rapid pace. Geoff is responsible for our technology platform development with a focus on control systems and assessing options for new platforms. Geoff brings 20 years experience in product management, client relations and business strategy, most recently in the roles of Director of Product Management and Vice President, Technology at both Neurio Technology Inc (Generac) and Corvus Energy. Geoff serves on the industry advisory board of Simon Fraser University, department of Mechatronics Systems Engineering.

Why this topic, why now?

We are exposed to data proliferation constantly through social media, the mainstream media, our homes, our cars and so many things in our every-day lives. The question is how can we make our lives better with all that data? It's natural then for us to ask the same question in the agriculture and cultivation space.

At Argus, we see this first-hand. We see a significant amount of data becoming available to us in the cultivation and ag-tech industry, the cannabis sector and, importantly, there is a lot more appreciation and understanding of the potential of all that data with our clients.

The shift that we're looking to create around data is not about having to collect the data. The data is already there. It's really about building a clearer understanding what can be done with the data and how to really leverage it to its maximum value. Our existing clients running our control systems have all that historical data. The question is, how do they go beyond that?

What is the right data to collect?

Within certain limits, there is no wrong data to collect. There is no sense collecting data on things that are not inherently meaningful or relevant. There is also no point simply adding sensors either because everything has a cost. The more pertinent consideration is to consider how to collect it all in a way that really allows you to add value.

For example, data comes in many formats. A cultivation facility probably collects data in too many different ways and in too many different places to allow it to be consolidated and viewed in a common way that really lets you create appropriate cause-effect connections and elicit insights.

This phenomenon is quite natural. In fact, we have always been storing data this way, for example in notebooks, on whiteboards, and in Excel spreadsheets. Each of these formats is serving their function and meeting users' needs. However, if you're not bringing it all together in a common place and a common view, then you will be missing the connections between those data points. Even more importantly is to be analyzing that data in a way that you can create a better decision about the growing space and what to do there.

How do you get all your data into one place?

Getting all your data in one place is a critical challenge.

Let's assume you are growing a crop and in a controlled environment. You will have a control system to run that facility and make sure that it is creating the growing conditions in the environment that you want. That alone is a massive amount of data. Temperature, light, humidity, CO2, irrigation, and fertigation are all factors that come together in one place to create that environment for your crop to grow. Meanwhile, at the heart of it is the control system which is supporting all those pieces in a digital and a "database" way.

The control system is a natural place for that first layer of data to be collected and consolidated. The question then becomes, do you export that massive amount into another location where you have other relevant but sporadic data being stored? For example, you could think of standard operating procedures related to the growing operation, registration data, growing notes or seed varieties, etc. which will be updated occasionally or applied less frequently. These sporadic events are not happening second by second, minute by minute yet they are important to record and may not be in a location or a format that's easy to tap.

So the next challenge is how do we create a data driven space digitally that allows for all the data to be consolidated into one place and have that layer in naturally next to the environmental control data.

We already see one way to get all the proper data in on the crop is when we have registration data coming in with growers walking around, using a tablet and typing information in. In this case you are putting data right into a digital environment and that can be automatically funneled and collected within another space.

We also see that there are opportunities to use camera systems to monitor crops, and then transcribe that image data into plant parameters and issues or problems with the plant.

There again, you're automating data entry and not having to manually go around, collecting data from notebooks and transcribing it, which creates the potential for error or loss of data.

How do we use all this data to our advantage?

Having the right data in the right place will let you find correlations between activities and issues or it might highlight scenarios within the grow that might not have been obvious in the past.

For example you may discover a reaction to a trimming activity. With trimming, you've physically altered what's in the space. The plants themselves have an impact on airflow, temperature, humidity, etc. Therefore depending on how you've structured your temperature sensors, whether you just have single point control, or if you have informational sensors, you will start to see impacts of things that happen as the plants grow as they naturally affect the space and change results.

This seems obvious, but until you actually link those data sets together, then you might really miss what the impact is. Maybe you find it does not change it as much as it did in the past or maybe it changes it more.

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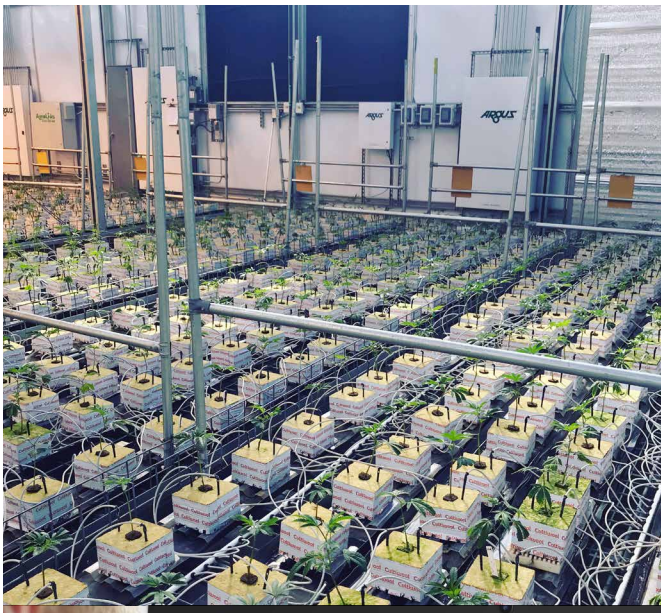
Another example might be powdery mildew. When that occurs we know that it's related to humidity. So you should be able to see that in the data. The question is, can you start to find a precursor? So rather than waiting for the mildew to happen and then conclude that the humidity must have been too high, you can start to monitor that humidity, spot the trend in the data and identify the issue before it becomes a problem for your crop.

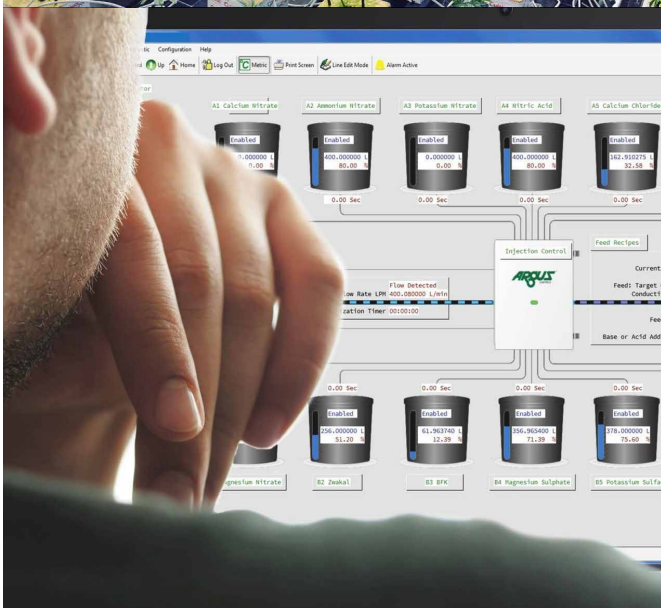
If you don't have that tight coupling between your environmental data and your plant observations you will not be getting a data driven view of your plants' experience. Even just being able to quickly tie together plant parameters, such as height, leaf area, stem diameter (or anything else that you're measuring) in parallel with your environmental control data will help you understand the plant experience from within your grow room or from room to room.

In this way you will have a database driven view of the plants experience. Not having a view that connects it all from start of life to harvest means you're missing the plants' experience.

Being able to look in a longitudinal way across time, not just for your current grow, but also all the previous grows as well – will enable you do determine what's worked in the past and what has not.

Finding the commonalities and the differences, and using those to drive the decision-making going forward will help you achieve optimized and predictable results.





Should you be using data to optimize what you control, how you control, or both?

Definitely both. I look at that from a macro and a micro point of view of the data. How you control is very much at the micro level. You're looking at decision-making in real time. It's a 24/ 7 view.

How you grow is a much more macro scale and thinking more about the recipe or the process that you would like to employ for the plants.

The learnings you can get from the data comes from both views. So you can look at success data to make decisions about controlling at the micro level. You can also look at the data of what's been happening in the environment to adjust your recipes or your processes at a macro scale. The influence comes from both views, and both should be used.

At what point in the process does learning occur and how do you record and repeat best practices?

You can't learn without understanding the outcome. You perform an activity and you look to see what the result of that was. You become informed from that and adjust as needed.

When you apply that to a growing situation, you've got a growing period of many weeks or months. You will set up a plan for that and execute that grow. From that you will record the results and register various plant parameters during the grow. There may be some moments that learning happens as part of that. Through observation and recording you will need to check for what you want to see, what you expect as far as timing for height and flowering and various stages that are expected.

But ultimately, the success of the grow is determined by what was produced. That output is the key point of learning. Whether you're doing a manual analytic or a human view of data and trying to find nuances, or you're trying to use machine learning or artificial intelligence methods - none of those will really be truly

successful without having the success metric or the actual result at the end of that process as a point of reference to learn from. The whole data set is key for that. Having that data set will enable you to get that repetition and to consistently repeat those best practices.

If you're not getting the results you want with your crop, how do you improve?

The answers are always in the data. This is how we've always improved to get the results that we want if our desired outcomes are not happening. This process and the methodologies that we're using here are not new. We've been performing them ourselves, as humans, for some time and much of our success as a human race is based on that.

As people, we're very good at capturing lots of data and synthesizing it, finding correlations and making change based on that. What is different now is that we are adding much more data than we ever have before which makes finding nuances more difficult. As such, we need tools to be able to help us with this complexity. Computer based tools and machine learning will help us efficiently spot these improvements and get the results that we want.

What is the distinction between zone relative data and batch relative data and how does each impact your grow?

I'll start with zone relative data because that is what most of us are used to experiencing. This is where you have a zone in your facility, whether it's a room or a chamber or greenhouse bay - essentially any space that's under control.

That control data is a time series set of data that is running that zone. Control systems have been controlling the growing environment for decades and growers are used to seeing the data this way.

But what the new view - or a more of a database driven view - of growing is when we look at batch relative data. It is quite common, expected, and actually quite desirable in many situations to move plants from one zone to another throughout a facility.

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In doing that, you lose the plants view of what is its experience is because the time series data is still only looking at the zone. So you have to collect data for when that plant was in each zone and stitch them together to create a batch relative data view. In a batch relative view, you're naturally looking at what the plant has experienced over time throughout its life, right from the seed or clipping stage all the way to production and harvesting.

And without that longitudinal or life-cycle view of the plant's experience, that strong data set of all the environmental data, as well as all the operational process manual data entered alongside, is lost and unable to be consolidated in a single location.

That's really the new way of looking at ones grow and making sure that you are capturing that plant centric view in a database format.

How can I move from being reactive to proactive to predict outcomes with my crop?

This is the essence of this data view that we're talking about. Without having all that data in one place, it does become very reactive. Also, once the grow is done, you can't undo that. The time is already passed.

That reactivity becomes a lesson learned that can be expensive. So if you are able to really understand all of that at once and collect all that history, you're able to then be more proactive with your outcomes.

This approach becomes very important from an operational standpoint. Anybody in the operations side of the business will appreciate predictability and knowing that you're going to achieve a certain amount of production or a certain level of quality to be able to then say, at this date, we know we'll have X number of kilograms and it will have this level of consistency and quality and characteristics because we followed exactly the same recipe.

We have the batch history of that. We're running it in the exact same way through the exact same spaces, and they've all been validated. So that predictability becomes extremely valuable in that there's not a guessing game anymore about when do we need to start a batch, what are we going to get at the end of it, or is it going to meet the market needs?

This approach is the most proactive, predicting those outcomes, knowing what it's going to cost, how much effort it's going to take, all of that can be rolled up into a business plan and really be much more predictable.

What is machine learning and what role can it play in crop optimization?

Machine learning is having computers look at the data in very similar ways in the way that humans look at it. In fact, what we're seeing the most success with is what are called convolutional neural networks.

The operative word in there is "neural". Indeed, it is very much trying to replicate some of the way our brains work in processing data, doing that in a digital format and trying to get to that same predictability or insights that humans have and have been successful with.

And so that is really the machine learning side of it. You've heard this called AI. You've also probably heard of things like fuzzy logic. All of this really lives within that same sphere.

There are different approaches, different ways of doing it. Lots of smart people are thinking about this from many different industries. We are just really leveraging that and figuring out what works best for what we're doing here with our data as it applies to growing plants.

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This data tends to live in what we call the cloud from a digital standpoint. This is the service provided to us by the likes of Microsoft, Amazon, where they have massive amounts of computing power - because we are taking in large amounts of data and performing a tremendous amount of operations that try to find different pieces of success.

So that's the mechanics of how we're doing it. It's role, of course, then just becomes being a very good place to find points of optimization.

As a grower, what are my next steps?

So really the takeaway right now is to think about what is it that you're doing in your operations, where you are collecting data, where is it going?

Since you have a control system already, is it giving you the opportunity to consolidate all that data in one place?

And most importantly, are you getting that batch relative data as a strong data set that is not just environmental data, but including everything in your operation?

Do you have the ability right now to put that all in one place and create those strong data sets that you can really start to see correlations and learn from?

And if you don't, then that's what you really need to start thinking about and moving towards so you can consolidate all of that data into one place to find those nuances, track that over time and start to have that predictability.

I can guarantee you, everybody has some level of data that isn't being consolidated in one place. Even if you think that you are, the chances are that you're missing on some aspects of it.

So that's the best thing you can do is find those pieces of data, know what's important to you and start collecting it all in one place. And ideally having that be in a software based tool that's going to be able to collect that over time and allow you to see the impacts of changes over time, not just on any one grow, but across your whole history of growing.

That's really where we're going to start to have those really great outcomes and find those opportunities
for optimization.

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> Machine learning will help drive us to better and better places and that's really what its role is, to create those insights.”

This transcript has been edited from the original for clarity and brevity.

CEL GROUP OF COMPANIES

Founded in 1964, the CEL Group of Companies (CEL) comprises Conviron Canada, Conviron USA, Conviron Europe and Conviron Australia together forming the world's leading designer and supplier of controlled environments for plant growth. The CEL Group also includes Argus Controls, the leading supplier of plant-centric environmental controls and automation systems used in greenhouse and indoor growing facilities. Together, Conviron and Argus provide technologies to our clients in the plant science research, commercial horticulture, and plant-derived pharmaceutical industries in over 90 countries around the world.

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