Summer 2011

ARGUS CONTROLS

ARGUS ADVISOR

Information for Argus Control System Owners

In this edition of the Argus Advisor we take a look at curtain control as an example of how a single equipment system can be made to serve multiple purposes. We also discuss the power of time-weighted and accumulated influences for developing advanced control strategies.

We'll be at the Ohio Florist's Association short course and trade show once again this year from July 10-12.

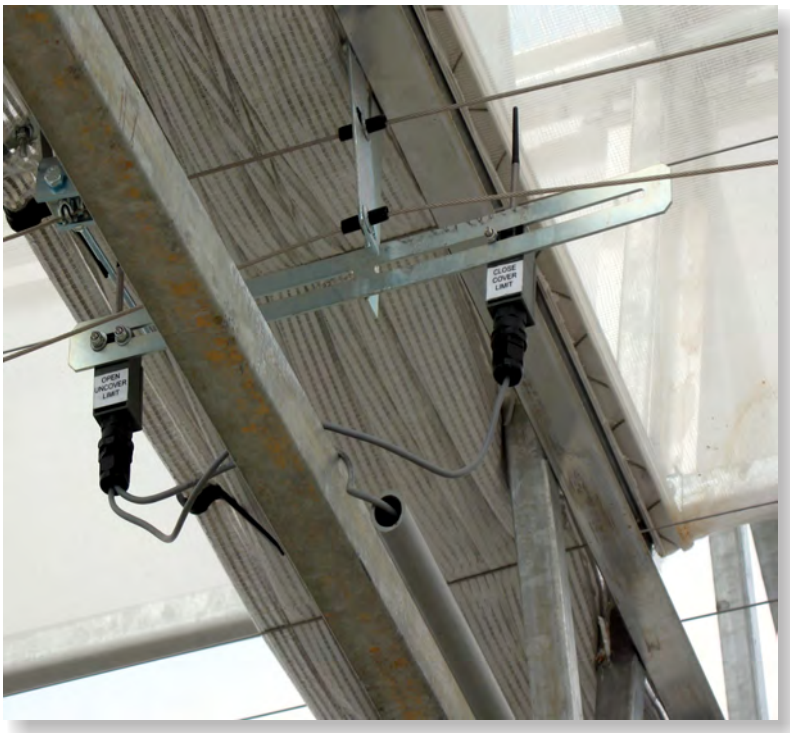
This year we will be showcasing our newest feature: Time-Stamped Imagery. Now you can combine time-lapse camera imagery with your Argus control data for an even more comprehensive overview of past and present crop conditions.

If you are planning to attend the OFA short course this year please stop by and see us at Booth 1021. It's always a pleasure to meet our newest customers and to catch up with old friends.

Hope to see you there.

Alec Mackenzie

The Push and Pull of Curtain Control



Retractable greenhouse curtain systems are one of the most beneficial and versatile equipment systems you can use in a greenhouse. They can moderate the greenhouse environment in several ways and provide major savings on your fuel bill. Although they have many uses, they also have a number of limitations that must be considered when devising the most efficient control strategies for managing your climates.

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Take Control With Argus

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Curtain Control...

First, let's look at some of the many things that a curtain system can do:

Applications for Curtain Systems	
Preventing Heat Loss	• Provides a mechanical barrier for heat retention. • Reflects radiant heat back into the crop (aluminized strips). • Reduces the surface area of the heated greenhouse space. • Reduces heat loss by blocking humid air from condensing onto the glass.
Preventing Overheating	• Shades sensitive crops from high light levels. • Moderates air, leaf, and soil temperatures by reflecting light and heat away from the crop (aluminized strips).
Raising Humidity, Lowering VPD	• Acts as a barrier for moisture loss. • Reduces air and plant surface temperatures, thus lowering effective VPDs.
CO_2 Management	• Provides a mechanical barrier to help slow the loss of supplementary CO_2 applications. • Reduces VPD under high light conditions helping to keep leaf stomata fully opened for air exchange.
Photoperiod Control	• Blackout curtains can be used to manipulate day-length sensitive crops such as poinsettias and chrysanthemums.
Supplementary Lighting	• Helps reduce light pollution at night. • Increases efficiency by reflecting light back into the crop.

While they are of proven benefit, curtain systems also have some significant limitations:

Limitations of Curtain Systems	
Slow to Reposition	• Whenever a curtain is moving it is not in the 'right' position. By the time it gets there, external conditions may have changed. If it is constantly moving it is *never* in the right position! • Each time the curtain is moved there is wear on the fabric and other components.
Fixed Light Transmission %	• Half-pulling the curtain is at best a weak compromise since part of the crop will be in shade and the other part in full sun. • However, configuring shade to pull in an E-W direction at least allows sun and shade bands to move as the sun moves through the sky.
Fabric Choice	• The best fabric for heat retention is seldom the best for shading so a compromise must be made unless multiple curtain systems are employed.
Heat/Cold Trapping	• When fully extended, curtains can trap a lot of cold or hot air in the space above them. • Heat buildup under the curtains from sunlight and supplementary lighting can be a problem. • When first retracting the curtains, particularly after a cold night, it is important to do so in stages to avoid cold shock to the crop and an overreaction by the heating system.
Ventilation	• Curtain systems can interfere with passive ventilation/cooling through roof vents, often requiring some adjustment in the curtain position, the vent positioning, or alternative ventilation equipment such as side-wall fans.

Control Implications

Despite their limitations, curtain systems are a great asset when it comes to saving energy and achieving multiple control objectives. In doing so, the curtain must serve several masters, and this is where control can get interesting. Some applications are complementary, while others can be in direct opposition. For example, the best position for maximum heat retention is usually fully closed, while the best position for melting snow is opened. In such instances one objective must take priority. In this case we'll go with snow melting since preventing a greenhouse collapse trumps energy conservation!

Almost any control mechanism including a time clock, a thermostat, or a light sensor can be used to make a curtain open and close. However, **curtain control can turn into a tug-of-war unless some form of intelligent strategy is implemented** for dealing with competing needs and the inherent limitations imposed by the equipment.

Time clocks are fine for fixed interval operation but they can't respond to changing weather conditions or emergencies such as snow loads. Simple feedback controlled strategies such as light sensors tend to produce poor results in variable weather since **external events can change a lot faster than the curtains can react**. If you've ever stood in the greenhouse and watched the curtains hunt back and forth as the sun goes in and out of cloud cover you'll know exactly what we mean.

Even if your curtains are only programmed for a single type of application such as shading, the control response needs to be adjusted to create an acceptable compromise between equipment wear, the performance limitations of the curtain system, and achieving your control objectives.

Developing a Custom Control Strategy

Every greenhouse controls vendor provides some form of curtain control application. The difference is in the depth and scope of options provided for managing curtain operation and using them to achieve multiple control objectives.

Argus uses an open-ended approach for configuring most equipment control applications including curtain control. Since there are usually one or two core functions that you are trying to achieve we generally configure these as the primary operating modes. For example, in the absence of any other overriding or limiting conditions you might want to operate your curtains for maximum heat retention at night and for shading protection as needed in the daytime.

We start by configuring a basic control strategy that considers how the equipment needs to be operated and any special operational requirements such as gradual opening steps for preventing cold spillage after thermal operation. We then configure a number of event-based options that will either limit or override the main control objectives as required.

For example, even though the primary objective in winter is to keep the curtains closed at night for heat retention, an override can be configured to have them automatically open whenever additional heat is needed at the roof surface to accelerate snow melting. Similarly, other position control decisions can be included to coordinate the positioning of the curtains for venting, humidity control, spraying operations, etc. In this way, **your main control objectives always remain in effect until a higher priority event takes precedence**.

All equipment systems have their own unique capabilities and limitations. Our general approach is to develop automated control strategies that will provide the best overall performance while at the same respecting the unique operational requirements imposed by your equipment.

Time-Weighted Control Influences

Simple control decisions are usually based on instantaneous feedback from sensors, timed events, or combinations of the two. With an Argus Titan system you can also use accumulated and time-weighted influences for creating advanced control applications. These types of calculations are important whenever you need to consider the *cumulative* effect of previous conditions on current control targets. They can be particularly useful in horticulture applications since many controlled processes tend to act like 'batteries' with cyclical accumulation and discharge phases.

For example, when propagating leafy cuttings the standard practice for controlling intermittent mist equipment is to either use a time clock or a feedback sensor such as an 'electronic leaf'. The goal is to provide just enough mist to prevent the unrooted cuttings from wilting, but not so much that the rooting media becomes saturated and oxygen starved.

Time clocks and moisture sensors both have distinct advantages and limitations. A time clock is very reliable but it is not sensitive to any changes in the evaporation rate produced by fluctuations in light, vapor pressure, and air temperature. Consequently, the cuttings may get too much mist during dull weather and not enough when it is hot and sunny.

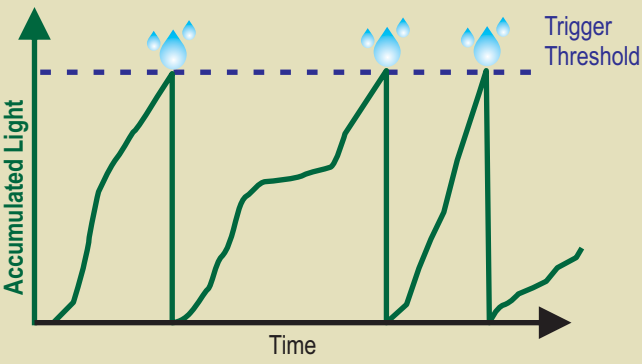
An artificial leaf sensor can often give a better approximation of the evaporation rate provided it is properly positioned and calibrated. However, it is subject to mechanical failures, mineral deposits, air currents, shading, and a variety of other mishaps that can interfere with proper operation.

Another approach is to accumulate and track the *influences* that affect mist evaporation such as VPD, light, temperature, etc. With them, you can create a model of the leaf wetting/drying process that will often outperform other methods.

This is a lot easier than it sounds, particularly with your Argus system. You don't need to develop any complex algorithms or models. You simply need to numerically accumulate the influence(s) and set a trigger point that will activate your mist equipment whenever a predetermined threshold is reached.

Often the easiest way to do this is by successive approximation. Start with an estimated value, just as you would when setting up a time clock or when calibrating a leaf sensor, and then fine-tune according to your observations.

A time-weighted misting model can provide better sensitivity than a time clock and it is immune to the vulnerabilities of an in-crop feedback sensor. With your Argus system you can even combine time-weighted influences with direct feedback, with one source acting as a 'back-up' for the other.



The graph above illustrates the effects of a simple time-weighted misting control decision based on accumulated light levels. Each time the accumulated light value reaches the trigger threshold the mist equipment is operated and the accumulator is reset. By observing the results and adjusting the trigger threshold as required, a highly accurate and responsive misting application can be configured.

Misting control is only one example of the many uses for time-weighted and accumulating influences. Argus uses them in a variety of standard and special applications including:

- Argus SmartHeat
- Accumulated Light and Daily Light Integrals (DLI)
- Average Daily Temperatures (ADT)
- Supplementary lighting programs
- Irrigation watering decisions
- Evapotranspiration models

With the power of our generic control modules any sensor reading or calculated value can be accumulated and mathematically manipulated, enabling us to configure sophisticated time-weighted influences for a wide variety of custom control applications.

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