momentum carries them down the transition plate to the second belt.

In the nursery trade almost all equipment must be modified to fit each nursery's particular application. We feel this is also true of our conveyer system. This system offers a low-cost, highly efficient means to load plant material that can be modified as needed.

BEDDING PLANT PRODUCTION IN A "STATE-OF-THE-ART" ENVIRONMENT

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Because of its seasonal nature the bedding plant industry is a difficult candidate for automation. However, changing markets, labor, and the rising costs of production materials have many growers considering automation technology.

Powell farms of Troup, Texas, a bedding plant grower since 1958, started considering a high-tech facility in 1982. Their existing facility was too extensive and productive to replace, so the facility of range was designed to integrate with it.

In the process of design to accommodate the two type production systems, Powells avoided one of the major pitfalls facing growers switching to high-tech automation—automation bottlenecks.

An example of a common bottleneck is having one rolling table unloader with a capacity of 1000 flats per hour as the sole source of a supply for a conveyer truck-loading system with capacity of 3000 flats per hour, which would be needed during peak season. Unless the capacity of this table unloading system is increased, either by supplemental hand work or by mechanical means, there is a bottleneck. Powells' solution to this problem is leaving enough room around each system to accommodate the hand labor required during peak season. By doing this, each mechanical system can be operated at its peak of efficiency, year-round and overloads are quickly handled by temporary help.

One area in which this solution did not work was seeding. All seeds are germinated in plug flats, making hand seeding impossible. Also, accuracy required in seed placement coupled with the volume necessary to meet company needs ruled out temporary or

[1]Paper presented by Bill Corbin

makeshift equipment. Powells chose a drum seeder built in Florida by S-K Designs.

This drum seeder meets volume requirements during peak season and accurately places the seed in the planting cell. Rows of seed ports across the face of the drum retrieve seed from the seed hopper by vacuum. As each row rotates through the hopper, one seed is pulled up over each port. The drum rotates in sync with the oncoming plug flat. This flat is held in a precise position on the flat conveyer by cleats. Just before the flat reaches the drum, the planting cells are lightly packed and indented by a rolling dibbler. As the seed ports on the drum align with rows of planting cells in the flat, the seed is placed by a quick jet of water from the seed port. At the Powell installation, flats then pass under a solid materials dispenser. This, in turn, is followed by a low-pressure water bath. Water is applied from a height of 4 in. in ⅛ in. streams with a maximum water pressure of two psi.

Four different sized plug flats are used. They are a 512, 392, 200 and a 72. Eleven drums are used, each having different spacing, seed ports per cell, and port size.

Seeded plug flats then move into the plug house complex via a power roller transport line.

This Exolite-covered complex is 85,000 square feet in size and divided into six compartments. The flats are stored on 36-flat rolling tables, which rest on rails 23½ in. above the floor.

Heating in the complex is by hot water traveling through pipes 20 in. below rolling tray bottoms and along the house perimeter. Cooling is by pad and fan, ridge row vents and shading. A unique feature of this complex is the central air intake corridor. The sides of this corridor are the cooling pads for the complex. Air is drawn into this corridor through overhead louvers. Turbulence created in the air improves air flow through the pads and reduces energy costs by about seven to nine percent. Fans, located on exterior walls, draw air across the distance of the house, which is about 100 feet.

Each compartment is equipped with a MEE fogging system. All compartments are equipped with automatic overhead shading. This shading is a function of foot-candle output of the sun at table-top height. The shading material is a 70% shade cloth and has a foil topside for radiant heat reflection.

Each bay or house structure has an overhead traveling boom. These booms are connected to the fresh-water system as well as to an injection system. Booms can be set to water the entire bay or any portion of it.

Plugs leave the plug house complex via power roller transport going to the transplant area. Each flat is removed from the rolling tables and punched from the bottom before going to the transplant line. This loosens the plugs in the cells for easy removal.

Transplanting is hand done on three transplant lines by 18 men,

six per line. Each person transplants 72 plants per minute. This gives the overall transplanting operation a maximum volume of approximately 1000 flats per hour.

Flats with liners filled and dibbled come to the transplant area from the soil mixing room. The soil medium is custom mixed here on the farm. Equipment required for this operation consists of one main conveyer, which passes under several hoppers. Each of these hopper's output onto the conveyer is regulated by computer. Medium is mixed by a horizontal batching mixer having a two cubic yard capacity. Medium is then stored above the conveyer going to the dibbler. Elements used in the soil medium are peat moss, sand, foam, vermiculite, lime, Osomocote, and trace elements. Plug flats are washed and reused after transplanting. They can be recycled approximately three times.

Transplanted flats travel by conveyer to accumulators where they are loaded onto 48-flat rolling tables. These tables then travel under a low pressure, high volume water and fungicide application administered from a height of about 6 in. Tables then await transportation to the grow-out areas in the headhouse.

The headhouse is glass-covered and almost 1000 feet long. It has ridge-row vents for cooling and is equipped to hang 8000 baskets. Embedded in its floors are guide rails for the trains. These trains transport 48-flat rolling tables to and from the grow-out areas, to the load-out facility, then return the empty tables to storage rails in the transplant area.

The grow-out houses are glass covered. They have overhead heat, perimeter heat, and heated floors. Watering is by overhead automatic sprinklers. This sprinkler system is connected into an injection system allowing fertilization and other types of chemical applications. In addition, the houses are equipped with ridge row-vents, pad and fan cooling and automatic overhead shading. Each house of the four-house complex covers 1¼ acres. Each has its own roll-out area. Moving here is done manually. To start the operation, one must place the bridge rails between the house rails and the outside roll-out area rails, then windows in the end of the houses must be raised. Eight men can roll out or back the entire 5 acres in about one hour.

The outside roll-out area is equipped with automatic overhead sprinklers. The sprinkler heads are a combination of spinners and pulsating types. One area of 1¼ acres is equipped with automatic overhead shading. This area is located on the south side of the grow-out houses and is well protected from the wind. The entire five-acre roll-out area is served by trains and is floored with concrete. Drainage is by 12-in. open paths in the cement floors.

Crops move via trains from the grow-out areas to the load-out area. Flats are loaded onto 88 10-in. conveyer belts according to cultivar. These conveyers move in either direction to facilitate loading

and unloading. Each will hold 96 flats.

These conveyers are housed in a 25,000 square foot glass-covered house. Above these loading conveyers are automatic carousel basket facilities with a total capacity of 15,000. Glass covering gives this facility a dual purpose. During peak season it is used as a load-out facility; off season it is used as a grow-out area.

The 88 ten-inch conveyers move flats up automatically on demand. Across the unloading end of the conveyers are three conveyer belts each going to a different truck that is being loaded. Load-out crews remove the required number of flats to fill the order and place them on one of the three belts going to the trucks. These three conveyers pass under a water-down facility, then transfer flats to a boom-type unit. This unit will extend into the hallway of shelved trucks enabling it to carry the flats to the front of that truck. Flats are then hand placed on the shelves. Approximately 20,000 flats can be moved through this system in one day.

Automation will save labor, increase plant quality and, if correctly designed, increase volume. However, a system must allow for seasonal fluctuations to remain an economical unit for operation.

USES FOR COMPUTERS IN PLANT PROPAGATION[1]

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Computers can be an effective tool in management of information and control of "real-time" events or processes. Common limiting factors to expansion of a plant propagation business are ready access to known propagation techniques for less common or difficult-to-propagate plants and the management and analysis of information gained through experience with particular plants. The optimum flexibility and management of environmental control devices may also limit the maintenance of an environment suitable for sensitive plant materials. Recent advancements in microcomputers can help in this area.

Computer programs have been written to assist in the calculation of rooting hormone formulations, calculation of dilution ratios for fertilizer injection into an irrigation system, and for storage and retrieval of propagation techniques for selected landscape plants.

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