Trends in Production and Logistics for Commercial Horticulture©

Tim Wilson
Brinkman/Viscon UK Ltd, North Moor Lane, Cottingham, East Yorkshire, HU16 4JW
Email: tim@brinkmanuk.co.uk

INTRODUCTION

This paper presents a basic view of how certain sectors of the commercial horticulture industry (mainly the protected crops sectors) compare with other industries in terms of production and logistical processes.

The protected crop sectors currently benefit from various degrees of automation. Development in this area is continuing at a rapid pace, driven by today's competitive global market. Several examples of current "state of the art" systems are detailed as practical references.

PRINCIPLES OF PRODUCTION SYSTEMS

In essence any commercial nursery unit is basically a production facility just like any other industrial factory with input of raw materials and components at one end of the process and output of finished products at the other. The "rules and principles" of production systems may not be something that's at the front of every commercial grower's mind but they affect all growing facilities to varying degrees and it is important to have a basic appreciation of them.

The industry has evolved rapidly over the past 20 years, in particular the last 10, starting with mechanisation, moving on to automation and then linking this with logistics. But what do these terms actually mean?

Mechanisation. This is the process of mechanising a task that has previously been carried out manually. This is generally a single task and mechanisation is carried out to improve efficiency, for example by reducing labour input. Examples include:

- Hand potting replaced by a potting machine
- Manual tipping of compost into hopper replaced by the use of automated compost feed, e.g., big bale or bulk feed
- Hand transplanting of plugs/plants, etc., into pots being replaced by a mechanical transplanter

Automation. This is the next stage, in which a series of mechanised tasks is linked together to provide an automated system. This generally allows the greatest saving provided we have balance within the system. An example would be a big bale unit linked via level sensing to the potting machine with the transplanting on the potting machine being carried out by an automatic transplanter. The automation of these tasks lies within the linking together and synchronisation to give benefits in terms of efficiency, reduced labour, elimination of double handling the product, and a more predictable output.

What is very important is to create a balance within the automated system. In other words, match the capacities of the elements to compliment each other and avoid costly bottlenecks.

Logistics. This is the final element and is involved with the storage, movement, and distribution of products at any stage from raw materials coming in to despatch and transport of finished goods to the customer. This links the production elements of the system together.

An example would be the storage of bulk compost in a hopper. This would be connected to the potting machine by a series of conveyors, controlled automatically.

Any automated production system will include a number of "critical events" and be subject to "systematic fluctuations." An example may be the batch loading of compost into a potting machine requiring a forklift truck. The downstream production can be very efficient in terms of pots filled, plants transplanted, a topping applied, and onward transit to the growing beds but any delay in the compost filling cycle is critical to the whole production process. This single event will affect the total system output. The ultimate goal is to achieve a balanced system where all elements compliment each other and contribute to a total measured output rather than individual "spot rates." To complicate matters further, in an ideal situation we must try to ensure that production can be adjusted quickly and efficiently to take account of fluctuating market demands, without excessive cost, while reducing stock levels to a minimum.

The application of production principles is further complicated in horticulture due to the diversity of products and market demands. Added to this, growers are dealing with nature and have weather changes affecting not only their sales but also their production rates. Any production or logistical system must take account of these factors.

EXAMPLES OF PRODUCTION AND LOGISTICAL SYSTEMS IN HORTICULTURE

Two current working examples of automated systems using today's technology and applying production principles are provided below. To demonstrate the diversity of the commercial horticultural industry a pot plant and tomato crop are selected as examples.

Pot-Plant Production and Order Collation. This comprises of a complete system taking raw materials (young plants, compost, pots, etc.) through to despatch. All elements with the process are linked and are designed to:

- Reduce labour.
- Increase throughput.
- Increase the lead time in terms of stock/stock quality and quantity availability.
- Improve the working environment.
- Ease management.
- Be suitable for a wide range of product.
- Provide a faster reaction time to fluctuations in order demand.
- Provide greater flexibility in terms of labelling / preparation of the final product prior to client commitment.
- Enable dual use of the area as a standard glasshouse/polytunnel when not in use enabling existing ebb-flood or overhead irrigation systems to be employed.

There are many variations available varying in complexity, all of which are modular allowing for future expansion.

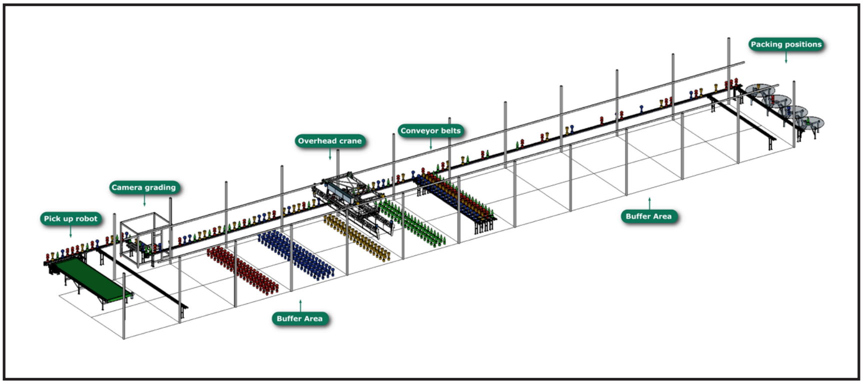

Figure 1. Use of the dynamic-buffer principle in pot-plant production and order collation.

The "dynamic buffer" compliments and completes the link between production and order processing. A typical system would involve the automated supply of compost and pots, a potting machine(s), feed to a buffer table, collection and retrieval / internal transportation to and from the beds using a prime mover/forklift with spacing facility. It is equally possible to feed the dynamic buffer from a mobile container system using loading robots.

Once this product reaches the processing area a significant degree of manual labour, simple belt systems and tables, is generally employed. Buffering is limited or at best labour intensive and involves multiple handing of the product.

The dynamic buffer system principle is shown in Fig. 1 in its basic format to illustrate the principle.

Once the plant product is deemed ready for order processing it is returned from the growing area(s) to the input conveyor (on the left in Fig. 1) via the prime mover forklift or via a positional robot from a container benching system.

Plants are then directed via a computerised vision camera grading station that grades by height, volume, colour, and number of flowers. These parameters can be combined and their values used to store and record data for analysis and/or tracking and tracing by batch.

Another important function of this camera vision recognition system is to electronically subdivide the dynamic buffer bay sections into segments depending on the size range of potted product being handled. The system can be set-up to allocate these areas efficiently based on predicted volumes and size range. The system calculates the area each plant/pot size requires and spaces them accordingly. This is generally based on the final growing bed density but can be altered if necessary depending on the predicted duration of storage.

The gantry robot collects the graded product, delivers it to and records its predetermined position within the store area. The robot is mounted on a sub-frame assembly within its allocated storage area above the crop and is made of lightweight aluminium. It collects the plants automatically with its gripper assembly, lifts, drives, and places them onto the floor in the allocated position. A single gripper design automatically adjusts to the pot size being processed.

All data relating to plant type, stored position, input time/date, quantities, and predicted shipping date/time and volumes are stored within the dynamic buffer's operating system and associated management software.

Throughputs vary depending on crop type/size, product mix, buffer bay dimensions and so-on but typically may be 30 gantry robot movements per hour with 50 plants per bay. In terms of variety or product mix it is possible to hold no more than one variety per row

Unloading is simply a reversal of loading. The operation is determined by the order batch, client, and product sequence according to the pre-programmed data within the system and available product held at that point in time. Final orders are packed, labelled/boxed and loaded onto trolleys or pallets at the packing table section.

Multiple gantry robots can be used to allow the system to both fill/grade and ship simultaneously (see Figs. 2 and 3). Very recent systems include automatic "product mixing" facilities, sleeving, labelling, and packing.

Figures 2 and 3. Gantry handling robots installed in pot-plant production facilities in Europe.

Automated Order Processing in Tomato Production. In principle the system enables numerous types of edible produce to be delivered from various growing operations, identified according to their producer, glasshouse bay or section, time and date of harvest, and stored in preparation for client order allocation/packing.

The client's demands in terms of product order type, packaging, and labelling determine the specific production line to which the product is delivered and processed. It is then palletised and shipped on a "just in time" basis.

This system (Fig. 4) provides one of the most advanced order processing units currently operating in commercial horticulture and is a key example of how state of the art technology and systems used in mainstream manufacturing can be applied to a commercial horticultural order processing and packing facility. The basic principles can be made to work in many forms of horticultural crop production, all of which require clients orders to be assembled and delivered accurately and on time.

Figure 4. A flow diagram of fully automated processing on a tomato nursery.

The design permits:

- High-speed input and shipping of product.
- Rapid storage and retrieval of product.
- Complete product traceability.
- A balance between production and demand at varying throughputs.
- Ease of management and linking with upper level software management systems.
- Provide a faster reaction time to fluctuations in order demand.
- Greater flexibility in terms of labelling/preparation of the final product prior to client commitment.

Raw product, in this case any combination of nine different cultivars of truss tomato, is harvested from the greenhouses into a range of trays and crates and delivered to the input area of the storage/product management system on bespoke pallets.

Each pallet is individually identified via a bar code label which is automatically scanned on entry into the store. Each of the three vertical elevators (see Fig. 5) can handle up to 255 pallets per hour and ensure the product is stored under its unique identity with the ability for automatic retrieval as the order production process demands.

The store operates like a "Rubik's Cube" (Fig. 6) shuffling product between lanes and levels as it is removed and replenished. This high density storage provides a very high efficiency within the stored area. It is situated above the crate washing and pallet handling areas.

As product is required for order production the relevant pallet is identified within the store and automatically delivered to a de-palletiser. The empty pallets are restacked and delivered to the underside of the store, in readiness for re-loading with empty crates, storage, and output for return to the greenhouses.

Figure 5. Vertical elevator.

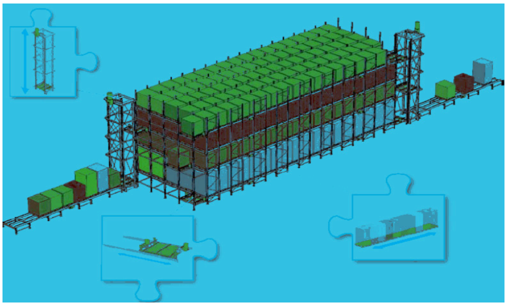

Figure 6. Schematic diagram of the tomato storage unit.

Figure 7. Tomato packing production line.

The stacks of crates with product transfer onto a "shunter" system consisting of a remote control train. This operates on a track adjacent to the individual production packing lines and delivers the stacks of product to the relevant production line. As the stacks enter each production line they are de-stacked and fed individually to the operators. Once the crates are empty of produce they return via a conveyor system, through a high-speed washing/disinfection plant situated underneath the store area. Each crate is then identified in terms of its height and colour, palletised, strapped, and stored ready for return to the greenhouses.

The production lines (Fig. 7) are allocated to individual client orders, using the available stored produce and bespoke packaging, label types, and data. At this point the final order specification in terms of total product quantity and mix is allocated to a particular pallet type or types. A range of pallets are used, including air freight units. The produce is packed in a range of punnets, flow packs, carton boxes, and crates as part of the production process.

Packaging is assembled on site using automatic carton box machines and stored. Each production line's requirement is displayed prior to initial batch start-up and in real time during batch runs. This enables the correct package types and quantities to be delivered to the production line on a just-in-time basis, eliminating congestion and unnecessary buffering.

Completed orders are transported to an area in front of the loading docks. At this point the orders are palletised, strapped, and labelled prior to loading for distribution by lorry.

All these logistical processes are totally automated, requiring no human manual intervention.

The total system is managed and controlled by two people in an operations room overseeing the total production area. Matching client orders to the stored produce, pack types, and labelling is all controlled via the management software and systems displayed on their PC screens. The SCADA (Supervisory Control And Data Acquisition) program provides a graphical display of the total process and allows real time updates of product positions and quantities. The print-and-apply label applicators integrated within the production lines are altered, label designs produced, and production initiated from the operations room.

THE FUTURE

Technology is constantly improving in areas such as process engineering, packaging, communications, traceability, and transport. All of these continue to benefit the commercial horticulture industry. The application of technologies such as RFID tagging (which uses radio waves to read microchips on products), "pick to voice," and intelligent robots using vision recognition for harvesting operations, are examples of present trends awaiting our exploitation.

CONCLUSION

Sales and marketing departments identify, cultivate, support, and service their clients but this can only happen when fully backed by an efficient production facility.

Balance is vital in any production and logistical system as bottle necks are costly in terms of capacity, increased operator downtime, and building of unnecessary stock.

Set key performance indicators for elements within your systems, monitor, and take action as and when required. Conduct regular reviews of your systems and implement beneficial change accordingly.