is over) these rooted cuttings are placed directly into containers or into beds. This method of bypassing the common practice of potting these rooted cuttings is producing a better quality liner and saving many thousands of dollars. Those placed in beds are handled in the same manner as described earlier for the hardwoods.

Cuttings placed in containers are watered by the overhead Skinner system. Fertilizer is alternately applied through the irrigation system and as a solid, slow-release material. Potting material is a U. C. mix (one-half peat and one-half sharp fine sand). All mixing and container handling is completely mechanized.

Our methods definitely would not apply for all propagators, but some adaptation of these methods will result in savings. After all, the commercial grower must make a profit while keeping quality in mind. We, as propagators, have an obligation to the American public to supply the very fast expanding market for plants. I know that we can meet this challenge by being alert to change and adopting new and improved methods.

PERCY EVERETT: Thank you, Vincent. Now we come out to the West Coast, in particular to the southern California area, to hear what the Research Director of the Monrovia Nursery Company has been doing and wants to tell you about. Conrad Skiminia is a graduate of the University of Illinois, 1955, and his field is principally agronomy and soils. He is with the Monrovia Nursery Company, considered, I believe, to be one of the largest producers of container-grown nursery material in the world. They have become so large they need Research Directors in the various fields, and Conrad holds this position. This is a way some of the larger organizations have of meeting the present day needs of our industry.

Conrad, will you come up and tell people how you handle things at Monrovia?

MECHANIZATION AT MONROVIA NURSERY COMPANY

CONRAD SKIMINA
Monrovia Nursery Company
Azusa, California

Mechanization is the use of devices, facilities or systems which will reduce labor requirements or create a more efficient operation. With the increase in costs, the nurseryman has to look for ways of cutting down expenses. One way is to develop a machine or a system that reduces expenses. Not all machines are made to save on labor directly, but their intrinsic purpose is to reduce labor costs whether directly or indirectly. For example, soil sterilization may be used *directly* to control plant diseases — however, this indirectly reduces labor because plants can be produced in a shorter time with less labor.

Designing a machine to do certain tasks in a nursery presents many problems normally not encountered in manufacturing. For example,

1. We are dealing with *disuniformity.* Every plant is different — and, it is dynamic — always changing. At Monrovia we have over 1000 varieties of plants and each variety has its peculiarities. In contrast, in the manufacturing industry the basis of automation is uniformity and exact duplication.
2. *Abrasion* — from sand, soil, and grit is another problem. It is murder on fine machine parts.
3. The *physical* problem of soil bridging, clumping, stickiness, resistence to flow, adhesion — all add to the complexity.
4. The *chemical* problem of moisture plus chemicals is hard on machines.
5. The *potential disease* problem is ever present. For example, in order to design an automatic pruning device you have to remember that this is an excellent way to spread certain diseases. You have to design with this in mind.

I will now show some slides of certain production devices and facilities in use at Monrovia Nursery.

1. This is our steam pasteurization chamber for propagating media. Flats are filled with propagating mix, set on a rack and then moved into the chamber. I like to call this our pasteurization chamber since we do not sterilize at 212°F., but at 140°F. The rack of flats is left in the chamber until the coldest flat reaches a temperature of 140°F. for one-half hour. We do not mix the steam and air at the point of entry into the chamber, but recirculate it *after* it has entered the chamber.

2. This shows the ductwork in re-circulating the steam and air. A thermostat sensing-bulb is installed in the return duct to detect the temperature of the air plus steam mixture and it regulates the opening of a steam valve to allow a certain amount of steam to enter in order to make up the difference in heat required. We like to maintain an air-steam temperature of 150-155°F. until the coldest point reaches 140°F. for one-half hour. The time interval for this period has been predetermined for different times of the year so all that is necessary is to set a timer and the rest is automatic.

3. This is the type of electric cart and rack we use to haul flatted cuttings between the cutting department and the particular propagating structure.

4. This shows a birds-eye view of our new all-plastic, steel, and concrete propagating house. The sheathing is an acrylic-fortified polyester fiber glass; the structural members are steel, epoxy-coated; the benches are steel and concrete. The house is 90 x 185 ft. — all clearspan — no posts anywhere in the house. This is a controlled environment house — the atmosphere is maintained at a pre-set relative humidity by

hydraulic and pneumatic nozzles and cooling is effected by evaporative coolers. The benches are heated by conductivity — that is, the heat transfer is from a liquid to solid to solid, i.e., from hot water to pipe to bench to flat.

5. Each side aisle in this greenhouse has a sliding door on both ends. The purpose of this is to facilitate traffic and future mechanization. Some time in the future, we will be designing a narrow cart to haul flats directly from the cutting department to the bench with the minimum of handling.

6. This is the interior of the house. All members are painted with a white epoxy to increase the amount of reflected light.

7. This shows preliminary construction details of the benches. The support frame is steel; the top will be concrete.

8. A close-up of these benches shows the copper tube heating grid to conduct hot water through this bench. A one-half inch layer of Styrofoam was laid down to reduce heat loss downward. This was followed by 4 x 4 reinforcing steel mesh upon which redwood spacers were placed; (to separate the overlying copper tubes from the steel) then the copper tube grid was installed and the entity encased in concrete. Our previous tests have indicated that 85% less heat is required to heat such a bench than conventional indirect, convection and radiation methods.

9. This is our "Paul Bunyan" soil shredder. It can mix, sift, water, and fertilize one cubic yard of soil every 40 seconds. It sorts out lumps, sticks or stones from a soil and ejects them to one side. We had designed the conveyor you see at the base; it carries this debris away from the machine and away from the prepared soil pile. We added the fertilizer hoppers you see at the top which add a set amount of limestone and superphosphate to the soil as it is moving along the belt. At ejection, water nozzles moisten the soil so that it has the optimum amount of moisture.

10. Since the soil shredder ejects one cubic yard of soil every 40 seconds, it was necessary to have a sufficiently large loader to keep this shredder supplied. A 1½ yd. Hough loader maintains a constant flow of soil from the shredder.

11. This is our fertilizer batching operation. We buy the basic ingredients such as ammonium nitrate solution, calcium ammonium nitrate, potassium salts, magnesium salts, phosphates, and blend them into our own formulas for our constant feed system. We make our own iron chelate for inclusion in our formulas. Liquid ingredients are metered into the batching tank; solid materials are weighed and added. All necessary ingredients are then blended and dissolved by hydraulic agitation until a true solution is obtained. It is then pumped to a central holding tank which feeds several fertilizer pumps so that there is very little actual truck hauling of concentrates. Some of our concentrate feed lines may run ⅓ of a mile to supply distant fertilizer pumps.

12. This illustrates the basic principle of our constant feed system. The flow meter measures the water flow in a main irrigation line. A signal is generated and after passing through a Servo system, regulates an injector pump. The resultant fortified irrigation water is then analyzed by a conductivity probe. This signal is then transmitted to a central recording panel which keeps a 24-hour record of electrical conductivities of all six of our injection points throughout the nursery.

13. This is our constant fertilization pump. It was designed specifically for us. It has a volumetric injection capacity of over 1000 to 1. The pump will respond from a flow of 40 gpm to 1200 gpm in 10 seconds. It begins to pump automatically with the flow and ceases to pump when the flow stops. It has a solid state electronic control system. It injects fertilizer at a pre-selected *linear* flow as opposed to pulsating or reciprocal feed pumps.

14. This is a gasoline meter which is used to measure the flow in the water line. A signal is generated by a tachometer and transmitted to the control cabinet. This is a direct displacement meter. However since it was built for gasoline service, bearing wear is high. On the other hand a water meter is grossly inaccurate. Because of corrosion and maintenance problems we will be experimenting with turbine and magnetic induction meters for measuring water flow. The magnetic induction meter has the greatest appeal from the standpoint of maintenance. It has no moving parts and all parts contacting fluids are resistant to corrosion.

15. We designed this combination spray-drench truck which can apply high pressure sprays or high volume — low pressure drenches. Any suspendable material can be applied as a drench — such as blood meal, cottonseed meal, hoof and horn, urea-formaldehydes, limestone, hydrated lime, herbicides, etc., or any sprayable material can be applied. All materials are hydraulically agitated. One or two pumps supply all of the energy for the system. This drench truck can apply a 125 ml suspension to a one-gallon can in 0.46 seconds per can. This cuts application labor costs at least in half.

16 This is our new straddle tractor designed for us for use directly over container beds. It is the first one of its kind in the United States for use specifically in container-growing operations. There are many pieces of equipment available for field crops, but there is no tractor for container-growing. This tractor was built to determine what operations would be feasible to do with equipment like this. The purpose here, of course, is to reduce hand labor as much as possible. The wheels can be turned 360° so that when the operator approaches a bed of one-gallon cans, for example, he can turn all four wheels 90° and enter the bed. Its purpose is to straddle the bed so that operations can be performed directly over the plants. Certain functions in this way can be performed with

greater ease, such as selection of material for orders, weeding, spraying, irrigation, fertilization, and transportation. Initially our intention was to build a one and 5-gallon canning machine. However the type of one-gallon canning machine we contemplated would turn out 50,000 gallons per day and present equipment would be inadequate to haul canned stock out to the beds fast enough. Consequently we had to build the horse before the cart — hence the tractor.

PERCY EVERETT: Our next speaker, O. A. "Jolly" Batcheller, is head of the Department of Ornamental Horticulture at Cal Poly, Pomona, California, and his problem is to train young people that are interested in horticulture to take over and to bring forth new ideas and to be able to operate the complex mechanisms Conrad Skimina has just shown us, as well as the more simple mechanisms. Jolly is going to introduce two of his students who will present papers on work in propagation they are doing.

I visited Jolly one time over in his working area. Of all the darndest little gadgets that fellow had worked up. I imagine he's going to show you some of those little gadgets today. Now I would like to introduce Jolly "Whistler" Batcheller:

CHALLENGING TECHNIQUES IN PLANT PROPAGATION

O. A. BATCHELLER
California Polytechnic College
Pomona, California

The advances made during the last 50 years in the production, handling, and germination of seed are well known to all of us. The quality and quantity of seed has become a constant and reliable factor. In the area of cutting propagation we have also made great strides by use of special rooting media, hormones, and mist. The one area where little has changed in the process of growing plants is that of transplanting and the handling of the seedling or cutting once it is rooted and is ready for transplanting. This is still the same process of carefully lifting the individual plant, carefully placing this in a container, and surrounding the new roots with potting soil. There has been little change, if any, regarding the soil, with the exception that it is now sterilized and perhaps more carefully prepared. It still is a loose, pliable mixture with just enough moisture to form a ball when held tightly in the hand, and yet of such a structure that it will break if this ball is dropped a few inches on a hard surface. Soil is still handled much as it has been over the centuries—wheelbarrow, shovel, trowel and by hand. Even hoppers with vibrators attached have been tried, but the difficulty of measuring out exact quantities is still a problem and usually necessitates over-filling of the container with the excess being scraped off. In the planting of new seedlings and rooted cuttings this is