not feasible and the placing of young roots into a dibbled hole has a tendency to misshape or crowd the roots.

A year ago our advanced plant propagation class explored all possibilities of improving the present system and came up with the idea of using soil, not as a semi-dry, loose solid, but as a slurry. Taking a page from the plastering trade, it is possible to mix and move the desired soil mix under pressure through heavy hoses. With this in mind, it is also easy to meter out exact amounts of the material to uniformly fill containers to a consistent level. Because of the semi-fluid nature of the mix, it is possible for it to flow between and around roots or ball and make immediate moist contact with all roots. This is aided by a slight vibration which can easily be provided at whatever point is desired. The removal of the excess moisture in the soil mix (such as the University of California mix) is done by the use of a partial vacuum. This not only reduces the moisture content to a desirable growth condition, but it also firmly holds the cutting or seedling in place at its desired position and depth.

I am sure you realize that no funds, or time, are available at California State Polytechnic College for research and, therefore, it has not been possible to actually establish a working model of the proposed operation. However, the process was studied by a group of senior students in the Mechanical Engineering School and all of the suggested mechanical ideas were found to be already in operation in other fields. No phase was considered in any way to present a problem.

I would now like to turn the presentation over to my students, Steve Hillmer and Mitchell Hoyles, who will give a brief demonstration of the principles and some of the units they have developed while working on their senior project (undergraduate thesis).

MECHANIZED POTTING

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The handling of rooted cuttings and seedlings is perhaps one of the most difficult aspects of the nursery industry to mechanize. The plants are small and tender; their roots are not well established, and are quite fragile. Machines are generally too rough in their operation to handle these small plants.

In the past it has always been not only more economical, but safer, to handle the transplanting of these small plants by hand. As has been pointed out, rising costs of labor, and a disappearing labor pool increasingly lead us to mechanize wherever possible. There have appeared numerous potting machines for transplanting larger plants into sizeable containers, and several semi-automatic machines to aid in trans-

planting small cuttings and seedlings. What Mr. Hoyles and I hope to accomplish is to develop a machine that will automatically handle and transplant these liners.

To achieve our purpose, the machine must not only be capable of handling and potting these plants, but must do it accurately and economically. We are attempting to develop a basic system that will accomplish this as simply as possible. Once this is proven to work, there are a number of modifications and sophistications possible that will increase the machine's scope of operation.

I hope now to show you quite quickly our present approach to solving some of the numerous problems that such a machine must overcome. These ideas are not yet in the blueprint drawing stage, and may seem a bit rough in places. Should you feel any of these ideas to be impossible, or have any suggestions, we would appreciate your comments.

The first problem such a machine must overcome is that of handling these fragile plants. In the prevalent practice these are seeded or stuck into a wood flat containing the media. As the plants develop, their roots twine about each other, making it difficult to separate them. When the plants are bare-rooted, many of these roots are broken, or at the least disturbed.

A possible solution would be a compartmentalization of the flat so that each plant has its own autonomous block of media. The compartment would prevent the roots from mingling, but would be open on the bottom to prevent root curl. This could be accomplished by the use of a plastic gridwork in the flat similar to the larger plant bands now available. By designing the grid as a series of separate strips of three-sided cells, rather than individual four-sided bands, each strip holding a number of plants could be handled as a unit.

This is a rather radical departure from the standard way of propagating, but would put the plants into a form sturdy enough to be handled by a machine, and at the same time eliminate the set-back caused by bare-rooting. The plants could also be allowed to mature further before being transplanted, as a media nearer to the composition of a soil could be used. Now it is necessary to provide some means of planting this plant and its media block into a plastic pot and putting soil around it.

Here we are thinking of the plants in their plastic grid/band moving along a table, below which would be an endless belt with the plastic pots. The plants would be eased out of the plastic grid, through a hole in the table and down into a waiting pot. This would all be accomplished mechanically, with the operator only placing the flat of plants on the machine, and refilling the pot supply.

If we stopped here, that would give us a plant sitting in an empty pot and nothing more. Actually the soil could be added and tamped at this point by hand, but we would rather that the machine be able to complete the job.

The machine must then be capable of moving the potting soil to the pot, measuring it out, and placing it firmly around the media block in which the plant is growing. To accomplish these tasks we are thinking of a soil and water slurry, or "mud", that is semi-liquid and can be pumped. This "mud" would, in effect, be poured around and below the media block much as concrete is poured around a fence post.

To achieve this semi-liquid state, we find that we cannot use a standard U. C. Mix (½ sand, ½ peat) because it is just too coarse and inflexible. By adding about 1 part of loam soil or clay loam to 6 or 8 parts U. C. Mix, however, we are able to achieve enough fluidity to pump the mixture.

This "mud" could be pumped by several methods, though at present a helical auger similar to those used in moving grain seems the best. It would move the slurry from an agitated hopper through a tube and to the pot. The volume could be metered by use of a solenoid valve, or by controlling the number of revolutions of the auger screw. An alternate type of pump would be a diaphragm pump similar to an artificial heart which has but one moving part to wear, and that made of rubber or polyethylene.

But now we will have created a problem that the machine must overcome. This soil slurry must be rather soupy to properly flow about the plant. Before the plant can be moved to the field, it is necessary to remove this excess water. We propose to do this by use of a vacuum suction fitting in which the pot sits on the endless belt. As soon as the slurry begins to flow in, the vacuum would begin removing the excess water, leaving the soil firm but wet.

From there the potted plant would move along the conveyor belt to waiting empty flats and the job would be accomplished. The machine would, of course, have to be planting a number of plants simultaneously to make it economical. A whole flat, or two flats, of plants could be proceeding through the machine at one time, with a line of 20 to 40 plants being potted at once. Using such a method we think that such a machine should be able to pot between 4000 and 5000 plants an hour with two operators.

It will require considerable experimentation to develop each of these systems and coordinate each with the others. Because of the time available to us and, of course, our limited financial resources, our product will be a very basic prototype, handling three or four plants simultaneously, rather than the large production of which I have been speaking. We hope also to be able to develop specific modifications that would permit the machine to handle bare-rooted cuttings, to cull the dead plants from live ones, and to enable the machine to handle different plant and pot sizes.