ENGINEERING THE CONTAINER -- Panel Discussion

Fifth of Nine Papers

TO "ENGINEER" THE CONTAINER 1/

Henry A. Spencer 2/

Abstract.---The relation between engineering criteria and biological consideration is examined in the light of the author's experience. Development of the Spencer-Lemaire Book-Planters is outlined.

What are the engineering criteria for mechanizing the growth of seedlings? First of all we want to design a whole system, which has parts that are adaptable to many different horticultural techniques, and to a great variety of trees. Second, we want to build a system that can be either mechanized or manual-ized to take care of a great variety of planting conditions.

All the container systems satisfy these two conditions, and as long as we speak strictly in engineering terms, the producer that has the cheapest system should get all the business. However, we know, as this engineering-only approach proliferates, that biological knowledge and experience must be applied throughout the whole design, or ultimate failure results. I thought perhaps you would like to hear about several of our trials in Alberta which did not take biology into consideration, and some of their results.

Back in 1963, shortly after we discovered that our short growing season in Alberta did not favor the use of Jack Walters' Bullets of that time, we tried to improve on them. We formed two shells out of thin polystyrene which were held together by a rubber band. Growing a small tree in one of these was not easy in an old-fashioned greenhouse that was full of damping-off fungus but a few were raised and planted. Examination showed root-spiralling along grooves molded in for the rubber band.

The big problem with experiments in this field was the time lag between ideas and results.

While we waited, we tried a few other ideas. The Alberta Tree Nursery near Edmonton began parallel trials for a great many possible containers. It was easier to use a dibble than to push a bullet-shaped object into the ground. The sharp point was discarded and some flatb ottomed containers were tried. We tried folded containers, with diamond and flat bottoms; square tubes made from A special tarred paper; round cardboard tubes; plugs made from foamed cement, from foamed urethane, from foamed urea formaldehyde, from foamed phenol formaldehyde, from latex-covered cigarette filter, and finally from split polystyrene tubes.

At a fateful meeting of minds in the winter of 1964, representatives of the Provincial Government, North Western Pulp and Power and ourselves met and decided that the split styrene tubes seemed to offer the best, least expensive and most mechanizable basis for growing trees in containers. A workshop atmosphere prevailed as we decided how to get 200 tubes 3/4 inch in diameter into a tray, and finally settled on dimensions of 7½'x 13½ Tubes were purchased from extruding companies, while trays were made locally. Other research was shelved, although we considered getting a block like the Styroblock made to hold the tubes, and some minor developmental work went into trying to build a device that would open the ground, and strip off the tube from the "tubeling" as it came to be called. The

1/Paper presented at North American Containerized Forest Tree Seedling Symposium, Denver, Colo., Aug. 26-29, 1974.

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Alberta forestry people geared up, however, for tubeling production. By doing so, they outlined and established the basic needs for growing a seedling.

During this period, it became evident that mechanized transplanting was nearly impossible. Rough and uneven ground, uncertain field conditions meant that teams of men, travelling in separated lines and placing trees roughly in a grid pattern were what was needed. To speed things up, a supply man would carry trays full of seedlings in tubelings, and would give handfuls to two planters at a time. Sometimes, it was possible to push the tubeling directly into the ground without dibbling a hole.

We were made confident of this approach by the news that the Ontario Government planned to transplant 37 million seedlings this way. For two years, we were content to slowly work on alternative methods. We mixed peat with styrofoam, and fused it into a block. We extruded a mix of urea formaldehyde and nitrified coal to give a slow-release fertilizer process. we sent samples of nitrified coal to John Walters who also had been working with slow-release fertilizers.

With our metaphorical "ear to the ground", however, we heard grumblings. A tubed seedling that had been force-fed showed some alarming root development. Roots had pushed all out of one side and were bunched and spiralled within the tube. There were fatalities and there as some frost heaving - plugs were simly pushed right out of the ground by rost. We realized in 1968 that we must develop a plug which could be planted without any restriction to lateral root development. Our first approach was to try to adapt to the system we had built, and to provide alternative types of plugs. We used starch to solidify the plug so that it could be removed from the tube when dry, only to realize that starch would grow fungi. We investigated silicates (water glass) for the same purpose, and then realized that the plants would probably die if they were allowed to dry out enough to set up the glue.

In 1969 at the International Botanical Congress in Seattle, I had the good fortune to meet Dr. Dick Tinus, and to discuss with him the container programs he had undertaken in North Dakota. We visited Weyerhaeuser's vast nurseries and saw their large containers, and had many discussions concerning how best to plant seedlings, whether they should be large enough to fend for themselves against the competition of weeds, or just big enough to survive.

That winter, Dick visited our plant in Edmonton. We decided we could most easily provide him with plug containers by making a kind of honeycomb - something like the units produced by the aircraft companies for cabin partitions. Dick first gave us the idea of air pruning of the roots, which he accomplished by setting the honeycomb containers on a wire mesh screen.

However this involved rather expensive pallets, and meant that the only way they could be handled was with a fork-lift truck. Dick soon asked us if we could form the cavities so that the bottoms came together, enough to support the peat growing medium, yet would allow him to build smaller units so that one man could handle 50 plants. We worked on this for several months, and had problems trying to get something satisfactory. The original idea of a folding book-planter occurred to me as I was working on the prospect for Dick Tinus.

In the early fall of 1970 a container conference was held in Edmonton. At this conference I heard the renowned Jim Kinghorn speak for the first time about Styroblocks and began to realize the potential for container-grown trees. I was given an opportunity by Mr. Bob Fish, the moderator, to show the honeycomb containers we had made for Dick Tinus. I had quietly invented our prototype book-planters and hinted that we had a new method on the drawing board. Steve Ferdinand was at that conference, and he and Des Crossley from North Western Pulp and Power descended on my office one cool winter's day to goad me into action on the new idea. We conferred intensely over two design parameters - one, the containers had to be removed before the trees were transplanted and two, the book-planters had to fit their existing boxes, which had been used for tubelings. By this time, through the kind cooperation of Bob Fish and Larry Kennedy of the Provincial Tree Nursery, I had tried out my first grooved root-training planters, to see how the roots might develop. We chose a size roughly equivalent to the 2.5 cubic inch units used by both the Walters bullets and the Styroblock, and put a few grooves in the sides. To prevent the bottoms from bunching together, we designed in a flap which spaced each Book apart from its fellow. The cavities, being tapered, were smaller at the bottom and had to be spaced this way.

Of course this flap was a big mistake and if we had asked for Jim Kinghorn's advice we would never have given the roots such a beautiful place to matt up and intertwine. The straight sided circular containers we designed for the Provincial Tree Nursery had this problematical feature too, so we had to redesign. Luckily we found out that it was just as good to dibble or dig a bigger hole than necessary for the seedling and to "heel-in' the soil around it, as it was to make a special hole dibble that would just fit the plug size, our way was then clear to make the plug any shape we wanted, as long as that shape was biologically sound.

Our first application of this was for Dr. Dick Tinus in the spring of 1971, and we went through ten designs before we got what we both wanted. We went through 25 designs before we got what Steve Ferdinand needed, at North Western Pulp and Power. And there came to be a demand for a different shape of container, especially for cuttings, so we worked with Dick Hillson, of the Provincial Tree Nursery to develop the ten cubic inch size. We conferred with Jay Allison, of Weyerhaeuser, to find out what size container would be most useful for growing Douglas Fir, and developed our "Fives" to suit that market. Altogether, we have perhaps built fifty different molds to produce four standard types, and even now we can see that a few improvements are necessary.

In cooperation with North Western Pulp and Power we also developed an open-bottomed box to hold approximately 100 pine or spruce seedlings. The open bottomed box was difficult to ship, however, so we designed a folding box. This, zoo, has gone through 10 or more machining changes to evolve finally to a useful box. he utilize all our scrap plastic, which is normally discarded, to injection-mold these boxes. The boxes can be used for all the three smaller sizes of ROOTRAINERS.

Incidentally, though it was not strictly "engineering", the hinged, ganged planters were originally called Groovy Gang Planters, and while its not a bad name, they became more dignified - Steve Ferdinand was the firs to call them this - by being called Book-Planters. Now we call the product ROOTRAINERS, which is, we think the most descriptive name.

From all these experiences, we can now point out the important features of a container system:

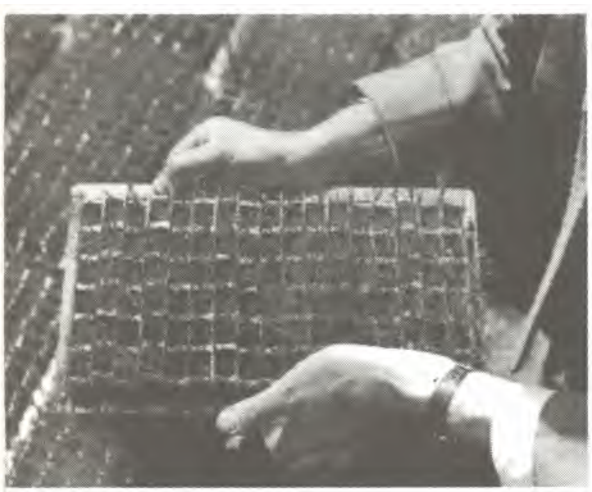

Figure 1.--Unfolded ROOTRAINER, showing individual seedlings growing in about 2.5 cubic inches of rooting medium.

Figure 2.--A tray of 17 ROOTRAINERS, 2.5 cubic inch cavity size, holding six seedlings each.

Figure 3.--
Hole made by steel dibble, mounted on a hoe handle. Hole is open for insertion of 3.5 cubic inch plug with seedling.
(Photo courtesy of A.A.Alm)

A. BASIC DESIGN:

(1) Container should be of the minimum size suitable for survival after transplanting.

(2) Medium should be capable of holding water for several days.

(3) Container walls should be either (a) unrestrictive to root egress or (b) removed completely at transplanting.

(4) Container must be designed to allow air withering of emerging bottom roots to promote fast root growth.

(5) No residue, possibly toxic to plants, tihould be left in degradable containers, and good ecological packaging principles should prevail.

B. SPECIAL DESIGN:

(1) Roots should be trained not to spiral.

(2) Containers should be designed for minimum handling of the individual seedling.

(3) Root development should be easily inspected.

(4) Containers should be non-bulky and easily stored and shipped.

(5) Cost should be minimal - either rugged design used many times or disposable.

(6) Bench density (plants per square foot) should be maximum in keeping with variety and biological needs.

(7) Spacing-out should be possible, at least in one dimension, while maintaining easy handling.

(8) A variety of sizes should be available, for different plants.

(9) Transplanting equipment should be extremely simple and light.

(10) The whole system should have no bottlenecks.