ENGINEERING THE CONTAINER -- Panel Discussion

Fourth of Nine Papers

# THE STYROBLOCK CONTAINER SYSTEM 1/

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Abstract.--Reviews the chronological development of the Styroblock System with particular reference to experience which determined basic design. The container, nursery facility, and equipment are discussed.

## INTRODUCTION

"Container systems, or for that matter any other new reforestation technique, must yield biologically acceptable results as well as be amenable to mechanization" (Kinghorn, 1971). Most effort up to recent time has concentrated on the biological factors without sufficient reference to the mechanical requirements of the container. As a result, many designs are not totally suitable for complete systems development.

The objective of the container program in British Columbia from its outset has been to develop a system that is acceptable biologically, physically and economically for both nursery production and field planting. Even though development is far from complete, a system is emerging - the Styroblock System. The System is intended to serve a dual function: to provide a satisfactory medium for growth in the nursery, and for providing a means of economical crop establishment. Seedlings are grown in modular styrofoam blocks and extracted in the nursery before planting. The extracted seedling can at this time be described as a secondary "container" due to the roots being confined within the soil mass as a "plug" during transport to the field and in the process of planting. The seedlings are presently dibble planted by hand. Future development to advance mechanical planting will examine the economic and biological factors of encapsulating the plug. The system will then be complete in the general terms of the program objective.

This paper reviews the chronological development of the Styroblock System with particular reference to the experience which determined the basic design.

## THE STYROBLOCK CONTAINER

### Evolution

Evolution of the styroblock container dates back to 1967 when the Pacific Forest Research Centre of the Canadian Forestry Service began a program to demonstrate and develop the use of small containers as a reforestation technique. Walters' bullet3/ was the container chosen for initial test work because it allowed high planting production rates. The first year results not only confirmed this fact but also demonstrated the potential for good field survival and the possibility of developing a controlled nursery environment. It was at this juncture that the Reforestation Division of the British Columbia Forest Service, the agency responsible for forest seedling production in the Province, became a full time cooperator in the program to assist with field testing and to undertake nursery production on a pilot scale.

In 1968, additional bullet seedlings were field tested. One of the treatments involved removing the seedling from the bullet and planting it as a plug. It soon became apparent that under certain conditions, seedlings having the bullet casing removed performed better than

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3/ An injection molded styrene container designed and developed by J. Walters, Director of the University of British Columbia Research Forest, Haney, B.C. to serve the functions of both growing and planting. The rigid bullet shaped container is plunged into the ground with a planting "gun" and thus reduces the planting time significantly as compared to standard methods.

those planted with the casing intact. The reason was thought to be related to the restrictive character of the container which prevented free and balanced root egress even though this was not entirely substantiated at the time. A progress report by the Pacific Forest Research Laboratory stated that "Lest it be misunderstood that our current interest in containerless plug approach means that we are abandoning Walters' bullet system, we wish to reiterate our conviction that Walters' system is the best yet devised for mechanizing the planting process. Yet extensive field trials will not accurately delineate the effect of container on tree performance (and thus the full economic impact) for several years. In the meantime, particularly in coastal areas where manual planting will be with us for some time to come, the container-grown/ container-free seedling promises to provide a real time and cost saving tool quickly", (Anon., 1969). This was the basis for a decision to proceed as soon as possible with the manufacture of a plug container.

The experience gained with Walters' bullet was invaluable in container design. A principal figure involved in development of the styroblock stated that... "by sheer luck in working with Walters' bullets and their tapered conical shape, we found that by getting the trees up off the ground where the roots could grow out into the air and then be dried, these are naturally air pruned... .we can essentially obtain a non-potbound tree even though it is quite large in relation to the size of the pot", (Kinghorn, 1970). In addition to this most important biological characteristic, information regarding cavity depth, volume, spacing and alignment was obtained.

What should the material be? The criteria as established by experience and by other factors considered important at the time, were:

1) The material and tooling must be of low cost for acceptance:

   - by the nurseryman in order to keep the growing costs to a minimum;
   - by the researcher in order that different cavity sizes, shapes and spacing could be economically tested and modified;
   - by the planting agency so that seedlings may be obtained at a low price which would compensate somewhat for the expected lower planting productivity as compared to the bullet; and
   - by the planter so that he should not be faced with the problem of disposal and further handling.

2) The material must be capable of incorporating certain design requirements:

   - of a cavity that is tapered and bullet shaped with rigid walls to form and contain the root system;
   - of a cavity not less than 4z inches deep to cope with the surface layer of duff common to West coast sites.
   - of a cavity configuration exactly modular for machine adaptation; and
   - of a size, shape and weight convenient for use in the nursery, during transport and on the planting site.

3) The material must not be toxic to forest seedlings.

An evaluation of the most promising materials and manufacturing processes resulted in the selection of expanded bead polystyrene known as Styrofoam. The new container became available in the spring of 1970 and was officially named the BC/CFS Styroblock (Kinghorn; Robinson, 1970).

## Description

The styroblock as introduced in 1970 (Fig. 1, Table 1) measured 13 7/8 inches by 20 1/4 inches with 192 modular tapered cavities, i.e. 98 per square foot. Each cavity had a gross volume of 2.45 cubic inches, was 4 1/2 inches deep, had a 1-inch top diameter, with a taper of 0.07-inch per inch of length to a 0.37-inch hole in the bottom. Two molded "runners" on the bottom supported and elevated the block for cavity drainage and air circulation necessary for root pruning. The top surface had a molded perimeter "fence" to prevent water run-off and "dome" protrusions between the cavities to direct soil and water into the cavities.

The styroblock was molded in four units of 48 cavities each that could be individually separated to yield a convenient size for handling during planting.

Styroblocks are designated according to the digit which corresponds nearest to the cavity volume in cubic inches, thus the 1970 styroblock was called Number 2.

## Modifications

A total of 1,225,000 styroblock cavities were sown in 1970 at two pilot-scale nurseries - one at the British Columbia Forest Service's nursery at Duncan and the other at the Pacific Forest Research Centre, Victoria. After one

Table 1.--Styroblock Container Measurements[1/]

| Styroblock Container | Block Length (in.) | Block Width (in.) | Cavity Top Diam. (in.) | Cavity Depth (in.) | Gross Volume ($in^3$) | Gross Volume ($cm^3$) | Density (Cavities/$ft^2$) |
|---|---|---|---|---|---|---|---|
| 2 | 20 1/4 | 13 7/8 | 1.0 | 4 1/2 | 2.45 | 40 | 98 |
| 2A | 23 5/8 | 13 7/8 | 1.0 | 4 1/2 | 2.45 | 40 | 105 |
| 4 | 23 5/8 | 13 7/8 | 1.2 | 5 | 3.94 | 65 | 71 |
| 8 | 20 1/4 | 13 7/8 | 1.55 | 6 | 7.63 | 125 | 41 |

[1/] Measurement at the time of manufacture subject to slight shrinkage.

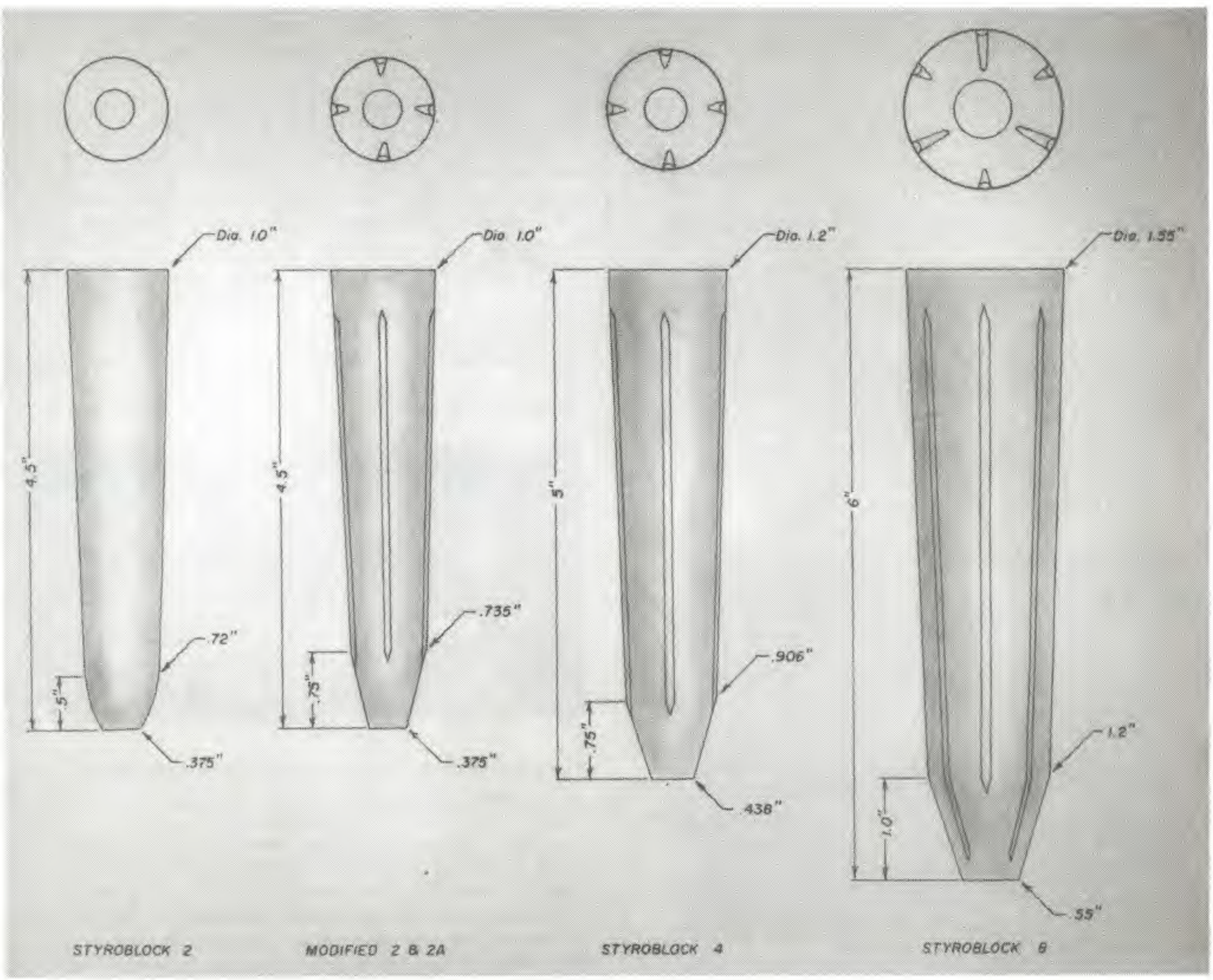


Figure 1.--Styroblock container cavity dimensions.

season's growing experience, it was found that improper fusion of the expanded styrene beads permitted the roots to penetrate the cavity wall, thus making plug extraction difficult. Modification and quality control by the manufacturer (Beaver Plastics Ltd., Edmonton, Alberta) effectively eliminated this problem.

Test work at the Pacific Forest Research Centre to assess container size and shape indicated that an increase in cavity volume and plant spacing resulted in superior quality seedlings. For the purposes of research, the styroblock 8 was designed and became available for use in the spring of 1971. It contains 80 modular tapered cavities, 6 inches deep, 1.55 inches top diameter, tapered at 0.070-inch per inch of depth to a hole 0.55-inch in diameter. Each cavity provides a gross rooting volume of 7.63 cubic inches (Table 1). This size of container was considered maximum for practical handling during transport and planting. To date, the use of styroblock 8 in British Columbia has been limited to growing stock for field performance testing and the genetic improvement program.

The styroblock 2 was modified in the summer of 1971 by removing the top perimeter fence and dome protrusions as they proved unnecessary and made soil loading more difficult. In addition, the cavity tip was changed from the curved bullet form to a conical shape (Fig. 1). It was felt that a straight wall configuration would better direct the root to the cavity hole and hence correct a tendency to spiral.

The stock produced in 1970 was shipped to planting sites in the container as was the original intent. (Matthews, 1971). This experience demonstrated the enormous logistical problem that would have to be solved when moving large numbers of seedlings. A most significant economic development occurred in the fall of 1971 - extraction and repackaging. Besides allowing for the grading of stock and the elimination of blank cavities, it effectively reduced the shipping volume by over 65 percent. It also simplified the carrying equipment used by planters, but most importantly, the styroblock container was left in the nursery for re-use. Styroblocks having a density of approximately 2.9 lb. per cu. ft. have been recycled twice and are now being tested for their third use. The practice has been to extract seedlings by hand and wrap in bundles of 25 in stretchable PVC film commonly used for produce and meat packaging. The bundles are placed in waxed cartons in an upright position for truck transport. This method of packaging not only makes handling in general much easier but permits economic temporary storage in cooler or cold storage facilities.

A tendency for the roots of lodgepole pine and white spruce to spiral was identified as a potential problem. Test work demonstrated that roots could be directed towards the cavity hole by vertical ribs on the cavity wall (Fig. 1). To evaluate this and to compare root form of a large number of provenances, part of the styroblock order for 1972 had one-half of the cavities with ribs and the other half with no ribs. In general, ribbed cavities exhibited less spiralling and produced more uniformly balanced root systems. All styroblocks are now manufactured with ribbed cavities.

The cost of restocking denuded land to acceptable standards with container grown seedlings will depend to a large degree on the size of the container. What then, is the minimum size for any given site requirement? In British Columbia, the styroblock 2 is the standard size and will remain so until the results in the nursery and the field prove otherwise.

The styroblock 4 was designed in the summer of 1973 to provide a container for evaluating an intermediate size between the styroblock 2 and 8. It measures 13 7/8 inches by 23 3/8 inches and has 160 cavities. Each cavity is 1.2 inches in top diameter and 5 inches deep, giving it a gross rooting volume of 3.94 cubic inches (Fig. 1, Table 1). The styroblock 4 is 3 1/8 inch longer than the styroblock 2. This extension was necessary to make full use of the manufacturer's molding equipment. For machine feeding, indexing slots to accommodate 3/8-inch pitch chain and sprockets have been molded into the base of each side. (Fig. 2).

Figure 2.--Styroblock 4 with indexing slots.

The styroblock 2 was made for separating into four units each of a size suitable for field carrying. Because of repackaging and container recycling in the nursery, the divisions separating the units became obsolete, and in effect, occupied valuable space. This fact, together with the desire to make full use of the manufacturer's molding equipment and to standardize sizing with the styroblock 4, was sufficient reason to modify the styroblock 2.

The new container was designed in the fall of 1973 and has been labelled the 2A. It is 13 7/8 inches by 23 5/8 inches and has 240 cavities. The cavity shape is identical to the styroblock 2 (Fig. 1). The one-quarter difference in length between the styroblock 2A and 4 is due to a compromise between cavity spacing and slot indexing requirements.

The changing of the block size and cavity spacing occurred at an opportune time when nursery equipment was being redesigned and replaced.

### Relative Merits of the Styroblock Container

The experience gained over the past four years suggests some advantages and disadvantages of the styroblock container.

Suggested advantages are:

1) the low tool cost for mold fabrication which permits economic container manufacture or modification so necessary during the development phase;
2) the low cavity cost to the grower when re-used a number of times;
3) the tapered cavity design with rigid and ribbed walls that contain and mold root growth, resulting in a fibrous, well developed, and balanced root system;
4) the block dimensions and its modular cavity design which lend themselves to machine adaptation and mechanization of the nursery process;
5) the light weight for handling;
6) a flexible manufacturing process which permits increasing tensile strength without retooling by simply molding at higher material density;
7) the sterile and inert character of the material; and
8) the possibility of converting the container to some other use when no longer suitable for growing trees.

Possible disadvantages are:

1) the reduced planting rate when compared to the bullet method;
2) the relative bulkiness of blocks requiring greater storage space when not in use;
3) the relatively low tensile strength requiring more careful handling;
4) the possibility of root penetration into the cavity wall with poor manufacture; and
5) the uncertainty of material availability affecting supply.

## THE CONTAINER NURSERY

### Evolution

The climate of British Columbia is extremely variable. In close proximity to the Pacific Ocean, it is characterized by high precipitation, warm winters and cool summers, resulting in a relatively long frost-free period. By contrast, interior regions east of the Coast Range have low precipitation, cold winters, warm summers and a much shorter frost-free period. How can nursery design and environmental control economically produce seedlings of certain quality standards under such variable conditions? Should container nurseries be located in the mild coastal climate to reduce capital expenditure and produce cheaper crops and if so, what are the risks and disadvantages of such production? These are two questions which have been asked and unfortunately, have not yet been completely answered.

When the container development program began, it was felt that sufficient fertilizer in the soil mix would sustain growth for the period necessary to produce a plantable seedling. This proved to be untrue and supplementary feeding of water soluble fertilizers began with the sub-irrigation method.

The work at the Pacific Forest Research Centre led to the construction in 1968 of a pilot facility at the Duncan Nursery having a capacity of 100,000 Walters 4½-inch bullets. (Fig. 3). It consisted of rows of plywood tanks with plastic liners in which the bullet trays were placed. The tanks were flooded with nutrient solution pumped at intervals from a mixing and holding reservoir to feed

Figure 3.-- Pilot nursery, designed for sub-irrigation.

the seedlings. To cool and protect the stock, shade cloth was suspended above the tanks by steel hoops. This facility was expanded to a production totalling 200,000 in 1969. Although the sub-irrigation method provided a uniform application of nutrients, the cost of such a nursery was judged to be too high for large-scale production. Besides, the styroblock container was then receiving interest and because of the buoyancy of this type of container, it would not be easily adapted to sub-irrigation.

In the spring of 1970, a one million production model shadehouse nursery was established at Duncan. A second of similar design with a capacity of eight million seedlings was established at the Surrey Nursery the following year.

## Shadehouses

### Description

The design is relatively simple, requiring shading with the shadecloth supported by link fence post and rail components and galvanized wire stringers (Fig. 4).

Figure 4.-- A shadehouse nursery.

A semi-permanent solid set irrigation system with sprinkler heads at 20 x 20 foot spacing provides uniform water application. Soluble fertilizer is injected into the system through a two-inch line, with a capacity of feeding of over two million seedlings at one time.

The base of the nursery is asphalt which is crowned to allow solution to run off and cold air to drain. This maintains a weed-free and generally sanitary environment, and prevents pooling of cold air at the time of radiation frosts.

Wood pallets support and elevate the container above ground for good ventilation and air pruning.

The total production capacity of nine million seedlings in two nurseries may seem large for essentially a new system under development. However, it was considered justified because of:

- the high survival results and good planting productivity obtained in field tests;
- the need for additional stock due to an expanding reforestation program; and
- the advantages of operational production to develop handling and scheduling methods and to obtain realistic cost information.

A basic measure of the styroblock seedling quality is the amount of root developed to hold the soil mass and retain the plug intact for handling and planting. If a seedling has had sufficient time and care to develop into an extractable plug, the chances are that the shoot-root ratio is acceptable and the shoot is of sufficient height and girth. This, to some extent is a safety factor which serves as a quality control that prevents the shipping of inadequately developed seedlings to the planting site.

Although the climate at the Duncan and Surrey nurseries is characterized as mild, annual variations in the weather do occur. This variability accounts in part for unevenness in results. If the season is warm and dry, most species can be grown to an acceptable quality. If the season is wet and cool, they do not develop adequately despite the best nutrient practice.

No stock in a shadehouse is free from the risk of overwinter injury. Heavy losses have occurred in particular to Douglas-fir and western hemlock due to root rot.

Western hemlock is a slow growing species that adds a high percentage of its total dry weight during the latter part of the growing season when it is susceptible to frost injury to roots and top. Test work had indicated the biological advantage of growing this species in a greenhouse environment. In 1973-74, three Ickes-Braun greenhouses with automatic heating, ventilating and cooling capabilities were constructed at the Duncan Nursery to examine greenhouse growing on a one million production basis. The cost-calculations undertaken before the recent increases in fuel and electricity costs had shown a favourable comparison with shadehouse growing provided more than two crops could be produced in one calendar year. A three-crop rotation is being grown in 1974 for assessment and costing for future direction (Fig. 5).

Test work in small greenhouses at three interior locations has been underway for three years to determine the growing requirements in colder regions. The results show that the growing season must be lengthened by environmental modification in order to produce acceptable quality seedlings within a calendar year (Fig. 6). Studies are continuing to determine the extent of modification.

Although our experience with controlled environment greenhouses is not great, some disadvantages are indicated, as below:

1) the risk of heat injury which requires an expensive and complex cooling system when natural cooling methods outside are satisfactory;
2) the risk of mold and disease due to high humidity and condensation even with good ventilation equipment;
3) the risk of structural failure due to snow loads which requires either more expensive construction or heating during the non-growing period;
4) the reduction in the amount of available light due to interference by the additional equipment required for environmental control; and
5) the risk of stock loss due to equipment failure that can only be rectified by expensive stand-by and warning systems.

In addition to these disadvantages which result in higher growing costs, the relative price of fuel and power will certainly continue to increase.

| Rotation | Species | Nursery Location | Time Sequence by Method (Feb Mar Apr May June July Aug Sept Oct Nov Dec Jan Feb Mar Apr May June) | Relative Cost Category | Remarks |
|---|---|---|---|---|---|
| 1 | Coastal Df, Pl | Coast | Shadehouse; Plant; Protect; Extract Coldstore; Plant | Low | Obsolete rotation if #2 successful. |
| 2 | Coastal Df, Ss, Int. Df, (Wh) | Coast | Shelterhouse-Minimum design for heating & cooling, $CO_2$ & light appl. early spring; Plant; Extract Coldstore; Plant | Intermediate | Two crop rotations to be examined. |
| 3 | Wh | Coast | Greenhouse - lights, heat, $CO_2$; Shadehouse; Plant<br>Shadehouse; Greenhouse-heating & cooling, $CO_2$; Plant; Shadehouse; Extract Coldstore; Plant<br>Shadehouse; Greenhouse; G.H. Store; Extract Coldstore; Plant | High | Three crop rotations being examined. Two crops are minimum due to high cost. |
| 4 | Pl | Interior | Shadehouse; Plant; Extract Coldstore; Plant | Low | Obsolete rotation. |
| 5 | Int. Df, Ws Pl, | Interior | Shelterhouse-Minimum design, $CO_2$, heating, lights & cooling; Plant; Extract Coldstore; Plant | Intermediate | One crop rotation being examined. |
| 6 | Ws | Interior | Greenhouse - lights, heat, & $CO_2$; Shadehouse; Plant; Protect; Extract Coldstore; Plant<br>Shadehouse; greenhouse heating & cooling, $CO_2$ & lights; G.H. Store; Extract Coldstore; Plant | Very high | One and two crop rotations being examined. Obsolete if #5 successful. |

Figure 5.--Potential crop rotations and planting times.

Figure 6.--Controlled environment greenhouse and shadehouse structures at Duncan, B.C.

What are the minimum environmental controls necessary to produce acceptable stock in any climatic region? This is the question which is now receiving attention. A number of truss-rafter structures with limited environmental control equipment have been erected this year. These will be compared biologically and economically with shadehouse and greenhouse facilities in both coastal and interior locations. Several similar structures have been in use in the State of Oregon for the past few years. We call them shelterhouses to describe their primary purpose.

## Shelterhouses

### Description

The shelterhouse is a simple truss-frame building with a rigid fibreglass roof (detailed structural designs are available upon request from the author). When a number of houses are placed side by side and connected, they form one unit (Fig. 7).

### Design

The shelterhouse design is based on the standards set by the National Building code of Canada for truss-rafter buildings.

Two types of materials are being examined. One steel frame house of bolted Redirack components has been erected at the Campbell River Nursery, the other at the Red Rock Nursery, Prince George. Three wood structures are being constructed at the Green Timbers Nursery, Whalley. These houses are 30 feet wide, being the maximum permissible width for 2 x 4 Douglas fir truss rafter construction. Wider houses would require larger components, thus increasing shade. The steel houses are the same width as the wooden houses to standardize size. The length of all houses except the one at the Red Rock Nursery is 200 feet, being the maximum distance considered practical for boom travel. The one at Red Rock is only 30 feet long, which is adequate for testing the shelterhouse method in a cold climate.

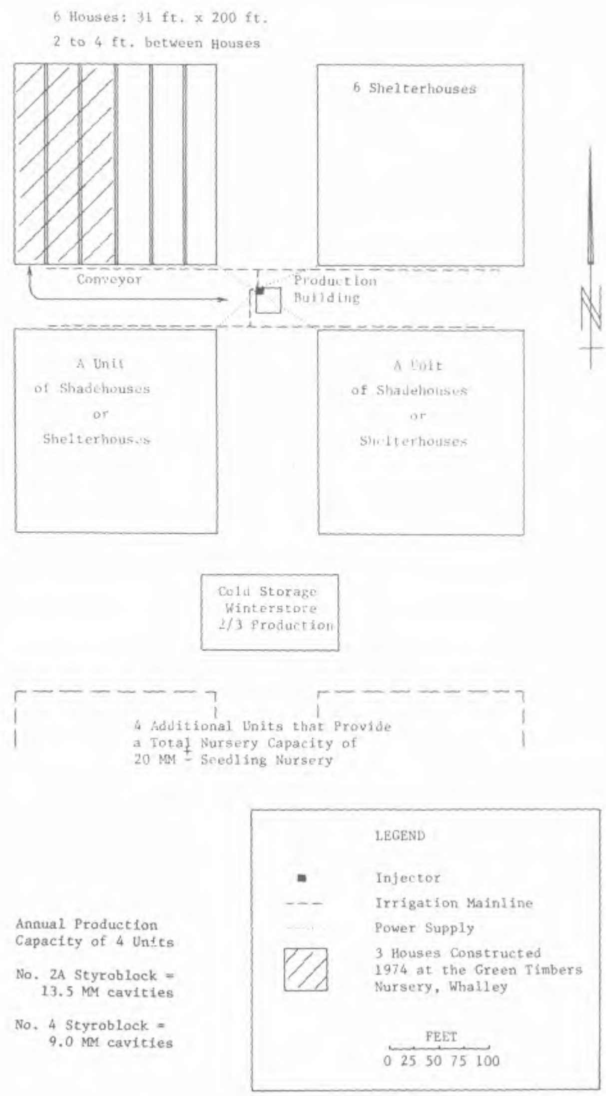


Figure 7.--A Proposed Container Nursery Layout.

## Shelterhouse Environmental Control

Natural ventilation of a unit of houses is provided by manually operated perimeter and roof ridge vents. To allow total exposure, the perimeter vents are removed during the summer season. Shade paint or shade cloth may be used to further reduce temperature if natural ventilation is found to be inadequate.

To reduce the risk of seedling loss by human error during the critical spring period, an exhaust fan system can be installed. The design should be calculated to prevent injury rather than to provide an optimum growing environment. This requires a lower exhausting capacity and therefore, a lower capital and operating expense.

The amount of supplementary heat required will vary with the location and the species. In a mild climate, solar radiation may be sufficient. In colder areas, supplementary heat will be necessary. However, until shown otherwise, the heating design is to be based on an indoor-outdoor temperature difference sufficient to prevent injury rather than on providing optimum growing conditions for the full 24 hours.

During the winter when the houses are not producing seedlings, the eave connectors can be opened to allow snow runoff and removal. These can also remain open during the summer months when maximum ventilation is desired.

# NURSERY EQUIPMENT

## Key Equipment

The development of nursery equipment has been the responsibility of the Canadian Forestry Service (Kinghorn, 1972). It was recognized at an early stage of the program that key pieces of equipment would be required for pilot production and to develop the system further.

The key equipment now in use or under development is described in order of its function (Fig. 8):

### Soil Mixing

A modified manure spreader is used to mix peat moss, vermiculite and dolomite lime. These soil components are placed in uniform layers in the spreader box and moved into the spreader blades by the box conveyor. The blades fan and mix the soil. During the fanning process, water plus a soil wetting agent is added to the mix.

### Soil Loading

Styroblocks are impact-loaded by a mechanical box dropping vertically on cams. A production of approximately 100,000 cavities per man-day can he obtained with this machine.

In 1972-73, the Department of Agricultural Engineering at the University of British Columbia developed a prototype capable of precision loading to a uniform density. Before this machine is developed to the production stage, the Pacific Forest Research Centre is testing the density parameters acceptable for seedling growth. Their results will determine the final design of a new machine.

### Sowing and Seed Covering

A precision seeder was developed by the Department of Agricultural Engineering in 1971 (E.O. Nyborg, C.D. McLeod and B.D. Narsted, 1972). The prototype has been field tested for three years and has met all the specified operational requirements.

In 1973, a gritter for covering seed was added as a component part of the seeding machine.

### Germinating

To increase the length of the growing season, a barn at the Surrey Nursery was converted to a germinator in which heat and humidity can be controlled. It can accommodate 1.4 million styroblock 2 cavities at one time.

The use of such a facility for shelterhouse production is to be assessed.

### Irrigating, Lighting and Working Boom

A boom capable of serving three functions has been developed and is being operationally tested this year. It is essentially a mechanically driven platform on wheels with an irrigation boom and lights that pass over the seedlings (Fig. 9).

The frame is designed to hold a number of people for weeding and thinning in addition to the irrigating and lighting equipment.

The speed and duration of movement can be adjusted for any one of its functions.

The extent to which this boom will be used operationally will depend on the outcome of an investigation into the role of intermittent light in improving seedling growth.

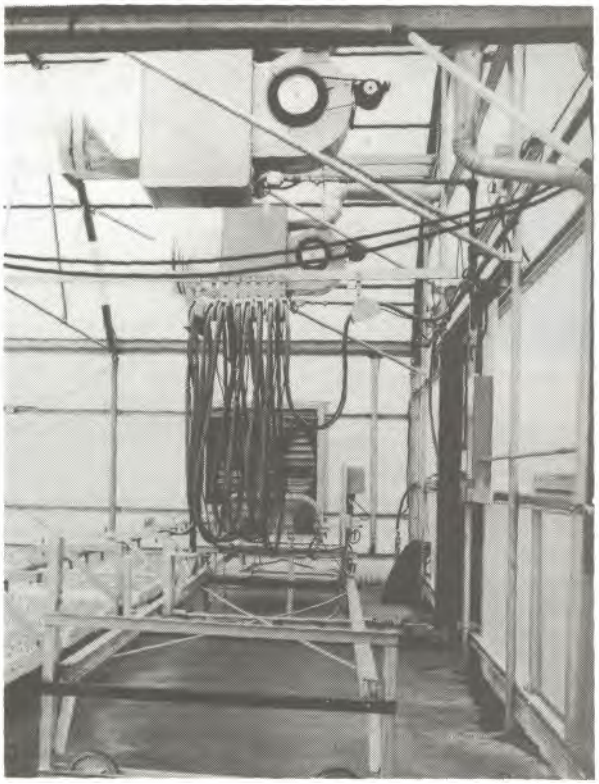

Figure 9.--

Boom designed for three functions: irrigating, lighting, and working.

Another method of extraction is being examined. The seedling plug is loosened by a bumping action permitting gravity extraction. A prototype machine is being fabricated.

Seedling Packaging

A commercial produce and meat stretchable film bander is used to wrap 25 seedlings into a bundle. This machine consists of rollers to dispense the film; a platform to wrap the seedlings; a hot wire to cut the film; and a hot plate to seal the film.

Block Cleaning and Sterilizing

A prototype washer consisting of two pumps to clean and sterilize used styroblocks has been built - one to wash at a sufficient nozzle pressure to thoroughly remove soil particles and the other to spray chlorine solution for sterilization.

Test runs with this machine indicate that it requires modification.

## Other Equipment Requirements

CO2 Enrichment

Test work has commenced to assess the growth response with CO2 enrichment of the shelterhouse atmosphere. The results will provide the basis for determining the modification necessary to the house and CO2 equipment requirements.

Light Modification

Test work to determine the quantity and quality of light for promoting and retarding growth will continue to establish design parameters (Arnott, 1973).

Block Handling

Experience with the use of gravity rollers has indicated that a combined mechanical and gravity roller system will be the most economical method of handling styroblocks. Work has commenced to design a continual flow system based on the seeder production rate.

Production Building

A production building for the sowing and packaging operations is to be designed (Fig. 5). Objectively it will be of economic construction because of its short-use period.

# PLANTING

## Hand Planting

The dibble (Fig. 10) is the standard tool for the planting of styroblock seedlings. It is inexpensive, simple to use, and difficult to

Figure 10.-- Planting dibble and packaged seedlings.

abuse. As a general statement, it can be said that the rate of planting plugs with a dibble is at least twice that of bareroot seedlings with a mattock.

A number of different styles of dibbles have developed. The most common has a standard "D" handle (Fig.10 ). Some are made with the stepping blade widened for use as a screefer when the removal of debris and duff is required.

A six-pouch plastic belt has proved to be the most acceptable for carrying plugs in the field because of good weight distribution and ease of seedling access. Each pouch contains 25 packaged styroblock 2 seedlings, (Fig. 10) for a total of 150 per planter. For longer planting runs requiring more than L50 seedlings, a back-pack combined with a pouch carrier is used.

Pottiputki tubes for paperpot planting have been modified to plant styroblock 2 plugs on a test basis. The results, even though not entirely conclusive, show that the dibble is superior because of higher planting rates and better planting quality. Further testing is planned.

Also planned is the testing of a dibble core planter in which a soil core is removed to accommodate the planted plug. This planter may reduce wall compaction of the planting hole, particularly in heavy soils.

## CONCLUSION

From its beginning with the Walters bullet, the Styroblock System has developed from an experimental to a production stage in a relatively short period. One of the main reasons is that emphasis of work has included both the biological and mechanical requirements for a total system. Even though work is not complete, a reforestation cost saving is presently being realized.

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