coils, requiring frequent defrosting as well as reducing the efficiency of the coils themselves. When this dried air is circulated over the produce in the walk-in room, excessive dehydration results.

Thus this type of reduction in first cost of the installation will result in greater power bills for operation, and in unsatisfactory operation of the plant as well as having an undesired and damaging effect on the stored food.

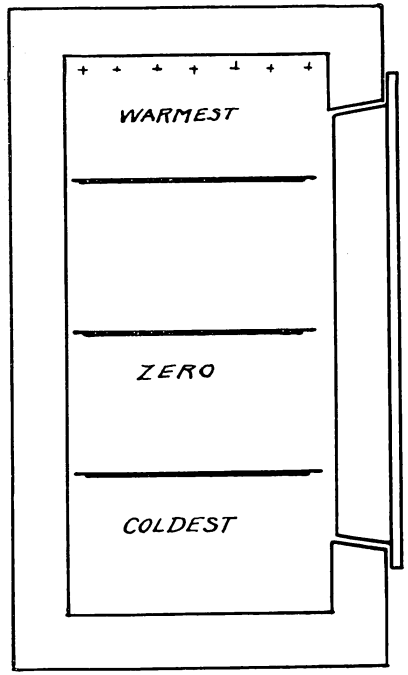

Figure VII

Figure VII illustrates a side door type zero box as compared to Figure III showing a chest type box. In Figure VII, again illustrating faulty engineering, the evaporator usually consists of plate coils used as shelves. Examination of temperature distribution in such a box will reveal that the space underneath the top shelf will be refrigerated to the desired temperature but that the space above the top shelf may be as much as 20 degrees warmer. In other words the material stored on the top shelf is not being stored at a satisfactory temperature and may therefore suffer damage in storage.

The obvious solution to this difficulty is to place additional refrigeration coils in the very top of the box to extract the heat which normally rises to this point.

In conclusion it may be stated that Washington State College has carefully studied not only the needs of zero refrigeration for the home but has also studied the performance of many plants in operation, including various commercial plants. The foregoing illustrations together with many others not herein included, outline some of the requirements for satisfactory refrigeration and some of the objectionable features to be avoided in poorly engineered commercial plants.

In the early years of zero home refrigeration the plants were all home made or custom built. Today many commercial firms are offering a wide choice of plants ready built for the trade. Some of these plants, unfortunately, possess serious shortcomings, and it was one of the purposes of this paper to point out these shortcomings and to show what engineering principles had been violated

THE SOCIAL IMPLICATIONS OF FOREST MANAGEMENT RESEARCH

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Forest management research deals primarily with the biological and physical sciences. It may, therefore, seem a little out of place to discuss its social science aspects. The purpose of this paper is to show that forest management research bears a direct relationship to the everyday problems of mankind.

The Economics section of the Forest Experiment Stations surveys forest resources, and their uses, and also points out the social significance of these findings in special publications. To a considerable degree, forest management research takes its cues from the findings of such resource surveys. It is the job of management research to find better ways to protect, improve, harvest and regenerate forests. The needs and practices of our society determine the direction and conduct of work programs.

As an illustration of how management research is influenced by economic factors, consider Western white pine timber. White pine is the backbone of the timber industry of northern Idaho and adjacent parts of Washington and Montana. Although white pine is only one of five or six almost equally abundant tree species that grow in close association, the wood of white pine has certain technical qualities which make it particularly useful and valuable to man. As a result, much of the forest research in this region has been centered around white pine.

One of the first needs in white pine management was to determine harvest cutting methods and basic silvical info: mation that would insure regeneratic of the type after logging. Obviousl if forests are to continue supplying d sirable products, it is necessary to ke the land stocked with the right specie

The studies of requirements for r generation, although most directly co cerned with ecological factors such sunlight, moisture and plant compet tion, impinged upon human activiti in many ways. Various methods logging, such as skidding with horse tractors, or jammers can have strikin ly different effects upon the regener tion of various trees. Logging operato near the Coeur d'Alene mines se somewhat different kinds and class of materials than in localities whe match plank is the principal produ Large logging organizations regular employ different methods and equi ment than small operators, and hen exert measurably different effects up the future timber stand. Even the ha its, customs and training of individu workers have to be taken into accou in setting up experiments and inte preting the findings into practical re ommendations.

Silvicultural practices are heavily i fluenced by economic considerations well as by physical and biological fa tors affecting the growth of trees. Abo five years ago, Dr. Kenneth P. Dav at that time a member of the Expe ment Station, and now Dean of t Montana Forestry School, investigat and published a report on econom management of Western white pine fo ests. In this special study, Dr. Da

considered the economic justification of different levels or intensities of forest management. As a purposeful attempt to bridge the gap between silviculture and economics, it is an important contribution to forest management.

Another major management problem of the Western white pine type was protection from devastating forest fires. The spectacular and costly disasters of 1910 and 1919 showed the need for reduction in fire losses to protect human lives and the timber industry with its attendant jobs and community developments. Hence, research in forest fire protection was made a major feature of the research program in this region. H. T. Gisborne has vigorously conducted studies of forest fire protection ever since 1922 and has made notable contributions in this field.

The next important need in white pine management, after getting the fire research project well established, was to determine the growth potential of this species. Accordingly, volume and yield tables were constructed to estimate volume and growth. The so-called normal yield tables which were built estimate the growth of fully-stocked stands from their inception until approximately maximum volumes of wood per acre have accumulated at age 160 years. Volume and yield tables are basic working tools of foresters. They are used to estimate the present volume of wood in individual trees and forests, and probable future growth of well-stocked stands. Yield tables are available for estimating at just what level timber production can be manitained.

Another subject that has been given some attention is artificial reforestation, by planting of nursery grown seedlings or tree seeds. The object, of course, is to restore denuded lands to productivity. However, artificial reforesation has been studied less diligently than the topics previously described, because there has been more need to make the best use of existing forests, than to rehabilitate idle land in this region.

Stand improvement, the care of forests in the juvenile stage, is an aspect of management that the station has worked on to a limited extent. It includes artificial pruning to improve timber quality, weeding to improve species composition of stands, and thinnings to hasten growth of individual trees. In addition to bettering the forests, such operations are frequently well-suited for use of otherwise idle time, as in periods of slack employment between seasonal jobs.

Currently, research in the white pine type is being devoted chiefly to studies of partial cutting in mature stands. These partial cuttings have three objectives: (1) they aim to harvest and use the individual trees which are likely to die soon; (2) they attempt to maintain or improve the thrift and prolong the lives of the remaining trees by removal of the trees which are most likely to harbor destructive insects, (3) they attempt to create environmental conditions unfavorable to the establishment of currant and gooseberry bushes, the alternate hosts of the white pine blister rust disease. Cuttings of this type are now made possible, partly by the increasing value of timber stumpage, and partly by the greater flexibility of modern road construction methods and truck logging.

So far, this paper has considered forest management only from the standpoint of timber production. Forests also provide other tangible but less easily appraised benefits to mankind. Forests are the source of most water that flows into the Columbia River. They exert a powerful influence upon the regulation of streamflow, the lessening of floods, soil erosion, and siltation. Forests are becoming increasingly important and necessary for certain types of recreation in our complex civilization. Growing populations, improved transportation, and greater amounts of leisure time are causing more use of the forests for pleasure and rest. Research perhaps has not given sufficient attention to these aspects of forestry, but neither has it wholly overlooked the fact that sound forest management must

provide for protection of the soil, preservation of wildlife and scenic values, and use by campers.

In the past the lumber industry has been characterized by a lack of permanency. Ghost towns, stranded communities, abandoned land are apt terms which have all too often been associated with lumbering. Similarly, the seasonal character of much of the logging work and the temporary shacks and bunkhouses of the logging camps have encouraged improvidence and absence of desirable community activities among the lumberjacks. The disadvantage of this migratory condition and its attendant evils are now generally recognized by sociologists, economists, forest managers, timberland owners, forest products manufacturers and labor unions.

Forest management research is one of the most promising means for converting timber utilization from a migratory industry into a locally stable and permanent industry. Research can contribute much by showing how to get the greatest yields of forest products. Timber stands can and should be cropped frequently for a great variety of products—Christmas trees, fuelwood, posts, poles, pulpwood, piling, veneer logs, and sawlogs, instead of yielding only one crop at maturity. In order to carry on the intensive management i plied by frequent light cuttings, it v be necessary to have forest workers side permanently within easy access all parts of the forest. Modern tra portation methods should make it p sible for woodsworkers efficiently harvest a continuous flow of dive products.

The trend toward diversified for production and harvesting by smal units has already made a good start certain parts of the United States. our own region some signs of the tre are evident.

Most past experience in forest search has pointed to the desirability shorter and shorter intervals betwe cuttings or other timber manageme operations. The oftener that timb stands can be thinned, the better a the chances to harvest products whi are currently in demand, the less na ural mortality losses will occur, and t more the remaining trees will be ben fited by timely reductions in compe tion. Much remains to be learned abc more specialized and intensified silv cultural practices, but the results, wh put into practice, will include more e fective use of the land, permanent cor munities, and improved standards living for forest industry workers.