A structural wood composite from short-rotation plantations

Australia has about 15 million hectares of native forests managed for sustained yields of sawn hardwood and some 800 000 ha of pine plantations for softwood production. Yet, despite the relatively small size of its population, it is a fairly heavy importer of forest products.

Most of the sawnwood imports are general-purpose softwoods, mainly used in house construction.

Only about one-third of the tree is utilized finally in producing sawn timber, and the trees must be tall and straight. It takes many years to reach this maturity, and timber in deep sections is becoming difficult to obtain.

It is perhaps surprising, then, that a structural-quality timber substitute, that could replace some of the imported timber and extend the supplies available from Australian forests, has yet to be developed, especially as other countries are facing similar problems.

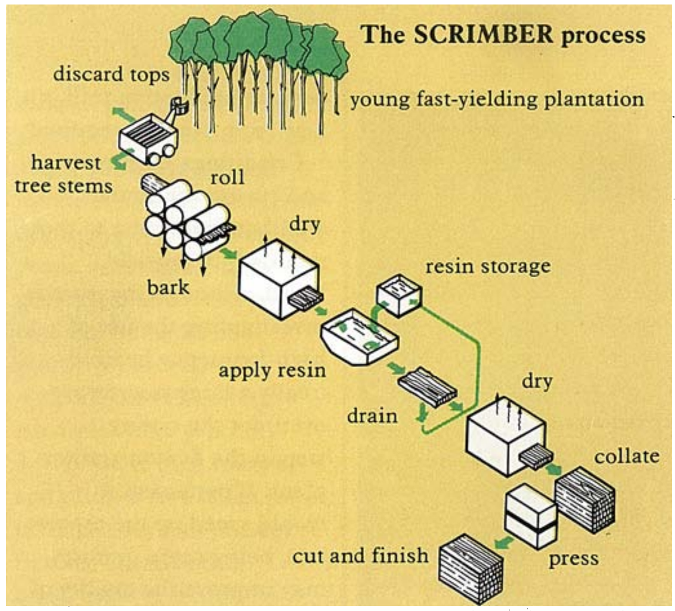
Re-assembled structural products — usually made of sandwiched veneers, particle board, or plywood pieces glued together — have been developed experimentally. However none, except for some heavy laminated beam products with limited applications, has yet been launched commercially.

Costs can be high, as large amounts of resin are needed for gluing together the various components. Technical and other production problems have also been encountered.

Alternative techniques — involving breaking the timber down into fragments and then using either mechanical sieves or electrically charged fields to align these in order to impart directional strength — have been tried, but with limited success so far.

On the other hand, the particle-board industry has expanded rapidly in the last 20 years, and its familiar sheet products are used in many non-load-bearing applications. The particle-board process makes more efficient use of the forest resource than sawn timber production. Even young trees and waste can be converted to this everyday material.


Stages in the conversion of young tree stems to the finished product.



The finished product largely retains the texture, strength, and normal machining characteristics of clear natural wood.

It would be advantageous if structural-quality reconstituted wood could be made on the same basis, if not by the same process.

In essence, each attempt to achieve this involves the steps of breaking down the raw wood and re-aligning and attaching the separate elements, whether large or small.

In considering the problems of actually doing this on an industrial scale, Mr John Coleman of the CSIRO Division of Chemical Technology felt that the best approach might be to restrict the initial breaking-down step so the raw wood would remain in a partly attached condition from which it could be 'reconsolidated' to form the desired shape.

By keeping the individual strands interconnected, the structural character of the parent wood would be preserved in the product. This approach would avoid the problem of re-aligning smaller elements altogether. He reasoned that it should be possible to manufacture a reconstituted wood material closer to the quality of engineering-grade timber.

He next had to choose raw material that would be both economic and environmentally acceptable. Why not establish plantations of fast-yielding tree species, with desirable properties, that could be harvested every few years instead of decades?

Mr Coleman's project, based on these concepts, has resulted in the development of a 'structural wood reconsolidation process'. It consists of several rather simple steps — a further advantage in industrial terms.

Young tree stems are cut to the required length, debarked, and put through special rollers that produce long and loosely connected webs of strands and splinters. These are dried, then coated with adhesive, before being combined and pressed to the final shape. Heavy sections can be built up by combining several of these strand bundles. There is no sawdust or other waste.

Laboratory-scale samples had properties that

Quick-growing, dense plantations provide straight, slender stems free of branching. And they lend themselves to mechanical harvesting every few years.

reflected the nature of the parent wood. They usually had a parallel grain, with some overlapping strands that reduced the tendency to split.

The processing averages out imperfections originally present in the wood. The product, which has been given the name SCRIMBER (registered trade mark, Repco Ltd), usually has some 70% of the bending strength of mature timber, and good compression properties too. It can be sawn, planed, and sanded. And it will retain normal fastenings.

Seeing a commercial opportunity, Repco Research Pty Ltd has further developed the process, in collaboration with CSIRO, and is currently building a demonstration plant.

Materials-handling and drying systems need some adaptation to enable them to cope with larger bundles of strands. But otherwise these basic processes are well understood and, with the exception of a specially designed reduction mill, no new technology is required.

Conditions for pressing and curing the strands are likewise similar to those required for particle board, although the team is investigating the use of high-frequency heating (really a large microwave oven) for the curing step in the demonstration plant. If perfected, it would speed up the process and, being more uniform, may improve the quality of the product.

In their laboratory trials, Mr Coleman and his colleagues found that tree stems of about 80- to 160-mm diameter, cut to the length of the final product, gave the best results.

Short-rotation, quick-growing, coppiced trees provide satisfactory raw material of this size. The stems are slender, uniform, relatively free of branching, and generally easy to process. Moreover, they contain neither heartwood nor well-formed knots, which compensates to some extent for the initial disadvantage in the lower strength of juvenile stem wood as compared with that of wood from mature trees.

The young stems could be grown in closely spaced rows, and mechanically harvested in a cycle varying from 4 to 8 years depending on the species, soil, and climate. It may be possible to establish tree farms close to markets for reconsolidated products.

Systematic and sustained wood production would be desirable as the basis for a commercial operation, to simplify processing and give a uniform product. It makes sense as an investment given the time needed to bring a forest to full maturity.

However, it might be possible also to utilize thinnings from established forests or alter the management regime of stands intended for logging to provide an early cut for SCRIMBER. In any event, the tendency would be to reduce pressure on natural forest or enable countries presently without forest to manufacture acceptable wood substitutes.

The team has evaluated the suitability of a number of commercial species. Among the eucalypts tried, manna gum (*Eucalyptus viminalis*) performed particularly well and river red gum (*E. camaldulensis*) was satisfactory. Silver wattle (*Acacia dealbata*) and some poplar clones gave satisfactory results also.

On balance, radiata pine proved a good all-round performer.

This familiar softwood grows fairly rapidly and splinters readily. However, it does have a spiral grain, which presents some difficulty, especially in younger stems. In the long term, this twist may be selectively bred out. Meanwhile, this species has been selected for the purpose of designing the equipment.

Wood put through the SCRIMBER process can be tailored to satisfy a range of specifications. For instance, the strands can be moulded in two directions, or even pierced during the pressing operation.

Mr Coleman has prepared, in the laboratory, a three-dimensional lacework in a rectangular section, forming a flanged beam. Sinuous pieces could be made for assembly into lightweight trusses. It is also possible to laminate SCRIMBER to veneers during moulding, giving a very pleasing surface finish. Even the density of the product can be controlled.

Several options are being considered for commercial products. Apart from deep structural sections, uniform, lighter elements could be produced for the high-volume building market. Other possibilities include products with significant market volumes but no critical performance requirements, such as skirting board.

Patents are being taken out covering the production of moulded articles, pallets for example — to take advantage of the unique nature of the process.

Jeff Culnane

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