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MECHANIZATION OF WOODEN FRAMED LAMELLAR PANELS DESIGNED FOR PACKAGING CRATES, WAY OF INCREASING PRODUCTIVITY AND QUALITY

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Abstract:
Wood packaging crates having generally a single cycle of use must be cheap in order not to affect the price of the products it stores or transports. For this reason, manufacturing costs (materials, energy consumption and labour) should place the packaging cost at the maximum 5% of the price of the product stored or transported, or even less. For this reason, all the ideas related to manufacturing process that could affect the cost of packaging must be taken into account. A significant amount of labour is consumed in forming panels in the structure of the boxes which involves the consolidation of lamellas (piece by piece) with nails or staples on the reinforcement elements (wooden cross rails or frames).The paper aims to present technological improvements (with a different degree of mechanization) of the lamellar panels' industrial flow, which may decrease the labour consumption on the product and implicitly may influence the price of the product. These improvements may help the activity of this industrial sector to be profitable in valorisation the poor quality and small sized wood.

Key words: *frames; crates; lamellas; packaging.*

INTRODUCTION

The woodworking industry in the manufacturing processes produces wastes, such as small pieces of wood unusable in the furniture manufacturing or for doors and windows or other products used for buildings. On the other hand, inferior quality wood due to the natural defects of wood, such as logs, edges, laths, are generally used in the parquet flooring industry and in the wood packaging industry. Thus, wooden packaging crates or containers used for storing and transporting products of various origins, such as agricultural, food or industrial ones are the final products of the low quality wood.

The efficiency and maintenance of the wood packaging industry is requested, because of the high volume of wood that could not be utilized in the other (basic) sectors of the wood industry. More than that, starting from the idea that packaging does not have to "load" the price of stored or transported products, the wooden packaging (crate type) would be among the few that would fulfil this role.

If it is also considered that at the end of the lifetime the packaging disposal must not affect the environment, it can be said again that wooden packaging can fulfil this condition, being burned (resulting in thermal energy usable in diverse utility thermal systems) or resulting in compost by biodegradation process.

As shown in a previous paper (Cismaru and Fotin 2016), wood packaging does not transfer dyestuffs or toxic products to stored goods during use. Under these circumstances, if wood packaging products are collected and recycled, they may be used in several exploitation cycles. Thus, just a small share value is transferred to the products and the efficiency of capitalizing these types of products significantly increases.

However, the cost of production remains the basic element that must be controlled, thereby ensuring the profitability of the packaging sector, which is of great importance to the general economy and to the woodworking industry in particular.

Meanwhile, there have been industries that have tried to take over this area of packaging (glass, plastics, metals, textiles, cardboards), some developing large-scale activity (plastics and cardboards) others quickly quitting as unprofitable (metals, glass).

Plastics, because of the flexibility of the technological process, have gained massive positions in the crate-type and containers packaging. The disadvantages are their higher prices and problems in terms of recycling or ecological disposal at the end of the lifetime.

Plastics used at a large scale for all kind of products are nowadays limited in use because of their high resistance to biodegradation, and because combustion recycling creates many hazardous and toxic gases.

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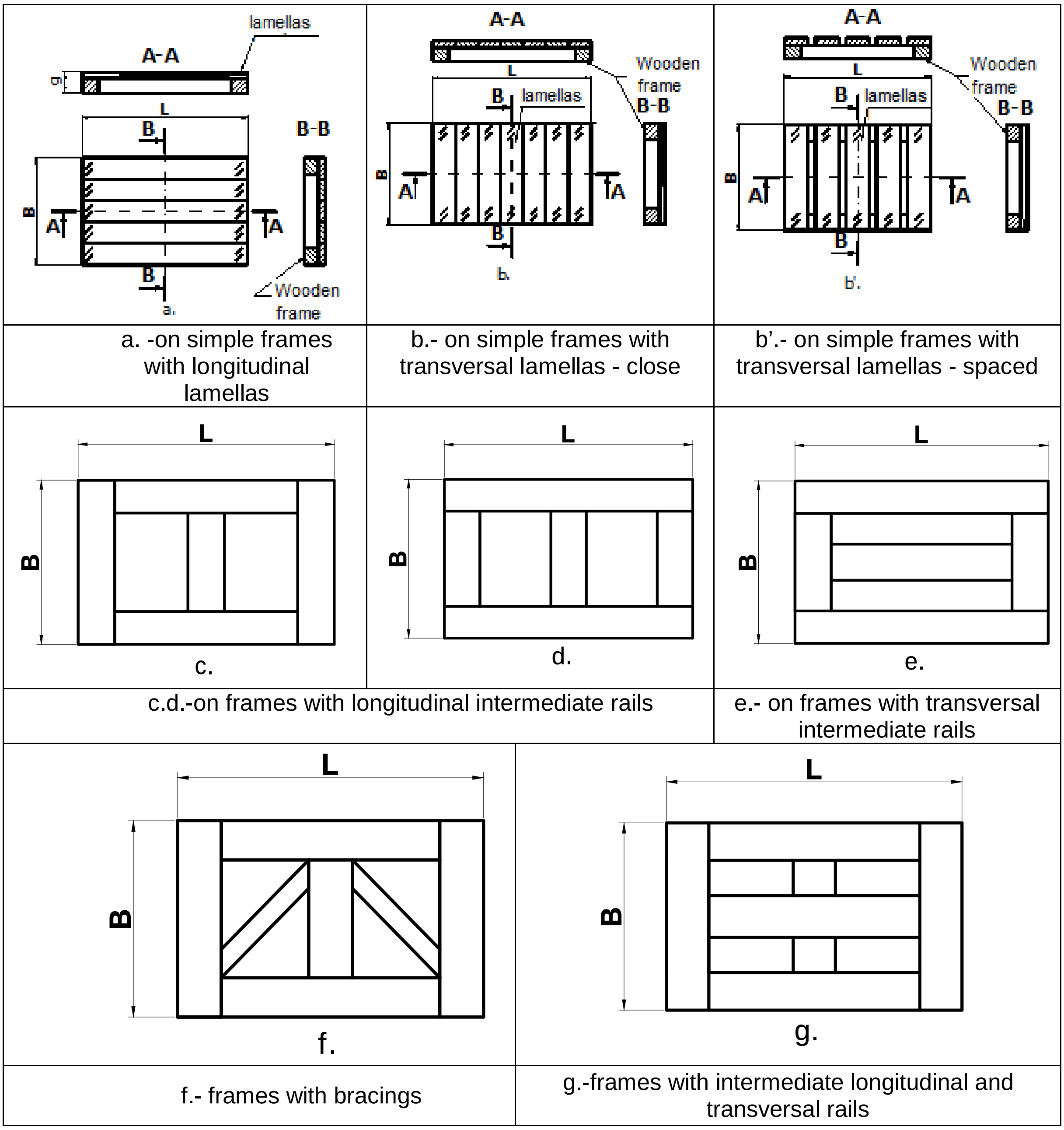
STRUCTURE OF WOODEN PACKAGING CRATE

Wooden crates are made of various shapes and structures, depending on the transported goods, their stacking mode (horizontally or vertically), the structure of merchandise (granular, in bulk or packed, etc.).

The wooden packaging crates are designed depending on the goods to be transported, the way of storage in the warehouses or in the means of transport, resulting in the following input data:

- inner volumes (implicitly the interior dimensions) of the crates;
- consolidation solutions (cross rails or frames);
- solutions of orientation of the lamellas against the other structural components (cross rails, frames), being positioned longitudinally or transversally, as the case may be;
- additional consolidation solutions using diagonal rails, longitudinal or intermediate rails;



a. -on simple frames with longitudinal lamellas

b.- on simple frames with transversal lamellas - close

b'.- on simple frames with transversal lamellas - spaced

c.d.-on frames with longitudinal intermediate rails

e.- on frames with transversal intermediate rails

f.- frames with bracings

g.-frames with intermediate longitudinal and transversal rails

Fig. 1.
Wooden framed panel types for packaging wooden crates (L>B>g)

The following results after calculation are obtained:

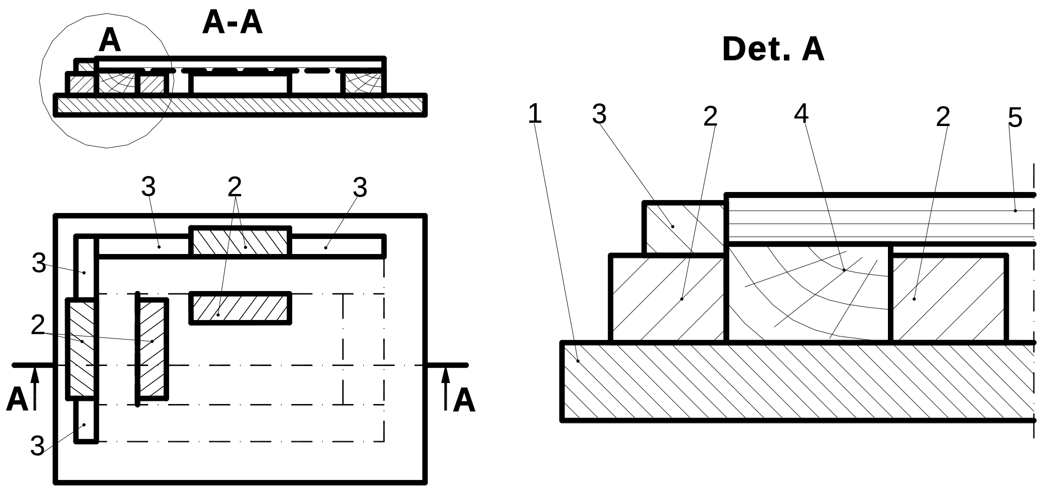
- the dimensions (lengths, widths and thicknesses) of the lamellas (Cismaru 2016, Cismaru and Fotin 2012);

- the dimensions of the reinforcing elements (cross rails) and their orientation in the product (vertical or horizontal) (Fotin 2012);
- dimensions and number of reinforcement accessories (staples, nails, screws);
- consolidation solutions with accessories, in the idea that the crates are fixed or foldable, etc.

PANELLING THE FRAME

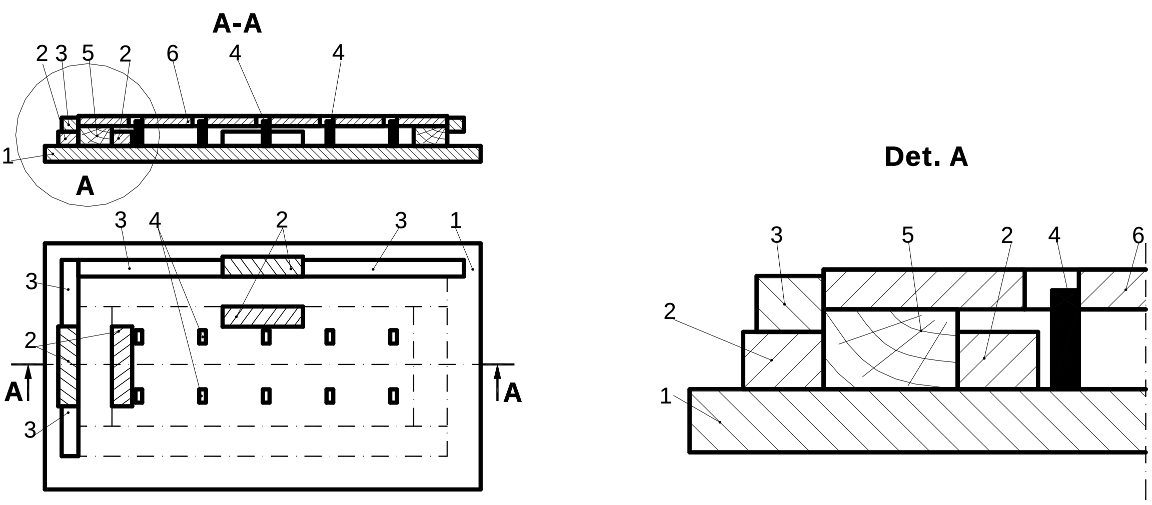
Attaching the lamellas to the frames in the panelling phase involves connecting the structural components with nails, staples or screws so that the accessories do not come in contact with the transported goods and prevent them from scratching or influencing the good quality of the products.

In order to fix the lamellas to the frames, they will be placed in well defined, close or spaced positions, identical for all batches. Specialized technological devices are used for close lamellas (Fig. 2) or for spaced ones (Fig. 3).



1.-device plate; 2.-guiding supports for the frame positioning on the device ; 3.-end support of the close lamellas relative to frame end; 4.-frame; 5.-lamellas

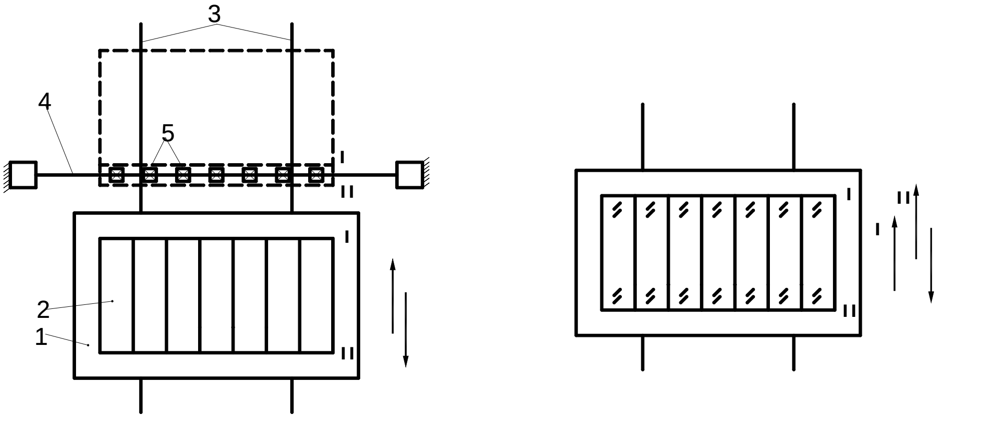
Fig. 2.
Technological device designed to position the close lamellas for their consolidation on the frame.



1.-device plate; 2.-guiding supports for frames; 3.-end support of the spaced lamellas relative to frame end; 4.-supports equally spaced for placing the lamellas; 5.-frame; 6-lamellas

Fig. 3.
Technological device designed to position the spaced lamellas for their consolidation on the frame.

Consolidating the frames by attaching the lamellas to the frames by means of the accessories is done manually or by moving the device in an installation to bring the lamellas under the beam on which the pneumatic or mechanical systems of stapling or nailing are located (see Fig. 4).



1.-Technological device situated on the machine table; 2.-frame and lamellas positioned close ore spaced; 3.- linear guides of the equipment for moving the mobile table; 4.- beam support, on which the nail or staple systems (mechanically or pneumatically) are attached; 5.-stapling or nailing systems.

Fig. 4.
Scheme for equipment of applying reinforcement accessories (nails or staples).

Beginning with the scheme in Fig. 4, one can think of the transition from the semi-mechanical or manual system to a mechanized system, respecting the operations and the technological phases in their sequence, the manipulations of the structural elements being executed mechanically, as shown in Figures 5 and 6, for both close and spaced lamellas.

The equipment shown in Figures 5 and 6 may automatically execute the wooden panels of the crates with continuous feed speed (variant A) or intermittent feed speed (variant B). The result is a high level of productivity simultaneously with the relieving of the operators by a relative high physical effort for nailing or stapling.

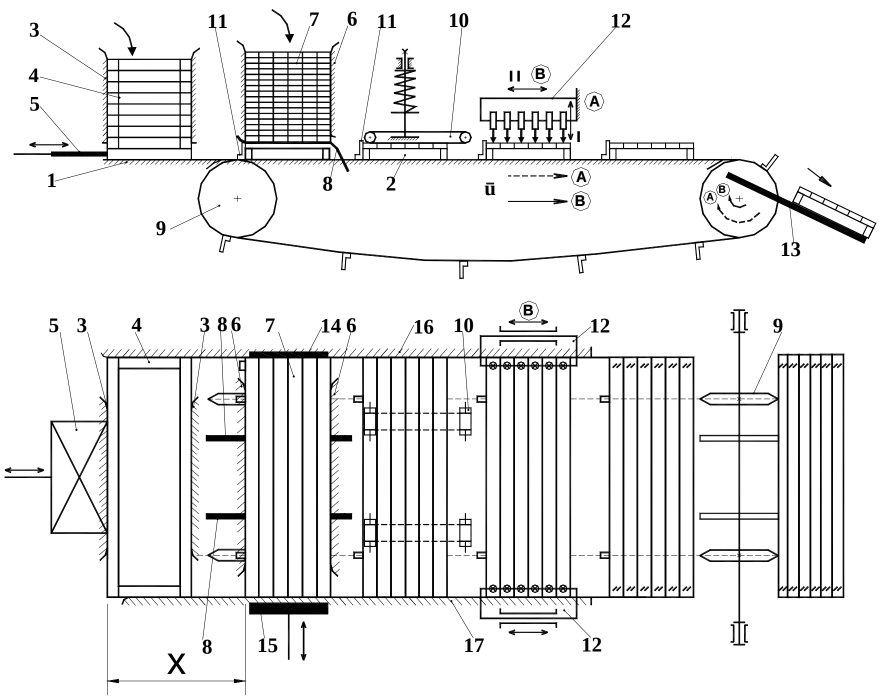


Fig. 5.
Equipment of panelling the frames with close or spaced lamellas.

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The operation of the equipment presented in Figure 5 requires the use of a cyclic (alternatively) pusher 5, which feeds the frame system 4, stored in a gravitational bunker. The frames are pushed under the bunker 6 in which the lamellas 3 are deposited in layers including one panel structure. The lamellas are supported on two bars 8 which place them above the frames pushed with the system 5. The frames are taken over by the conveyors 9 with the help of the claws and in the same time the layer of the lamellas from the bunker 6 are deposited on the frame. The conveyors 10 (not driven and applying a braking force on the lamellas) are used to set an adequate positioning of the lamellas. After positioning the lamellas at the ends (with the help of supports 14 and of a vibrating plate 15), they are placed correctly on the frame according to their width. After forming the panel, it reaches the nailing or stapling system 12, which pneumatically or mechanically applies the nails or staples (on the position - variant A, or by simultaneous advance with the panel and return - variant B).

The system 12 has an equal (or double) number of nailing or stapling systems or double-headed devices mounted on the beams.

After applying the nails or staples, the panel is transferred through a sloping plane to the storage location.

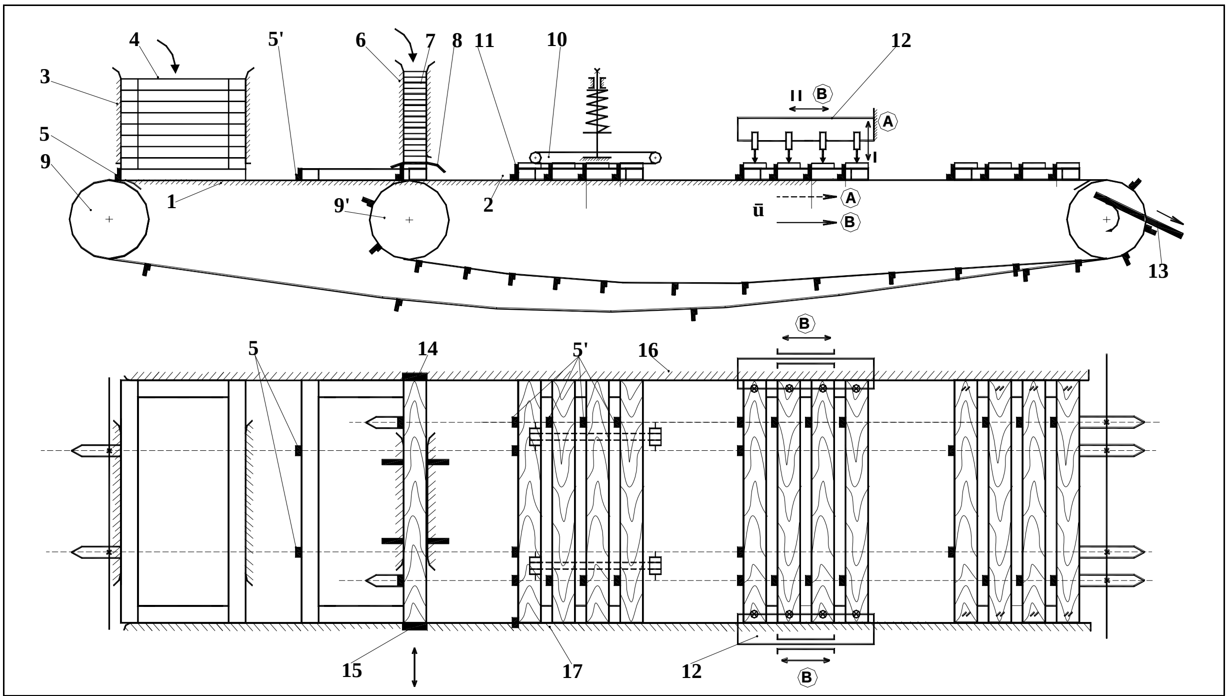

Fig. 6.
Equipment for forming wooden framed panels for crates by using frames and spaced lamellas.

Movement I is the one that performs the application of the staples or nails (application by the intermittent feed speed of the frames), and the movement II is that of advancing and returning - to the continuous feed speed application of the frames.

The components of the installation are as follows:

1. Support of the frames stock;
2. Supports for framed panels when passing through the installation;
3. Frames storage bunker;
4. Stock of frames;
5. Alternative frame pusher (variant A);

The claws of the conveyor 9, which drive the frames (Fig.5) or frames and lamellas (Fig. 6);

5'. Claws of the conveyor 9 '(Fig. 6), which drive each lamella;

6. Lamellas storage bunker;
7. Stock of lamellas;
8. Positioning beams of the last lamella layer;

9, 9'. Crawler conveyors with claws;

10. Non-driven conveyors - acting as brakes;
11. Drive claws;
12. Nailing or stapling system;
13. Sloping evacuation plan;

14. End panel - for laying the lamellas in the same plane;
15. Vibrating panel having the role of keeping the lamellas on the same plane;
16, 17. Side guidance of the frames and lamellas (left-right).

The correct operation of the equipment involves the synchronization between the movements and maintaining the position of the lamellas on the frames until the nails or staples are applied.

In the case shown in Fig. 6, the two conveyors 9 and 9 'must have the same peripheral velocity and a part of the claws located on the same plane (those which drive the frame and the last lamella on the frame). Similarly, the claws that ensure the spacing of the lamellas on the frame (5 ') must be placed within the same plane.

CONCLUSIONS

Mechanization of the wood packaging crates manufacturing sector, no matter if they are used as packaging for agricultural, food or industrial products can be considered as one of the main ways to control production costs and the quality of these products, in the conditions when there is so much interest in greening the recycling of products that have exceeded their lifetime.

Wood and cardboard, as well as lignocellulosic composites could be the solution for the raw materials used for packaging, so to massively solve the packaging recycling.

More than that, if we also add the advantage that wood is a natural renewable product, we could say that the use of wood, cardboard or lignocellulosic composites as packaging materials will not have the effect of consuming the Earth's reserves. In fact, the wood grows constantly and people do very little for tree growth.

Since wood is also an inexpensive material, the cost of the packaging is expected to be in the acceptable percentage rate with the stored or transported products.

To design packaging using all kinds of raw materials such as solid wood, veneers, paper, cardboard or other lignocellulosic composites is particularly necessary and could be achieved by a more active marketing activity in the packaging area in the direction of its design and technology.

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