

## SMALL WOODEN OBJECTS USING EUCALYPT SAWMILL WOOD WASTE

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Forest industries look for multiple utilizations for their timber production. In Brazil, the genus *Eucalyptus* has a great potential for solid wood products; however, only a small amount of *Eucalyptus* is used as sawn timber. About 50% of the log volume ends up as waste during mechanical processing, resulting in serious economic and environmental problems. In most cases, such residue is discarded at random or used as fuel, and in this context the sustainable management of processing industrial waste is an urgent necessity. Parallel to this, *Eucalyptus* has not been employed for small wooden object (SWO) production. Hence, the aim of this work was to evaluate the performance of small wooden objects produced with *Eucalyptus urophylla*, *E. camaldulensis*, and *E. grandis* waste from sawmilling. Brazilian craftsmen manufactured SWOs with *Eucalyptus*, and these crafted objects were presented at exhibits and trade fairs for assessment. The proposed small wooden objects made with *Eucalyptus* residues exhibited satisfactory performance and achieved excellent acceptance by the visitors. This work gave evidence that the use of sawmill waste as raw material for small wooden object manufacture has potential to generate income for economically underprivileged communities near to a plantation.

*Keywords:* Small wooden objects; *Eucalyptus*; Wood; Handicraft; Sustainability; Economy; Sawmilling waste

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### INTRODUCTION

*Eucalyptus* is one of the most widely cultivated hardwood genera in tropical and subtropical regions of the world. As a fast-growing and short rotation source of wood, *Eucalyptus* is the basis for several industries, such as pulp and paper, charcoal, sawmills, and others (Santos et al. 2004). Nowadays, forestry industries are looking for multiple utilizations for their timber production to improve profitability.

The genus *Eucalyptus* has great potential for solid wood product manufacture in Brazil (FAO 2007); however, only a small amount (1%) of a *Eucalyptus* plantation is directed toward timber production (BAFPP 2008). In addition, the log yield is still very low, less than 50% (Ferreira et al. 2004), although processing techniques have made significant progress (Souza et al. 2007). The residues generated are discarded randomly or used as fuel, which introduces serious environmental, logistical, and economic

problems. At the same time, populations near *Eucalyptus* plantations are largely made up of low income families. In this context sustainable management of waste from the wood-processing industry is an urgent necessity. An alternative to circumvent these problems is the manufacture of small wooden objects.

In general, small wooden objects (SWO) are present in the daily life of many people, as practical or decorative domestic objects, and also as parts of other objects, toys, sports, or personal articles (Sternadt 2002). Indeed these products are available in the market and can be manufactured industrially or as an artistic craft. However, technical and marketing knowledge is required to successfully produce small wooden objects from a range of forest species. Hence, the National Institute of Research of Amazonia (INPA) provides specific courses for professional development concerning the utilization of forest specie residues used by the local lumber industries (INPA 2003).

Despite the high timber productivity and availability of *Eucalyptus*, the species has not been employed for small wooden object production in Brazil. Thus, SWOs manufactured from small-sized residue pieces, such as those resulting from sawing, laminating, or peeling operations can be an alternative to solve waste and storage issues. At the same time, this activity generates income for families and provides social participation of communities near the plantation. The manufacture of SWOs from plantation residues is complementary to the industrial use of the forest plantation, because it uses a byproduct of the main manufacturing process. In addition, the involvement of the local communities in the economic activities may reduce some of the criticisms against *Eucalyptus* reforestation. The creation of new jobs and the generation of income also can contribute to improve the image of *Eucalyptus* plantations.

Small wooden objects can have an impressive economic impact. For instance, Sternadt and Angelo (2001) showed that the amount of SWOs exported in 1998 and 1999 was 273 million kilograms, an equivalent of US\$ 356 million based on economic data from BRASIL (2000). Wooden scaffoldings and handles for tools, brushes, and others products have totaled 64 million kilograms, producing US\$ 74.4 million, at an average price of US\$ 1.13 per kilogram. The North America market was the primary importer, receiving 43% of the objects, followed by Belgium, the United Kingdom, Germany, and others.

Technical literature on SWOs is scarce. Nevertheless, some old articles such as Panshin et al. (1959) described the processes for the production of SWOs such as pencils and different packaging techniques. The authors considered the necessary wood properties with regard to the characteristics of each commodity.

SWOs are widely manufactured in many countries. In Kenya, a country with a tradition in wood handicrafts, Chonga (1999) evaluated alternative timbers for SWO production and reported that *Eucalyptus*, *Casuarina*, and *Melia* genus demonstrated exceptional potential for wooden handicrafts. Similarly, Rutiaga and Garcia (1999) mentioned that the species *Dalbergia* and *Platymiscium* are appreciated in the Mexican lumber industry, and handicrafts with good characteristics can be manufactured from these woods.

In Brazil, Santos and Bonduelle (2004) developed pedagogical games from residues of some forest species to evaluate the viability of the manufacture of these SWOs. Abreu et al. (2009) produced handmade small objects using boards and mixed

board residues in order to compare their quality. These authors concluded that it is technically feasible to produce small objects using wood panel residues generated by the furniture industry. In regard to *Eucalyptus* from Brazilian plantations, preliminary work was presented by Vieira et al. (2008), who showed the potential of *Eucalyptus* wood for the manufacture of a teaching kit for children apprentices. Hence, the aims of this work were: (i) to evaluate the potential of *Eucalyptus urophylla*, *E. camaldulensis*, and *E. grandis* sawn solid residues for small wooden objects manufacture, (ii) to propose a viable and social solution for attenuating raw-material waste and improving the public image of forestry companies.

## METHODOLOGY

Initially, a reference collection of SWOs manufactured from many types of wood was acquired from commercial products and handicraft fairs, or by means of loans or donations from people interested in this research. The goal of this collection was to provide a representation of a large range of wooden object categories. From all available objects, ten SWOs were selected by category, dimensions, and duplication difficulty level. Technical drawings and detailed technique descriptions were developed for each object chosen. The reference collection of SWOs was comprised of 104 distinct objects that were produced from many wood species (Table 1). Some SWOs were manufactured according different models, for instance, 6 types of Bottle opener were made. The category of domestic utensils was easily found. Pedagogical toys, games, and ornamental pieces were acquired at the Handicraft Fair in the city of Lavras. The average price of the SWOs, obtained at the commerce and handicraft fair, was US\$ 2.60, the highest price was US\$8.00, and the lowest was US\$ 1.30.

Later, prototypes of these objects were fabricated using hybrids of *Eucalyptus urophylla*, *Eucalyptus camaldulensis*, and *Eucalyptus grandis* in the Laboratory of Wood Workability of the Federal University of Lavras (UFLA), in Brazil.

Subsequently, public and private sector companies and entities were approached in order to identify craftsmen from Lavras and other regions of the Minas Gerais State, Brazil. Then, six craftsmen were invited to reproduce the ten types of objects, with six repetitions each. Sawmill residue from many research projects carried out at UFLA was used as raw material to produce the SWOs. In order to follow the work progression and to collect technical information on wood performance, periodic visits to the craftsmen were made during the project. At the same time, questionnaires were submitted to craftsmen in order to evaluate performance and wood quality. Later the finished quality of the SWOs was evaluated by the craftsmen.

Expositions were organized in diverse cities of Minas Gerais State, in order to demonstrate the manufacturing techniques developed during this project and to assess the public acceptability of the *Eucalyptus* SWOs. The acceptability evaluation of the proposed objects was performed by surveying the visiting public. The surveys questionnaires used to verify acceptability were based on questionnaires, interviews, and subjective notes.

## RESULTS AND DISCUSSION

The city of Lavras is typical of Brazilian cities in regard to the average population density, and a considerable range of SWOs are available in its market. Hence, the acquisition of the collection easily took place; however, SWOs manufactured from *Eucalyptus* were not found. This collection, in addition to providing greater understanding of the diversity of SWOs on the market, provides information on the wide range of objects that can be made from *Eucalyptus* wood.

**Table 1.** Collection of Small Wooden Objects from Eucalypt Sawmill Wood Waste

Small wooden object	# of types	Small wooden object	# of types
Bottle opener	6	Mini chest of drawers	2
Coffee tray w/legs	1	Table lamp	2
Chest	2	Wooden Shrine	1
Ornamental bicycle	1	Ice Cream stick	1
Coat hanger	2	Toothpick	1
Coat\Hat racks	1	Manicure stick	1
Car	2	Duck with wheels	1
Ox cart	2	Top	2
F1 car	1	Picture frame	4
Ashtray	6	Key holder	3
Wooden spoon	2	Paper towel holder	1
Small wooden spoon	3	Matchbox holder	1
Trivit	2	Pencil holder	4
Chinese dominoes	1	Napkin holder	4
Heart ornament	1	Toilet paper holder	1
Woodturning piece guide	1	Object caddy	6
Dry farina bowl	3	Dish	3
Pedagogical Kit	1	Clothes pins	6
Pedagogical Kit slide	1	Pestel	4
Pedagogical Kit of assembly	1	Wine bottle support	2
Rolling massager	1	Cup holder\rack	4
Mini-bench	1	Cutting board	2
Mini-bed	1	Train	2
Total objects produced			104

The bottle openers, wooden spoons, trucks, tractors, meat cutting boards, playing card boxes, key holders, pan rack set, foot files, and napkin holders made up the selected set of SWOs, which were reproduced with *Eucalyptus* sp wood. The fabrication of the SWO prototypes was easy, due to the accumulated experience of the technicians at the Workability Laboratory at UFLA and the technological level of the machines used in this project. Nevertheless, one problem was the warping of playing card box parts and the

meat cutting board. However, this defect did not compromise the viability of the production of these objects. The warping probably was due to the growth and drying stresses released during machining, as well as the effect of the variation of the relative humidity on the equilibrium moisture content after the objects had been manufactured.

Eleven craftsmen from Lavras City were invited to reproduce the SWOs. Initially, they demonstrated some resistance to using *Eucalyptus* wood. Therefore, the prototypes were presented to the more conservative craftsmen, those who prefer the use of traditional wood. Providing concrete examples to the traditional craftsmen appears to be the better method of encouraging them to use *Eucalyptus* in their craftwork. Figure 1 presents some of the SWO's from the reference collection used to persuade them.

From a quick visual comparison, the prototypes exhibited a better quality finish than the objects made with wood from the *Pinus* species, which are commonly used in the fabrication of SWOs. Thus, the reference collection presented in Fig. 1 proved the potential for the use of *Eucalyptus sp.* by-products for successful SWOs production.



**Fig. 1.** Small wooden objects manufactured from eucalypt sawmill wood waste

Some SWOs manufacture presented practical difficulties. For example, the rolling massager and the flower pot proved to be difficult to produce. Craftsmen justified these difficulties citing the wood machining behavior in the lathe resulting from small, knotty areas. The latter caused fibers to be pulled up where the grain angle had been disturbed.

Meetings with hall representatives involved in the projects were carried out through local technical notes of the Secretary of Economic Development of Minas Gerais State, by means of the Undersecretary's Handicrafts office, and members of the SEBRAE (Brazilian Service of Support to Micro and Small Enterprises). The project and prototypes of SWOs of *Eucalyptus* were presented, and the public demonstrated an enthusiastic acceptance. In addition, lectures and courses were scheduled for the communities thanks to the support of the Minas Gerais State Government.

Entrepreneurs, researchers, and visitors had, in general, expressed interest and were surprised by the high quality and diversity of the objects produced from *Eucalyptus* wood residues. All the interlocutors met during the study, including professionals and

potential clients, displayed general acceptance of the SWOs from *Eucalyptus*. This fact could be evidenced by the enthusiasm in their comments when the objects were shown to them.

The results of the subjective assessment of quality requirements including raw material, color, weight, design gracefulness (aesthetics), and finish of the *Eucalypt* SWOs provided by 300 interviewees and are presented in Table 2. It is important to stress that, in most cases, the questions were based on the assessment of the *Eucalyptus* SWOs. The majority of the people polled considered the general quality of Eucalypt SWOs as "very good". The criteria "raw material", "beauty", and "finishing" had impressive acceptance (more than 80%).

**Table 2.** Percentage of the Subjective Assessment in Quality Requisites of the Eucalypt SWOs made by 300 Interviewees

Quality requisites	Bad	Regular	Good	Very good
Raw material	0.0	0.8	11.2	83.2
Colour	0.0	2.4	25.6	68.8
Weight	0.0	4.0	24.0	67.2
Design	1.6	1.6	16.0	77.6
Gracefulness	0.8	1.6	10.4	85.6
Finishing	1.6	0.8	12.0	82.4

From the direct responses, after presentation of the SWOs, 97% favorably acknowledged the viability of *Eucalyptus* for SWO commercial production. Ninety percent stated that they would pay a similar price for a *Eucalyptus* SWOs as compared to those manufactured from traditional woods. Fifty-six percent were concerned about the origin of the wood. More than 86% chose the pink wood color of *Eucalyptus sp*, when asked about their preference, as compared to clear *Pinus sp*. Sixty-seven percent affirmed that they already knew about the commercial usage of Eucalypt sawn timber for various products.

Table 3 demonstrates the awareness the respondents had of *Eucalyptus* use. Considering that approximately 80% of the production of *Eucalyptus* furniture is not commercialized in the domestic market (BRASIL, 2004), it is surprising that 75% answered "furniture" as a product manufactured from *Eucalyptus*. This observation may explain the favorable acceptance of this *Eucalyptus* for SWO manufacture.

The subjects chose, as the main product preference, household utensils, ornaments, and personal utensils for the production of *Eucalyptus* SWOs, with a proportion of 75%, 54%, and 40%, respectively.

A general analysis of the answers indicated that the respondents appreciated the initiative of using *Eucalyptus* for SWO projects and acknowledged the viability of the use of sawmill residues for manufacture. Some people also commented that wood is a material that is always present in their nearby environment, either in the form of domestic utensils or ornaments.

**Table 3.** Percentage of Familiarity of the 300 Interviewees with the Use of *Eucalyptus* Wood for Fabrication of Typical Products

Product	Percent
Charcoal	69.6
Pulp and paper	68.9
Furniture	75.2
Fence post	67.2
Post	39.2
Others	10.4

The following sample of sentences illustrates the frame of mind of the respondents regarding *Eucalyptus* SWOs:

*"Nowadays Eucalyptus is widely used and certainly will continue being so. This fact is due to the wood being rustic, it can be sawed and it is better than the Pinus"*

Marcos Roberto Amaral - farming Technician.

*"It is a rule that wood absorbs much water"*

Beatriz Descni Pereira Oliveira - Farm worker.

*"I know that this wood warps a lot when it is not dry."*

Leandro Bortoli de Freitas - Student.

*"I have books on Eucalyptus, it is rich and diversified with medicinal, ornamental and utilitarian properties."*

Carlos Fernando de Moura Delphim - Architect.

*"I know little about Eucalyptus. I see cultivated areas only destined for charcoal production and I find it wasteful."*

Renata Damasceno - Physiotherapist.

*"Reforestation with a fast growing species is of great utility, taking the pressure off the native forest."*

Rodrigo Gomes de Pádua - Student.

*"It was a contested wood due its natural characteristics: interlocked grain and prone to cracks".*

Ana Cláudia Alvarenga - Student.

*"I was surprise with the technological development applied to Eucalyptus, in view of its current quality."*

José Pereira - Retired.

*"It is an investment for the future and is a plant that dries up the ground."*

Marco Aurélio Silveira - Public official.

*"I know that Eucalyptus is not of national origin and difficult to work with".*

Vanderlei R. Caetano - Military Policeman.

The small wooden object market could be expanded, as it can be supplied by small, medium, and large industrial units. According to Sternadt (2002), the viable production of the SWOs requires mass production, with coherent processing lines, specific equipment and patterns to simplify and to speed up the manufacturing process. This would necessitate the mill organization for each object to be produced.

SWOs such as handles, knobs, and other similar objects are components of more complex products, which are mass manufactured. In this case, manufacture is in favor of the companies that dominate the necessary and specific processing technologies, from the initial design to the skilled labor involved. These factors can lead to more competitive prices for the SWO production (Sternadt 2000).

## STUDY LIMITATIONS

The major obstacles encountered in this study were: (i) the difficulty of the craftsmen in finding available raw material and (ii) the SWO's buyers. In general, people liked the wooden products, but offered some resistance to buying them. At the beginning of this work we thought that the main difficulty would be in relation to product quality, but we demonstrated that the lack of visual quality of some objects can be remedied with proper artisan training.

## CONCLUSIONS

In general, associations and forestry companies showed great interest in contributing to this research. In this project, the industries were interested in participating because the results could demonstrate social and environmental involvement of the forestry corporation in the society. Companies involved in social projects such as these have improved their public image. In short, the use of *Eucalyptus* sawmill wood waste was suitable and profitable for manufacturing of SWO, generating job and income for the local communities nearby the plantations or sawmills. Moreover, the following concluding remarks can be drawn:

1. Entrepreneurs, researchers and visitors were, in general, surprised and pleased with the quality of the SWOs manufactured from *Eucalyptus* residues.
2. The fabrication of prototypes of SWOs with *Eucalyptus sp.* wood was easy to achieve.
3. The main problems found with the *Eucalyptus sp.* wood were the presence of warping and the difficulty in lathing operations; however, these impediments should not make manufacturing impracticable.
4. *Eucalyptus sp.* SWOs exhibited better visual quality than those of the commonly used *Pinus* species.
5. The *Eucalyptus* SWO reference collection proved the potential of this wood.
6. The results indicate that the general public liked the quality of the SWOs manufactured with *Eucalyptus sp.* and that the products were considered very good.



7. Ninety-seven percent of the subjects favorably acknowledge the potential of the *Eucalyptus* for SWO production.

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