INTARSIA – CUTTING-EDGE PROCESSING METHODS

Camelia COŞEREANU[1],
Lumininiţa Maria BRENCI[2], Adriana FOTIN[3]

Rezumat. *Lucrarea îşi propune să prezinte un ornament utilizat în decorarea pieselor de mobilier stil, a cărui realizare clasică presupune multă muncă manuală, răbdare şi talent artistic. Sunt prezentate elementele generale privind realizarea intarsiei, stilurile de mobilier în care aceasta a fost utilizată ca ornament, metoda clasică de obţinere, precum şi tehnici artistice aplicate. În antiteză cu varianta clasică se prezintă metoda modernă de obţinere a intarsiei şi anume procedeul de tăiere a furnirului cu laser, analizând totodată avantajele aplicării acestui procedeu în obţinerea unei lucrări de intarsie de calitate superioară. Procedeul modern de tăiere cu laser a furnirelor în vederea realizării lucrărilor de intarsie reprezintă un imbold pentru fabricanţii de mobilă în revigorarea exportului de mobilă de artă, atât de apreciată odinioară peste hotare, dar al cărei preţ îngloba o manoperă extrem de ridicată.*

Abstract. *This paper aims at presenting an ornament used to decorate the art furniture, whose classic realization requires a lot of manual labor, patience and artistic talent. General elements about the way of obtaining the inlaid veneer named intarsia are presented, continuing with the styles of art furniture where it was used for decoration purpose, the classical method and artistic techniques used by the manufacturers. In contrast to the classic method, the modern one is presented, namely the process of veneer cutting by laser beam, together with the benefits of applying this method to obtain a high quality intarsia work. The up-to-date method of laser cutting of veneers in order to obtain intarsia decoration has to be an impulse for the manufacturers in order to reinvigorate the art furniture export, furniture so much appreciated abroad in the past, but whose price included an extremely high workmanship.*

Keywords: intarsia, marquetry, art furniture, technique, laser beam

1. Introduction

Mosaic, marquetry, intarsia are decoration techniques that resort to incrustation; the raw materials differing in each particular case, both for the underlying board and for the inlaid veneers. The incrustation technique implies decoration by application of valuable materials (gemstones, pearl, ivory, bone, precious metals, glass, porcelain, ceramic, tortoise shell, veneers or wood pieces) on less precious underlying surfaces (wood, stone, metals), being used both in civil engineering (in order to array walls and floors), and in decorating objects (weapons, cassettes, jewels, etc.) and furniture.

[1]Prof. Assist, Dr., Eng., Transylvania University of Braşov (e-mail: cboieriu@unitbv.ro).
[2]Prof. Assist, Dr., Eng., Transylvania University of Braşov (e-mail: brenlu@unitbv.ro).
[3]Lecturer, Dr. Eng., Transylvania University of Braşov (e-mail: adrianafotin@unitbv.ro).

With applicability in civil-engineering, the art of the mosaic is an ancient method of artistic expression devised by the human being. The proof thereof dates back in the third millennium b.Ch. in Mesopotamia, where patchworks out of coloured stone, pearl and ivory, disposed in geometric drawings, were discovered, in the temple ruins of Abra (Fig. 1). The art of the mosaic was perfected in India (the renowned mosaics of Bombay) and was taken over by the Antique artists of the Roman and Greek Empires, enjoying special flourishing during the Byzantine Empire, when it replaced painting in architectural decoration.

Fig. 1. The first mosaics, dating back in the 3rd millennium b.Ch. (Mesopotamia).

Marquetry, a particular case of mosaic, has become an appraised and frequently used technique, since the XVIth century, in Florence and Naples, where marble, jasper and other coloured semiprecious stones were used, in order to construct facades and pavements. An eloquent example to this effect is Basilica San Lorenzo in Florence. Nevertheless, the technique of marquetry reached its artistic apogee, with the use of wood as support material, especially in furniture decoration.

Fig. 2. Flemish cabinets (Anvers, cca. 1650).

a. walnut, with incrustations of tortoise shell and ebony http://www.christies.com,

b. ebony, with painted panels and incrustations of ivory http://www.culture24.org.uk.

The first workshops to have used and developed this modality of decoration for art furniture, were the Flemish ones, from Anvers, by the year 1600, where the so-called Flemish cabinets were achieved, whose underlying material consisted generally of ebony, walnut, with incrustations of tortoise shell, ivory, pearl, silver etc. (Fig. 2). The masters of this art would be known as ebony cabinet-makers, as a consequence of their using ebony wood, in constructing these types of cabinets.

Marquetry, imported in France in late XVII-th century, reached its artistic apogee therein, during the cabinet-maker André-Charles Boulle (1642-1732), who has been reckoned the greatest artist to have made luxury cabinets, and who was allowed, during the king Louis XIV, to organize his workshops at the Louvre.

André-Charles Boulle was allegedly influenced in the technique of marquetry by his father-in-law, Pierre Golle (1644-1684), a Flemish cabinet-maker, who was working at the royal ateliers Gobelins, which were providing Versailles palace with tapestries and decorative elements, inclusively furniture; the atelier had been bought upon request of king Louis XIV and brought together masters of the decorative art. The Flemish technique of the incrustation with metals and precious elements was nevertheless much surpassed by the genius of Boulle, who introduced tin and lead alloys in order to cast metallic decorative elements and likewise developed the inlaid veneers from varied wood species, in ever more intricate designs, for the cabinet fronts, with doors or drawers. The technique of marquetry, specific to the French Baroque style of furniture (style Louis XIV) and to school initiated by Boulle would bear his name over the centuries (Fig. 3).

Fig. 3. Cabinet André-Charles Boulle (1675) in walnut, with incrustation of silver, pearl and other wood species http://www.wga.hu

Therefore, from Baroque, the inlaid veneers, out of various wood species, of an ever-richer colour palette, had developed and been increasingly used in furniture decoration, for three centuries. This technique of the incrustation, which resorts only to veneers, is called *intarsia* and yields absolutely plan ornaments. Boulle’s technique spread across Europe, and intarsia is also suggestive of English *baroque* (*Queen Anne* style – Fig. 4) and later on, of the French *rococo* (style Louis XV – 1735-1770), English *rococo* (*Chippendale* style), (Fig. 5), French *neoclassicism* (*Louis XVI* style and subsequently, by 1830, *Empire* style) as well as English (*Sheraton* – 1751-1786 and *Regency* – 1769-1830), (Fig. 6), English *classicism* (*Victorian eclectic* style by late XIXth century), as well as Spanish (*eclectic Isabelino*) and German (*Biedermeier* style), prior to *Art Nouveau* style (Art 1900) by early XXth century, where intarsia appears less frequently and delicately decorates the tabletops, where applicable (Fig. 7).

Fig. 4. English Baroque art furniture (Queen Anne style) using *intarsia* technique.

Fig. 5. Rococo art furniture resorting to *intarsia* technique.
a. Louis XV (French rococo); **b.** Chippendale (English rococo).

Fig. 6. Art furniture pertaining to Neoclassicism, decorated with intarsia.
a. Louis XVI style; **b.** Empire style; **c.** Sheraton style.

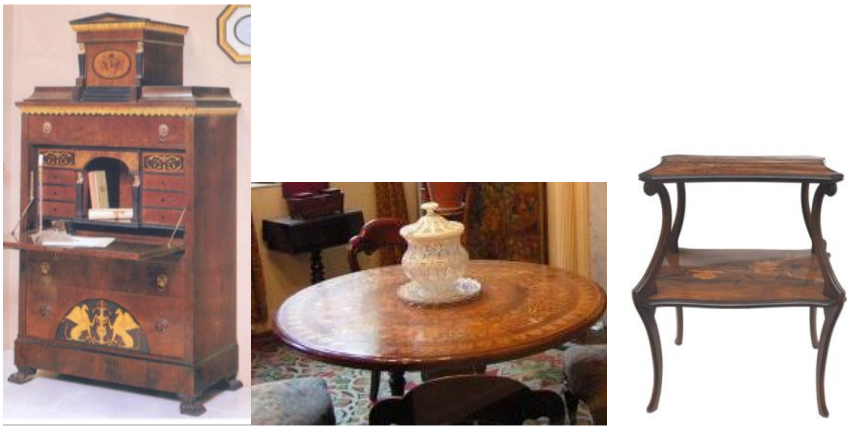

Fig. 7. Art furniture from the XIX-XXth centuries, which resorts to *intarsia* technique.
a. German classicism – Biedermeier style **b.** English classicism; – Victorian style **c.** Art Nouveau style.

2. Intarsia technique. Classical method

A specificity of intarsia, besides its being manufactured of veneers, is its achievement, which supposes separately piecing on the *intarsia* constituents and subsequently applying them on the frame. The component elements of the intarsia can be seen in Fig. 8.

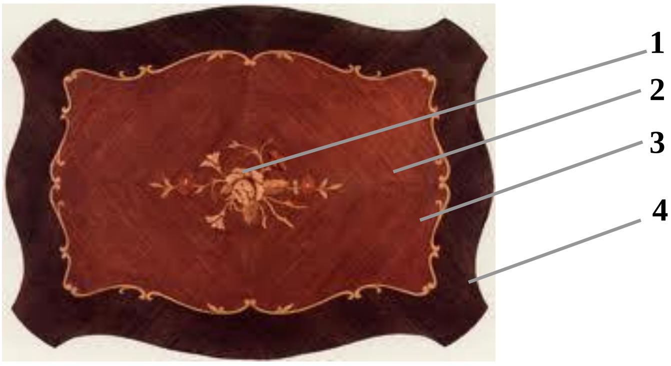

Fig. 8. The constituents of the *intarsia* work; 1- composition; 2 – background; 3 – netting; 4 – frame.

An original ornament, made by the *intarsia* technique, specific to the styles of art furniture may be easily reproduced nowadays, by cutting-edge techniques: scanning, photographing, then copying in AUTOCAD and drawing; eventually, the drawing on a 1:1 scale being obtained. With a view to deepening the *intarsia* technique, we choose a model for us to follow herein (Fig. 9). The orientation of the veneer structure for the frame and background, as well as the choice of their colours, of the netting and of the veneers in the composition, are made in accordance with the original, choosing the adequate wood species for the required nuances and contrast.

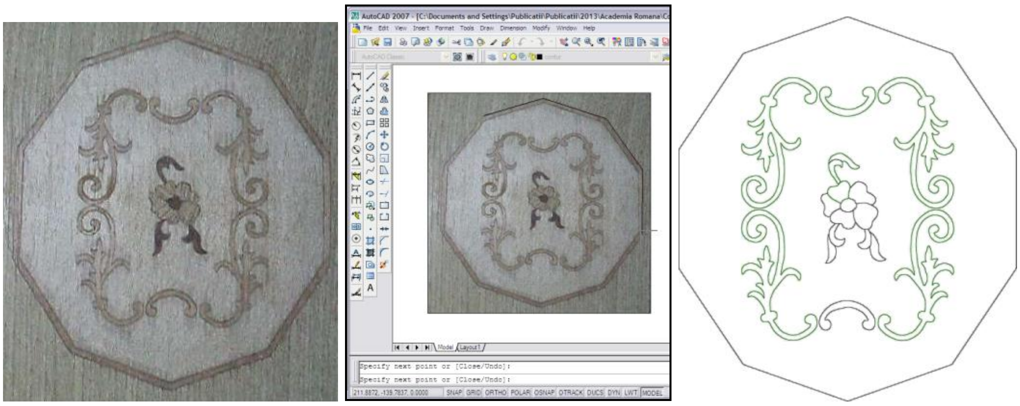

Fig. 9. Reproduction of an original ornament by scanning, copying in AUTOCAD and drawing.

The colouristic and contrast potential of the wood is being exemplified, only by a few nuances, in Fig. 10.

Fig. 10. Colour and contrast potential of the wood.

In the reproduction phase (design) of an *intarsia* work, this study of colours is highly important, so that the desired aesthetic effect might be obtained.

Wood species may be grouped in light wood species (fir, spruce, maple, linden, birch, hornbeam, lime, limba tree, framire), reddish (beech, cherry, oak, ash, alder, pear, hazelnut, pine, apple, bubinga, mahogany, rose) and dark (walnut, heartwood of yew, ebony, African cedar, mahogany, mansonia, roseweood, teak, ebony).

In terms of wood drawing (structure), it depends on the veneer cutting direction. Many a time, some timber growth defects benefit wood drawing, assigning it higher aesthetic value, as in the case of the curly fibre, nests of pinholes, node configurations, furcation, deviated fibre or roots (for instance, walnut).

In order to execute the intarsia works, the aesthetic veneers, especially those obtained by radial sawing, whose thickness ranges between 0,6 mm - 1 mm, are mostly used as raw material. After timber sorting in terms of colour and structure, the veneer package of 20-30 mm oversized length and width is formed - package which comprises all veneers necessary for the intarsia work, both for background, composition, and for netting and possibly frame.

Schematically, the *intarsia* technique, in classical version, is shown in Fig. 11.

Fig. 11. *Intarsia* technique in classical version.

For better fretsawing, in case of brittle veneer, it is advisable to moisten the veneer sheets prior to forming the package. The first and last sheet are protective veneers, not to be introduced in the work; and the sheet with the drawing will be glued on the veneer package.

Veneer tinting is intended to create the drawing shadows, which assign it a similar image to the real aspect. This is usually achieved on the veneer elements of the composition, especially when they pertain to the same wood species.

The *intarsia* works, of great artistic value, in classical version, require the reproduction or design, with faithfulness, skilfulness and talent, with patience and artistic propensities, as well as with passion and thoroughness.

3. Intarsia technique. State-of-art cutting methods

Intricate *intarsia* models require extraordinary meticulousness and precision, when fretsawing the composition elements. Most often, after mounting the work, unforeseen results occur and influence its quality, because of the large spaces between the background veneer and the composition veneers, the broken lines unintentionally fretsawn on the curved trajectories, the inadequate tinting by burning etc.

Therefore, art-furniture manufacturing, with this decoration technique has been on the decline; this comedown being doubled by the high selling prices, owing to the high workmanship. State-of-art cutting methods, respectively by laser beam, bring a hope of reinvigoration to this *intarsia* technique, as the fretsawing work of a few hours may be replaced by a rapid cutting of a few seconds, which adds furthermore the advantage of high cutting precision; therefore the mounting defects occurring with the classical method actually disappear, and the quality of the intarsia work is significantly higher.

Colour tinting, by veneer burning in sand or salt baths, in line with the classical method, disappears in the modern version; as, by adjusting the operational factors of the laser-beam cutting machine, a deliberate burning of the edges can be obtained.

Cutting by laser beam, owing to its being a recent technique, does not have a database of the operational factors necessary for processing on this type of equipment, depending on the thickness of the veneers or of the veneer package, according to the wood species and the veneer tinting degree.

Therefore, each new *intarsia* drawing requires nowadays research work on the operational parameters of the equipment, so as not to obtain uncontrolled contour burning, or consistent blanks between the composition elements and the background; or, on the contrary, not to succeed in piercing the last veneer sheets, with the laser beam.

LASER processing (**L**ight **A**mplification by **S**timulated **E**mission of **R**adiation – supposes using the continuous or pulsed light beam, emitted by a quantum optic generator. By resorting to the laser beam, one may process manifold materials, as the temperature of the application point ranges between 5000 - 8000° C, much over the melting or burning temperatures of most materials (Sprânceană, F., Anghel, D., 2006); therefore it has become a topical cutting method in most processing industries. The processing occurs due to the very rapid heating and local vaporization of the processed material. The processing by laser beam relies on the erosive action of a radiation beam of high energy, strongly focalized through an optical mirror and lens on the surface of the material. Laser beams are defined as monochrome and coherent electromagnetic radiations from the optical range (whose wavelengths range between 0.1 and 20 μm). The coherence is given by the issuing constant of the frequency and phase change in time, by the radiation source. Another characteristic of the laser beam is directionality, defined by the property of rectilinear propagation, of extremely low divergence. The absorption degree of the laser radiation by the processed material depends on the wavelength of the radiation λ (for processing metals $\lambda < 4$ μm; and for processing non-metal materials $\lambda > 4$ μm), of the type, temperature, roughness and homogeneity of the absorbing surface.

3.1. Principle of veneer-cutting by laser beam

Laser beams are generated by the internal-energy resources of the atomic or molecular micro-systems, considering withal their mutual influence and their interaction with the exterior electromagnetic fields. As a result of the interaction, part of the system atoms will occupy higher levels. According to Boltzman's Law – the higher the level, the smaller is the number of atoms thereon. When the electrons simultaneously pass on inferior levels, the micro-system atoms chaotically irradiate light energy quanta (photons), of varied wavelengths. In other words, non-homogeneous oscillations, in terms of phase and direction, of varied frequencies, are emitted and occupy a fairly large portion of the spectrum (as the emission of the regular light sources). If the electrons pass from higher to lower levels in a controlled manner, under the influence of an exterior electromagnetic field, of equal frequency to the transition frequency, then the emission will be stimulated or induced. This way, the excess energy of the atoms appears as coherent electromagnetic emission, to wit all system particles oscillate simultaneously and in phase. Unlike the previous case, this emission covers a very narrow frequency spectrum, being almost monochromatic. By an optic system, the laser beam is focused on the surface of the material, in a circular impression of small diameter (0.1-0.2 mm). The power density of this impression is very high (a beam of 1 KW produces power densities of the order 1011 W/m^2), which produces the heating and melting of the material across its width (www.laser-tech.ro).

The generation of the laser beam also implies the stimulation of a laser-beam gas (Fig.12.) by electric discharges or lamps in a closed container.

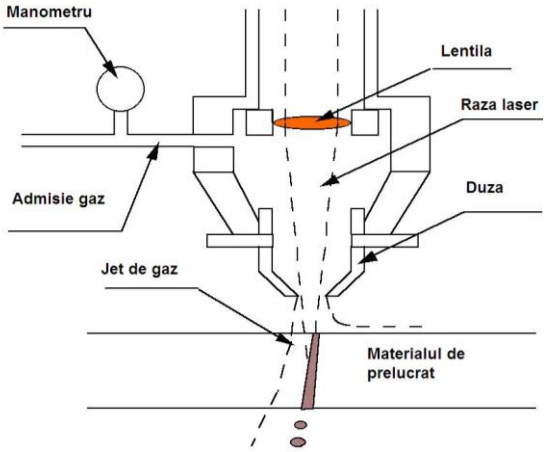

Fig. 12. Principle of cutting by laser beam and equipment for intarsia work:

a. Principle of cutting by laser beam **b.** Cutting equipment by laser beam OMNIBEAM.

Pressure gauge (Manometer), Gas admission, Gas jet, Material under processing, Nozzle (Duza), Laser beam, Lens.

In order to make the *intarsia* experimental model, respectively in order to cut the veneer package, the cutting-equipment by laser beam OMNIBEAM (Fig. 12. b.) made in USA, manufacturing year 2011, was used; the equipment is currently located in the Research and Development Institute of *Transilvania* University of Braşov.

The installation allows processing metallic materials, plastics, wood, paper, composites, prefabricated parts, rubber and textile materials.

The device uses a fully closed and water cooled CO_2 laser, of average power of 150 W and peak power of 375 W; Working gas: nitrogen.

The minimal rate of doing work of the equipment is, depending on the operation, the following:

- 50800 mm/min for cutting;
- 91500 mm/min raster-type engraving;

The equipment has a positioning system of high precision and reliability, as well as a resolution of 2 µm. The material to be processed is fastened on the mass of the device by means of a vacuum system, and the device has an external heat exchanger based on liquid agent (chiller).

The upper limits to the thickness of the processable materials are the following:

- for plastics (acryl and ABS) and wood: 15 mm;
- for veneer: 5 mm;

4. Researches on veneer cutting by laser beam

For the model to achieve as *intarsia* work (Fig. 9), a three-veneer package was made: cherry, mahogany and beech. For this package, the operational parameters of the cutting equipment by laser beam (OMNIBEAM) were varied, namely cutting speed, pressure and power, until optimal cutting was reached (complete cutting of the three veneers, without burning). To this effect, 21 tests were made and their results are shown in Table 1.

Tabelul 1. Test results

<table>
<tr><th>No.</th><th>Cutting speed [mm/min]</th><th>Pressure, %</th><th>Power, %</th><th>Observations</th></tr>
<tr><td>1.</td><td>2000</td><td rowspan="3">25</td><td rowspan="3">40</td><td rowspan="4">engraving</td></tr>
<tr><td>2.</td><td>846</td></tr>
<tr><td>3.</td><td>150</td></tr>
<tr><td>4.</td><td>500</td><td>30</td><td>50</td></tr>
<tr><td>5.</td><td>600</td><td rowspan="2">25</td><td rowspan="2">70</td><td rowspan="2">no piercing to the third veneer</td></tr>
<tr><td>6.</td><td>500</td></tr>
<tr><td>7.</td><td>500</td><td rowspan="5">25</td><td rowspan="5">80</td><td rowspan="2">penetration through the 3 veneers, burns on the veneer surface</td></tr>
<tr><td>8.</td><td>400</td></tr>
<tr><td>9.</td><td>300</td><td rowspan="3">veneer burning</td></tr>
<tr><td>10.</td><td>150</td></tr>
<tr><td>11.</td><td>100</td></tr>
<tr><td>12.</td><td>150</td><td rowspan="10">25</td><td rowspan="10">60</td><td rowspan="2">veneer burning</td></tr>
<tr><td>13.</td><td>200</td></tr>
<tr><td>14.</td><td>400</td><td>almost cut</td></tr>
<tr><td>15.</td><td>420</td><td>no piercing to the third veneer</td></tr>
<tr><td>16.</td><td>300</td><td rowspan="2">between cut and a little smoked</td></tr>
<tr><td>17.</td><td>350</td></tr>
<tr><td>18.</td><td>280</td><td rowspan="2">smoked areas on the veneers</td></tr>
<tr><td>19.</td><td>265</td></tr>
<tr><td>20.</td><td>250</td><td>almost well, with a few smoked areas</td></tr>
<tr><td>21.</td><td>240</td><td>well</td></tr>
</table>

For the test number 12 and the test number 21 (optimal regime), one can see the results of the cutting, in Fig. 13.

Fig. 13 Research results on the optimal processing regime;
a. test no. 12. **b.** test no. 21.

Conclusions

The state-of-art procedure of cutting veneers by laser beam, with a view to achieving *intarsia* works, might be an impulse for manufacturers to reinvigorate art furniture because, as shown in the introductory part, artists had resorted to intarsia as furniture decoration technique for three centuries.

The advantages offered by the technique of cutting veneers by laser beam are of importance and consequence: shortening the time allotted to veneer cutting and tinting, raising the quality of the *intarsia* work, possibility of executing watermarked *intarsia* works, of small sizes, otherwise difficult to make by fretsawing.

Although this cutting-edge technology can allegedly bring only benefits, however there is no database on the optimal regime of cutting by laser beam, for veneers of various thicknesses, wood species, number of veneers, so that the cutting might yield the expected results. Nevertheless, this disadvantage can be removed by assiduous applied research, based on experimental tests for the highest possible number of veneer species and thicknesses, so that the optimal cutting regimes should be rendered available for producers. This is what the teaching staff within *Transilvania* University of Braşov, Faculty of Wood Engineering, have initiated and endeavour to carry through.

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