REPORT OF A SHORT TERM SCIENTIFIC MISSION

COST Action	**FP1006**
COST STSM Reference number	**COST-STSM-FP1006-300115-052276**
STSM title	**Influence of tool wear on morphological characteristics of the machined surfaces - Part 2**
Period	from **30th of January 2015** to **27th of February 2015**
Host institution	**Salzburg University of Applied Sciences**, Markt 136a, A-5431 Kuchl, Austria FH-Prof. Univ.-Prof.Dr.-Eng.Dr. **Marius-Catalin Barbu** marius.barbu@fh-salzburg.ac.at
STSM Applicant	Assoc.Prof. **Gorazd Fajdiga**, Ph.D. University of Ljubljana, Biotechnical Faculty, Department of Wood Science and Technology, Laboratory of mechanical processing technology, Jamnikarjeva 101, 1000 Ljubljana, Slovenia, e-mail: Gorazd.fajdiga@bf.uni-lj.si

Table of Contents

1. Purpose of the visit

The motivation to apply the Short Term Scientific Mission (STMS) again is to work further under the guidance of FH-Prof. Univ.-Prof.Dr.-Eng.Dr. Marius-Catalin Barbu from Salzburg University of Applied Sciences, Campus Kuchl, on a problem of influence of drilling tool wear on machined surfaces. In my first STMS visit at the end of 2014 we found some additional topics that would be needed to investigate and we agreed for my second short stay in Kuchl in the beginning of 2015.

2. Description of the work carried out during the visit

During my visit at the Salzburg University of Applied Science, Department for Forest Products Technology and Wood Construction, Kampus Kuchl, my work was divided into two parts:

- Exchanging knowledge with students, researchers and professors at the department of Department for Forest Products and Wood Construction, Campus Kuchl;
- Continue to work on the project of investigation of the influence of drilling tool wear on quality of machined surface.

2.1 Exchanging knowledge with students, researchers and professors at the Department for Forest Products Technology and Wood Construction

- Supporting and assisting students in their projects and thesis,
- Involving in discussions about the open issues on active project,
- Performing lectures on a Bachelor and Master level in English on the field of development process and development evaluations of wood product in the course of »Computer Integrated Manufacturing« for the Study Program »Forest Products Technology & Wood Construction« and » Process control and analysis« for the Study Program »Forest Products Technology & Management«.

2.2 Working on the project of investigation of the influence of drilling tool wear on quality of machined surface

The influence of drilling tool on quality of machined surface was the topics that I started to investigate under the guidance of FH-Prof. Univ.-Prof.Dr.-Eng.Dr.Marius-Catalin Barbu from Salzburg University of Applied Sciences, Campus Kuchl, already in my first STSM at the end of year 2014.
The fact is that the geometry of a drilling tool largely affects the quality of the newly formed surface. Drilling process through a composite panel cause that the hole edge quality on the outlet side is significantly worse than on the inlet side. That means that the choice of the appropriate tool geometry is crucial. On the quality of the newly formed surface of the holes has, in addition to tool geometry, a strong influence also the tool wear. The main parts of investigations are correlated to the tool wear during process of drilling. During the process of drilling the tool can come into the contact with some solid hard particles in composite panel. The result is damaged of the tool which can be seen in changes in tool geometry and consequently in increasing the thrust force.
The whole described process resulting in composite delamination on the outlet side of the hole. The dependency of tool wear, the force in the direction of drilling and torque around the axis of drilling and the delamination of particle board on the outlet side of particle board is researched in detailed.

3. Description of the main results

Measurements of cutting force and torque in the drilling direction, as well as measurements of the holes, was made on experimental models which was partly done also in Laboratory of Mechanical Processing Technologies at the Biotechnical Faculty of the University of Ljubljana. The main goal of the project performed at Department for Forest Products Technology and Wood Construction at the Salzburg University of Applied Science in Campus Kuchl was to finding out the correlation between the drilling tool wear and the quality of the holes (surfaces).
The proposed model for hole edge quality prediction on the outlet side was tested on an experimental model where the cutting forces and torque in the drilling direction were measured, and the quality of the newly formed surfaces was evaluated.
Based on all measurements the delamination factor $F_d=d_d/d$ was defined*; where* d_d is diameter of the circle drawn around delamination area in [mm] and d is hole diameter in [mm], Figure 1.

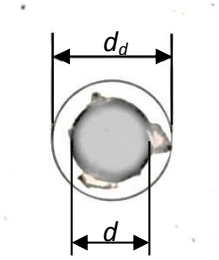

Figure 1: Graphic presentation of determining the delamination factor

In Table 1 the results of calculated delamination factors of five test specimens (Sp1…Sp5) after *N* drilled holes are shown.

Table 1. The measured delamination factor

	Delamination factor F_d					
N	185	1110	2220	3330	4440	5550
Sp1	1,00	1,21	1,24	1,31	1,44	1,28
Sp2	1,00	1,30	1,36	1,25	1,26	1,33
Sp3	1,00	1,24	1,25	1,45	1,32	1,26
Sp4	1,00	1,00	1,15	1,22	1,22	1,35
Sp5	1,00	1,16	1,43	20	1,35	1,34
Avr.	1,00	1,18	1,29	1,29	1,32	1,31

It has been found:

- during the phase of drilling the thrust force reaches two peaks, and both peaks represent structural properties of particleboard or its density profile,
- two denser layers on the surface of particleboard have a greater specific cutting and thrust force,
- at the inlet side the peak is slightly lower than the peak at the outlet side,
- the inlet side peak can be attributed to the geometry of the used tool which was intended for drilling holes and therefore had a very small point angle,
- the outlet side peak occurs in the phase of drilling the bottom layer of particleboard, and in the event that it exceeds delamination value of the layer, it causes delamination of the particleboard on the outlet side of the hole,

The dependence of measured thrust force and the delamination factor on the number of drilled holes is presented on Figure 2. The measurements show that the maximum permissible thrust force which has no influence on the delamination of outlet hole is around 60 N.

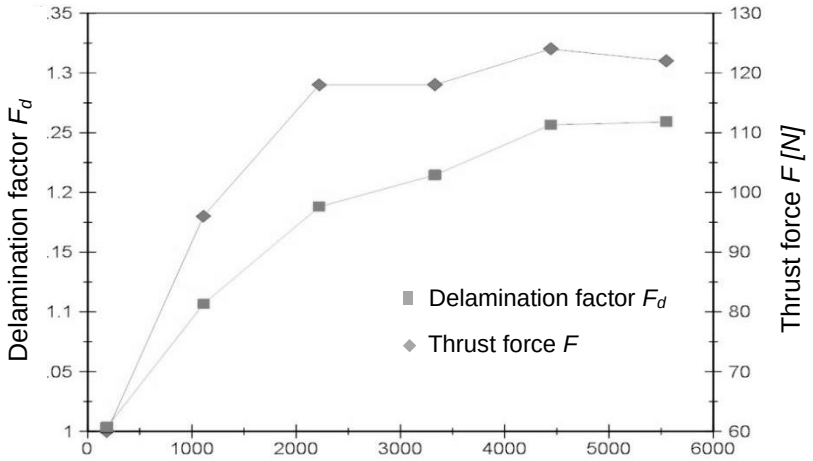

Figure 2. Dependency of delamination factor F_d and maximum thrust force F of drilling from the number of drilled holes

From the results of measurements the following conclusions could be made:

- a relatively good relation between thrust force magnitude and particleboard delamination factor,
- the maximum value of thrust force can be used to determine the surface quality on the outlet side of the hole or the degree of particleboard delamination,
- possibility of using the thrust force measurement as a starting point in the setting up the technological parameters of the feed rate or the rotational speed of the tool to the optimum, or still the satisfactory degree of composite delamination on the outlet side of the hole.

4. Future cooperation with host institution

I could now confirmed that both STSM strengthen my personal research network and the cooperation between my research group (Laboratory of mechanical processing technology at University of Ljubljana, Biotechnical Faculty, Department of Wood Science and Technology), and research group of FH-Prof.Univ.-Prof.Dr.-Eng.Dr. Marius-Catalin Barbu from Salzburg University of Applied Sciences, Department for Forest Products Technology and Wood Construction in Kuchl.
Based on good cooperation between both departments we agreed to continue with cooperation also in the future in the form of new common projects or common articles.

5. Acknowledgments

The financial support, provided by COST organization, to this short term scientific research project presented in the report is gratefully acknowledged. Special thanks go to dr. Stefanie Wieland, a chair of COST Action FP1006 and Ms. Ingrid Seidl a Grant holder Administration of COST Action FP1006, for their help and support through the application process.
Last but not least, special thanks go to FH-Prof. Univ.-Prof.Dr.-Eng.Dr. Marius C. Barbu, Head of the Forest Products Technology at the Department for Forest Products and Wood Construction at the Salzburg University of Applied Sciences, Campus Kuchl, for his availability and all useful advices.

Appendix

1. Confirmation by the host institute of the successful execution of the mission.

Prepared by: Ljubljana, 3.3.2015

Gorazd Fajdiga, Ph.D.