REVIEWER'S OPINION OF FINAL THESIS

I. IDENTIFICATION DATA

Thesis name:	**Analysis of defects of the electronic component during packaging – suggestion of elimination of the issue**
Author's name:	**Ros-Jacquier Nils**
Type of thesis:	master
Faculty/Institute:	Faculty of Mechanical Engineering (FME)
Department:	Department of Automotive, Combustion Engine and Railway Engineering
Thesis reviewer:	Ing. Josef Kazda
Reviewer's department:	ČVUT Praha

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment **extraordinarily challenging**

Electromagnetic shields are installed during assembly of the electronic boards. Some shields are significantly deformed at the assembly end. This deformation is making the entire boards unusable. . **Two tasks were defined**. The first one – to make detailed analysis of the assembly to exclude or confirm if some distorted shields arise during assembly. The shields winded on the reels (before assembly) could be visibly deformed. Due to this the second task has been defined - to specify conditions (parameters) of winding to exclude this issue. This product is in Continental newly manufactured, that is why **the solution of this issue is very challenging**.

Satisfaction of assignment **fulfilled with minor objections**

The first task – analysis of the assembly process with respect deformation of the shields - has been correctly made and detailed described in the thesis (Chapter 2). Solution was not easy, because partial steps of the assembly are hidden in the "Surface-Mounted Devices" line – Figure 1.7. For a complete study of the defect's appearance on the SMD line, several series of observations were carried out during production runs. On observations of 500 produced parts, were made conclusion that the **defected shields were mostly winded in several "center" layers on the reel**.
The second task – Study of the shields packaging on the reels is described in the chapter 3 of the thesis.
Planarity of the shield anchor brackets was measured by an **optical tool**. The shields taken as samples were removed from the manufacturing circuit when entered the workshop. Deformations of the shields winded around the reel center were outside acceptable tolerances.
Non-destructive X-ray analysis was used to reveal deformations within the reels, before manipulating the shields, for better understanding how the shields are positioned and how interact within the packaging.
Numerical simulation of shield bending by FEA (Abaqus). One separate shield was loaded by displacement and tested with elastic and elastoplastic material. Character of deformations was adequate to shields deformations in the center of the reel. Considering complex packaging of shields would be too complicated task for the diploma thesis.

Probably unsolvable by Abaqus due to number of contacts.

Three-point shield bending tests by force-driven compression were carried out in the laboratory at Continental. Care has been taken not to exceed displacement values that are too high with respect to given existing clearance in the packaging. The critical load for the shield alone was 30 N (plastic deformation threshold) – Figure 3.23, but the first stress drop occurs when the reaction force reaches approximately 13 N – Figures 3.28, 3.29. Then planarity of the shields has been measured. For correct function is needed planarity error less than 200 μm. The errors of planarity of the shields obtained for a **15 N load** would cause scraps of the electronic boards.

This is the most valuable result of the diploma thesis.

Three solution suggestions were defined in the diploma thesis – elimination of the first 4-5 layers of the shields on the reel, approximately 20% (50 pieces), stiffened tape and addition of small stiffeners under every shield - Figure 4.3. Using this modified packaging yielded highly unsatisfactory results. Rigidity of the tape has not increased sufficiently to prevent deformation of the shields.
Diploma thesis conclusion - winding torque must be monitored during the packaging process.

This is correct conclusion of the diploma thesis.

Method of conception	**correct**
All methods and experimental used in Continental has been applied correctly and dutifully.	

Technical level	**B - very good.**
Technical level of the diploma thesis is very high.	

Formal and language level, scope of thesis	**A - excellent.**
Formal level is professional.	

Additional commentary and evaluation

What is missing in the diploma thesis:

- The shields would be ideally (smoothly) winded on the reel in spirals, but the first layer is specific. The shields of the 1st layer are winded on circular surface and the last shield of the 1st layer (or the 1st one of the second layer) are "elevated" over 1st shield fixed on the reel. This "void" contact is "dumped" in the next several layers (it generate chaotic edge contacts).
- **Missing basic static analysis** - It is simple solvable task in Excel, for example, on "table" without laboratory tests, without complicated computer tests. It would be clear, for example, that after winding of all layers on the reel with constant tangential force 5 N, the 1st layer will be loaded by 25 N and the 5th layer still by 16 N. All these loads are greater than critical value 15 N, defined in the thesis. It would be clear that winding by constant torque is less aggressive than winding by constant tension in tape. **It is a pity, that this analysis was not made if the thesis**. It would be nice part of the diploma thesis conclusion.

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III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

Possible question during defense: Static of two connected shields winded on the reel – tension and radial force equilibrium, influence of the layer radius.

I evaluate handed thesis with classification grade **B - very good.**

Date: **6.2.2024** Signature: Ing. Josef Kazda