6.) SUMMARY

6.1) Practical Findings

From material properties perspective, It is clear, that wear resistance has no correlation with material density or material hardness, but is instead based on combination of formation & structure.

FDM plastics from company Iglidur are meant to be most resistant, from the lowest to highest - 180-260-170, but data shows the exact opposite, with 180 being the most resistant, but even then experiencing wear beyond optimal values. This does not apply to FDM plastics from TTÜ, where the only difference in forming of P and A is lower temperature of P – which might result in more coherent structure. But unlike FDM Iglidur, SLS printed materials live up to their description, with wear drastically decreased, compared to their FDM counterparts.

Looking at the manufacture properties of metals gives some more insight into wear, but there are few correlations between PPS, PS, LT and laser forming power on erosion resistance. Instinctively, lower PS and thinner LT should increase resistance, and this can be seen in the case of F – which has twice as thick layers as other materials, and also the highest wear of metals. Also, 6L is printed 2x faster than other metals, and at smallest PPS, and even with thinner layers experiences second highest wear (only at higher speeds lagging behind Aluminium-based materials).

Concluding from this, the method of printing, and variables such as PPS, LT of material have some effect, but not as concrete as material itself. SLS printing offers better resistance than FDM, while in metals, LT & PS seem to hold some weight, but are nonetheless overshadowed by integral material properties. Testing of effects on single material with different printing properties could shed more light on this topic.

From the SEM images, it can be seen that if printing involves creation of miniature crevices, or if the material does not form solid chunks, it is likely that material that is not tightly joined to the rest of the piece can chip away. If such formations are present not only on the surface, but within the material too (as a result of printing), the whole piece will experience high wear at all times. Together with this, in plastics, rougher surfaces were found in more resistant materials, while in metals the opposite was true, the less worn materials had smooth surface.

6.2) Material Evaluation

This part is about assessing the most suitable materials for different criteria.

The best material in all aspects is Ti and C. Ti has the lowest mass wear at all times, but due to higher volume loss, at higher speeds C becomes superior variant, because its 10% higher mass loss outweighs 40% lower volume loss. Their sole drawback is very irregular deviation.

The most optimal material from plastics is P. It offers best erosion resistance at all circumstances, has good protective surface layer, and surface changes from dark-blue to light upon cutting, which could be also beneficial for visual inspection.

For least suitable materials, F has the most inferior characteristics. Wear is too high, forming properties are not optimal, and multiple samples show signs of rust, after minimal exposure to elements. For plastics, the least suitable is 170. This material has no quality to make up for severe loss of material and volume at all conditions. However, SLS Printed materials from Iglidur, both I3 and 6 offer very good capabilities, only slightly lagging behind superior P.

The most positive surprising result was also the best plastic, P – due to most tangible surface roughness in the form of ridges and FDM printing. However, the ridges turned out to be beneficial for the wear, and weakness of FDM printing was prominent only in Igildur materials.