Technology/Process: **Robotic vibration assisted drilling**

Responsible: **Saab**
Partners: **ÅF Industry**
Work package: **4.2/4.8 – ”Automated assembly part 1/part 2”**

GRÖN FLYGTEKNISK DEMONSTRATION

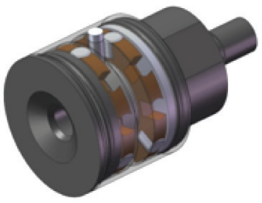
Description of Technology/Process:

Robotic vibration assisted drilling uses a conventional industrial robot equipped with an end-effector for drilling. The end-effector is equipped with a conventional spindle and into the spindle a special tool holder is installed. This tool holder is equipped with an axial bearing which has a curved bearing surface generating the vibrations during drilling in axial direction. The principle for this kind of mechanically controlled vibration drilling is not new but the application in a drilling end-effector for robotic drilling is new.

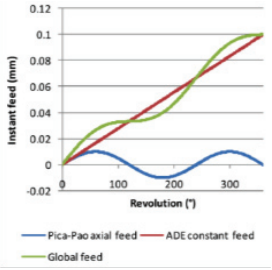
Before:

The inventor of mechanically controlled vibration drilling (MITIS (fr)) has developed various applications with this technology but not for robotic drilling. Therefore the technology readiness level (TRL) at the start of the project is estimated to TRL3-4.

Illustration:



Principle of a tool holder with integrated bearing to create axial vibrations. 1,5 or 2,5 vibration cycles are generated per turn.



The diagram shows the variation in feed rate due to the generated vibration (“Pica-Pao”).

Keywords:

Aerostructure,
manufacture,
methods,
tooling,
composite,
assembly,
drilling,
automation,
vibration,
Pica-pao

Benefits:

- Major benefits by introducing vibration assisted drilling is the improved hole quality through a chip breaking phenomenon. This means that the chips are broken into small triangular shaped chips which are easily extracted from the hole. This has a positive impact on the hole surface especially when drilling hybrid stacks of carbon fibre and metal (in that order).

  It has also been said that the cutting forces can be slightly reduced and also the cycle time for drilling the hole.

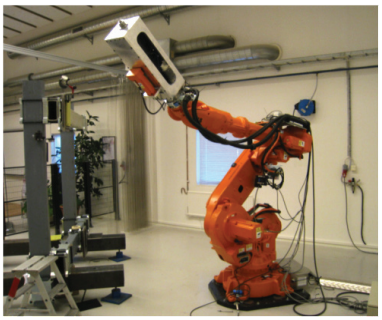
Work performed:

A tool holder with ISO25 interface has been procured and tested in the drilling end-effector which has been manufactured in the project. The tests have had the objective to optimise the cutting data in order to reach the desired formation of small chips to enhance the hole quality. The trials have been successful in this aspect.

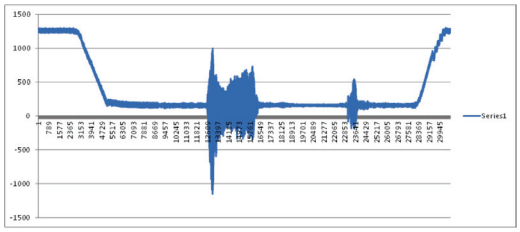
The ISO 25 tool holder with bearing for vibration drilling

Generated extracted chips from vibration drilling in aluminium

The results from the tests where successful in terms of reached chip breaking and hole quality, although some questions still remain. The measured cutting forces where not decreased, in fact due to variating feed rate through vibrations the cutting forces also variated proportionally to the feed rate (see diagram) and could reach high levels. Also the impact of the vibrations to the wear of life on the surrounding equipment is not known. Reached TRL is estimated to 4-5.



End-effector and robot used for testing robotic vibrating drilling



Measured axial cutting (reacting) forces in newton (Y) created on the end-effector during one drilling & countersink cycle

Future developments & exploitation:

The tests done in the project proves that vibration drilling can be implemented in robotic drilling. Still further development, testing and analysis is required to reach full optimisation in terms of recommended cutting tools and adapted equipping (spindle, end-effector, robot mechanics, etc) to handle vibrations and secure wear of life. More knowledge needs to be obtained in this technology. This will be done through new R&D project within Lighter-program.