

FROM A HORSE AND BUGGY TO A SPORTS CAR

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Abstract

Silence is what Acticut International is about! Vibration and noise in industry is a challenge that requires immediate attention and demands new and innovative solutions. Acticut® represents the culmination of extensive research that now provides a new era in the cutting industry with the potential to become the new standard. This powerful and innovative method was developed in Sweden by a team of experts and the results show a marked improvement over traditional methods currently used in industry. The brain in an Acticut® system is the unit that registers the vibrations via vibration detectors (sensors) and a digital signal processor that, in real-time, calculates and injects the proper "counter vibrations" using embedded actuators. Acticut® is a combination of traditional cutting industry technology, high-tech solutions and new material development within the field of "smart materials." We're confident that our customers will be thanking us - for their silence!

The Industry Challenge

Vibration and noise in the industry is a challenge that requires attention and demands new solutions – realities that the industry must carefully analyze from production efficiency and environmental aspects. In the cutting industry, this is a common challenge. Frequently, these challenges imply costly production failures and increased wear of tools with increased cessation as a consequence.

The competitive situation is such that optimal production methods for a minimum investment giving cost savings, is of interest. The time usage for a cutting edge used for metal cutting, is often a maximum of 15 minutes before a change must be made.

The cost for tool tips and tool holders is often 5% of the turnover. To compensate this, based on efficiency and cost needs, passive damping of tools is used, though with limited performance.

The handling of vibration and noise often requires a reduction of production speed, which is moving in the wrong direction in terms of efficiency. The industry is in need of new solutions enabling a better handling of the above mentioned optimization parameters.

A New Era in the Cutting Industry

Acticut® represents unique research that has the potential to become the new standard for the cutting industry. This new method has successfully been developed in Sweden, despite documented failures by large corporations and research groups, with more than 10 years of attempts. The method gives the following advantages:

- Faster and more reliable production process
- Improved surface roughness (see picture below)
- Substantial sound reduction
- Savings in regards to holders and tool tips
- Effective and robust monitoring
- Rapid return on investment
- Service and maintenance by experts
- System financing

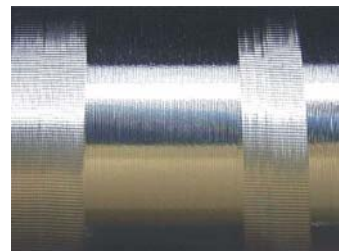


Figure 1. Surface with/without Acticut®.

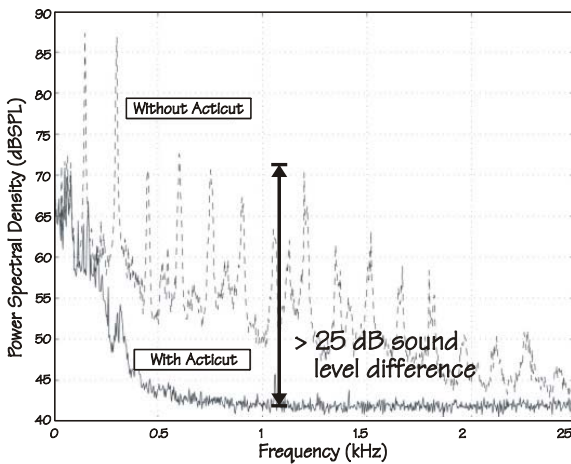


Figure 2. Sound levels before and after the deployment of the Acticut® system. There is a measured broadband attenuation of more than 25 dB and the perceived sound reduction is “remarkable.” The sound from the cutting process is removed!

How does it work?

The tool holder is the part where the cutting edge is placed. When the holder is starting to move, vibrations will impact the process negatively with increased surface roughness, increased sound levels, production interrupts and increased supply needs (i.e. cutting edges, tool holders etc.). In the tool holder, an active component has been embedded that induces a counteracting force (actuator) and a vibration detector (sensor) registers the vibration – all happening in real-time via a controller using a DSP (Digital Signal Processor), [2].

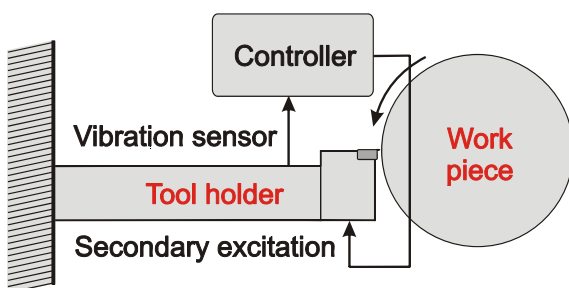


Figure 3. The fundamental principle behind the Acticut® system approach.

The Control Unit

The brain in an Acticut® system is the unit that registers the vibrations together with a digital signal processor that in real-time, calculates the proper “counter vibration.” The mathematical implementation is a dedicated algorithm that has been developed especially for this application. Figure 3 depicts the system’s basic

principle. All elements to counteract and register the vibrations are embedded in the tool holder and thus the dimensions of the tool holder have not been altered. Today, products are available for both external and internal cutting verifying that this new method provides better production efficiency for a lower cost.

The amplifier and on-line control system are included in an external unit that can be easily connected to the Acticut® active tool holder, creating a powerful vibration control system, [1].



Figure 4. Acticut® controller.

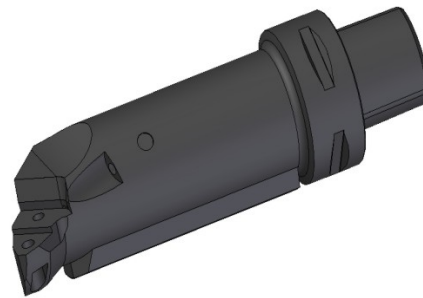


Figure 5. An Acticut® tool holder with embedded sensors and actuators.

A series of different tool holders are available today. Given a specific customer application, using a different tool holder than the ones existing today, it is possible to custom design a system for most applications rather quickly. The Acticut® controller is designed with flexible power driving capabilities and the controller can easily be re-programmed. It is therefore possible to adapt the complete system to new cutting applications.

The product in combination with equipment for robust vibration monitoring, control and documentation, creates a powerful platform for a successful product. Acticut® is a registered trademark owned by Acticut International and is a combination of traditional cutting industry technology, high-tech solutions and new material development within the field of “smart materials.”

Customer Segments

Acticut® focuses on the cutting industry with declared needs in terms of rational and economically defensible investments. For these customers it is possible to distinguish three different market segments, based on their requirements and production complexity.

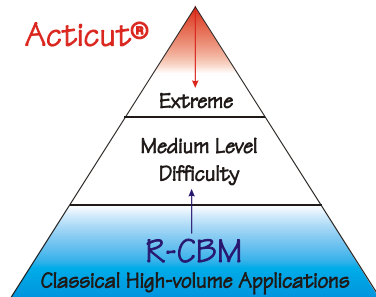


Figure 6. Acticut® market segments.

Extreme Level

Processes with extreme requirements where classical methods to decrease harmful vibrations are insufficient. The customer is willing to invest in solutions solving his challenges and is not particularly price sensitive. The sale of an Acticut® system is prefaced by a consultant effort, analysing the situation in more detail to make sure the solution is right for the customer.

Middle Level

Not as extreme cutting operations where passive methods to some extent solves the customer's need. The customer demands a higher level of economic solution and more rapid return on the investment.

Lower Level

A level where passive methods are the most common solution for the vibration challenges. The industry's processes require excellent quality but not bleeding-edge technology. The customer's price situation is exposed to challenging competition and a constant focus on improved production systems is important. It is possible to view today's Acticut® systems as too modern and an "un-known" solution, therefore, the investment level might not be possible to defend as of today.

To help customers in this segment, systems for robust and efficient monitoring using new and patented methods are offered. This is typically what this customer is looking for. Combined with logistics, educational programs and documentation, these systems give an excellent base for production enhancements.

The customer can later upgrade to Acticut® as an option, giving a real-time control functionality.

The triangle (figure 6) depicts how powerful solutions are offered to these market segments via Acticut®, R-CBM and partner companies. With time, these market segments will be covered by modern solutions and the monitoring system will have an option, allowing for "control" of the vibrations. Acticut AB is today focusing its primary efforts in the top segment where vibration challenges are substantial and classical solutions often are insufficient. Research and development is undergoing further extending and applying this technology in more applications.

Robust CBM (Condition Based Monitoring)

Monitoring of sound and vibration in the cutting process can give key advantages. The experienced operator has traditionally used a screw driver held to the "ear" or a stethoscope to "listen" and then changing cutting parameters accordingly. During the 1970:s, a computerized system for frequency analysis became available and many attempts were made to incorporate automated methods. It was predicted at the time that these methods would dominate the industry within a few years. That did not work out as planned! Therefore, these system solutions have often been associated with "methodology problems" and many operators chose to get rid of the sensors and systems that they felt hindered them. It was, however, clear from the beginning that the experienced operator often could use his "ear" to find acceptable cutting parameters.



Figure 7. Example of a classical approach using a screw driver to monitor the "cutting parameters" from the machine while turning.

With this information as a base, a new method has been developed, with substantially more reliability and robustness. The method has been granted a patent in many countries and was awarded a prize as "best patent in Sweden."

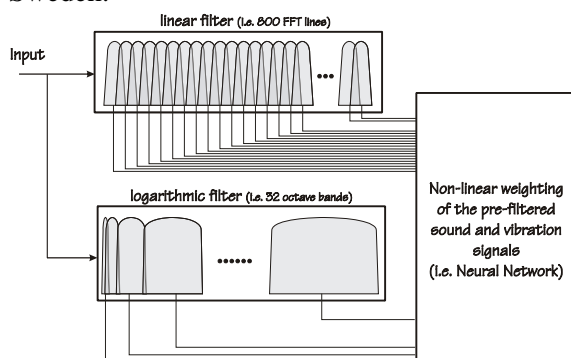


Figure 8. Illustration of the Robust CBM filtering method (patented) that is also used for classification of sound and vibration signals.

Horse and Buggy

It has been very challenging to explain how it is possible to counteract the vibrations in real-time when cutting. The classical approach is to refer to "self induced vibrations" and most text books covering cutting are focused on this as the basis for its understanding. We have proven that a new approach and a new understanding of the vibrations in the cutting industry is needed. Despite clear evidence and documentation outlining the technology and its fundamental principles, the "horse and buggy" society is relating all we do to their own historical reference, suggesting that our solution is "impossible". Figure 9 depicts a metaphor describing this challenging situation.

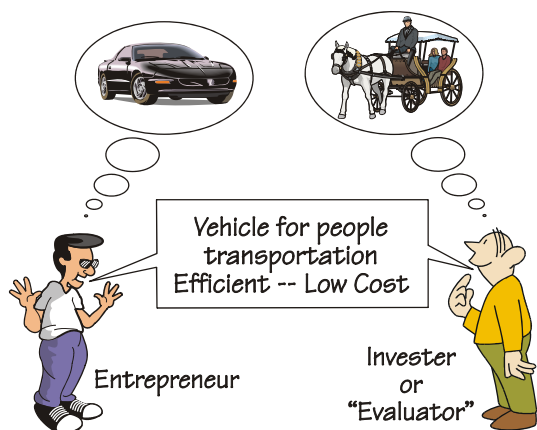


Figure 9. Metaphor illustrating the challenge when presenting bleeding-edge technology.

Both teams are discussing "a vehicle for transportation" but due to historical "knowledge," and experience, it becomes impossible to vision the new, bleeding-edge

technology since the other party thinks about completely different "vehicles." This is not an uncommon situation when seeking funding for technology that has the potential of becoming a new industry and the knowledge base becomes a hindrance, not an advantage. Thinking outside the box is not always easy!

The Sports Car

The Horse and Buggy versus the automobile is a good example for us to illustrate our point and our business model. Just before the automobile became reality, manufacturers of the horse and buggy had done all that they could to perfect it in areas such as comfort of ride, speed, and product quality. It had reached its peak. Along came the automobile and the leaders of this new category enjoyed a high level of success for its innovators, investors and of course, its customers.

The Acticut® product portfolio offers a possibility to counteract vibrations in real-time, a new and powerful system solution opening up new applications. Together with key partners, total solutions can be offered, including sensors and data collection systems. Through high level international research, Blekinge Institute of Technology is helping Acticut International in expanding the applications for these new and exciting bleeding-edge system solutions.

Silence, please!

Silence is what Acticut International is about! Acticut International brings to the cutting industry what Henry Ford brought to the world of transportation. In this well established industry, we are positioning our solutions to become the market leader by using new, proven and patented technologies. We're confident that our customers will be thanking us - for their silence!

Acknowledgement

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References

- [1] C. Fuller, A. von Flotow, *Active control of sound and vibration*, IEEE Control Systems, pp. 919.
- [2] Åkesson et.al, *Active Boring Bar Prototype Tested in Industry*, Adaptronic 2006, Germany.