Case Design Sheet

1. CASE DESCRIPTION
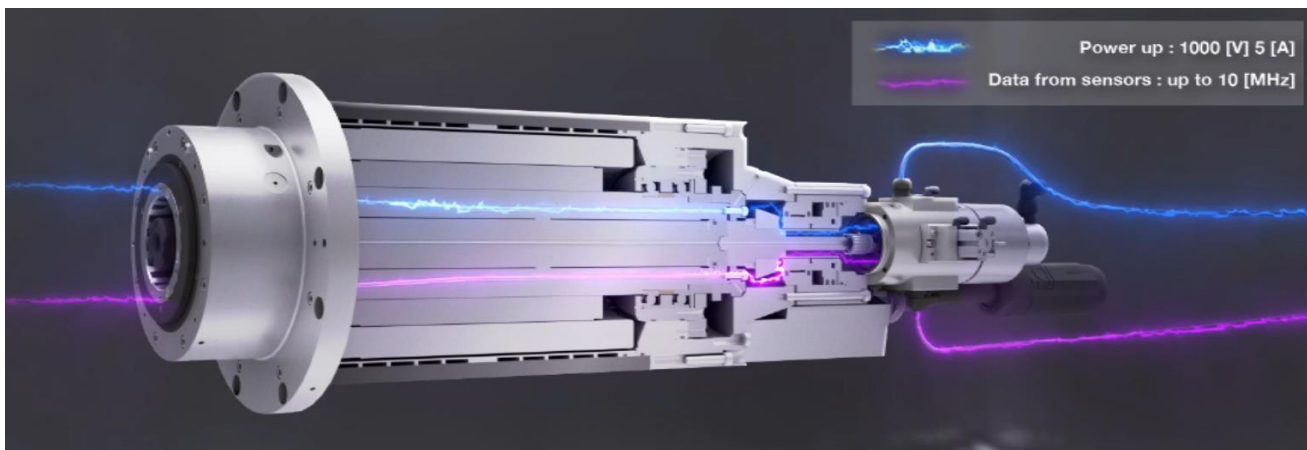
TITLE: E-SPINDLE – From e-spindle and e-machining projects to servitization

PARTNER	LOCATION	TIME/DURATION
CIMES	France	2 years

R&D project eSPINDLE aims to develop a smart spindle for intelligent machining. The device is the IIoT bridge between the process and the machine.

This brand new bride allows to ways:
1. To bring information from the process to the machine. Any sensor located into the tool-holder and monitors the process in temperature, pressure, strength, vibration, acoustic emission, etc.
2. To power up the process and to supply electricity (5kVA per channel) to any actuator located into the tool-holder. This can be: cylinder, electrical motors, piezo-actuator, etc.

The global concept is to get accurate and reliable signals thanks to embedded sensors closed to the machining process. This is signal in (1).
Based on the collected information, artificial intelligence works to detect any unappropriated behavior and operates new cutting conditions which may be
- To adjust the cutting conditions: new speed, feed, etc. thanks to the CNC.
- To act into the tool-holder thanks to actuators: change the tool geometry (e.g. bigger diameter on a boring tool), start active damping with piezo-actuators, etc. this all is done thanks to power out (2).

Examples: refer to https://www.youtube.com/watch?v=vL4JOCPeapU&
This project has been leaded with Cetim and AMVALOR / Arts et Métiers.

Case Design Sheet

2. DIGITAL TRANSFORMATION CHALLENGE

2.1. BUSINESS TRANSFORMATION

The eSPINDLE project makes possible to bring brand new business model for PCI onto the automotive market. As an example, it is now possible to sell machining operations as a service instead of selling machining facilities as today.

As an example, it is noticeable that bringing measurements into the machine are of great interest for PCI, which enriches its applications portfolio from machining to certified work-piece. This is one more step in the self-integrated turkey offer. This also brings the necessity to certify PCI products as measurement equipments.

2.2. CONCEPTUAL TRANSFORMATION

The main transformation is for engineers to admits that the machine learns from the sensors and will know how the adjust better and better. This IIoT application needs several changes
- To take into account the fact that the machine may change or adapt itself according to its environment and ensure the operator safety whatever the conditions
- To bring new contracts closes because the systems automatically sets and is not frozen as it was until now.
- To train PCI engineers and the customers accordingly

2.3. TECHNICAL TRANSFORMATION

The eSPINDLE is a tool. This basic tool requires tool-holders with sensors and/or actuator to enhance the machining process performance.

3. SOLUTION

The solution is to gather a common 10 years background from Cetim, Arts & Métiers, and PCI in terms of ideas, concepts, results, knowledge, publication, and patents. This makes alternative manufacturing ways and products such as eSPINDLE.

eSPINDLE has a total of 12 electrical tracks which may be dedicated to signal acquirement or power supply (max 5 kVA each). The only limit is the engineering brought into the tool-holder!

4. KEY SKILLS AND COMPETENCES

- Adaptive learning
- Automation
- Data monitoring

5. RESULTS

Three e-SPINDLE applications that showcased smart machining technology:
- A toolholder demonstration highlighting real-time monitoring of cutting process variables including force, vibration, and coolant pressure,
- An adaptive drilling application illustrating the benefits of ongoing vibration control,
- A honing toolholder operation highlighting integrated measurement of workpiece diameter to permit continual control of abrasive honing tooling.

6. CONCLUSIONS AND RECOMMENDATIONS

The development of this new technological solution has allowed to reach some initial objectives as mentioned below:
- Improving productivity and optimising tool life and workpiece quality with immediate process correction,
- Allowing smart value-added machining,
- Modifying operating parameters in real time.

7. REFERENCES

- https://www.ic-arts.eu/e-spindle-lusinage-intelligent-debarque-sur-lemo-2019/
- https://www.youtube.com/watch?v=vL4JOCPeapU&feature=youtu.be
- https://www.cetim-engineering.com/smart-machining-on-display-at-the-emo-event-with-e-spindle/
- https://www.manufacturingtomorrow.com/news/2019/10/03/pci-scemm-introduces-e-spindle-that-monitors-cutting-processes-in-real-time-to-optimize-tool-life-and-workpiece-quality-/14104/
- https://absolutemachine.com/pci-scemms-e-spindle/

8. APPENDICES

All charts, financials, visuals, and other related items can be placed here and referenced in the report.