MACHINE MONITORING AND PREDICTIVE MAINTENANCE FOR INDUSTRIAL MANUFACTURING EQUIPMENT

CONTEXT

For any manufacturing production process, industrial machine uptime is crucial. Any unplanned downtime would turn into production delays and loss of revenue. Thus, there is interest for clients to track and assess their machine consumables that are more prone to wear and tear, such as cutting tools, to better optimise equipment service-life.

Currently, manufacturers and suppliers recommend scheduled maintenance/replacement of parts to maintain the equipment. However, such schedules are estimated based on past empirical data collected from other users, which do not reflect the actual wear and tear situation. When such manual inspections are carried out, parts are replaced whether or not it is actually required. While this avoids any unexpected machine breakdown in between maintenance schedules, it hampers clients from accurately assessing their equipment health and service-life.

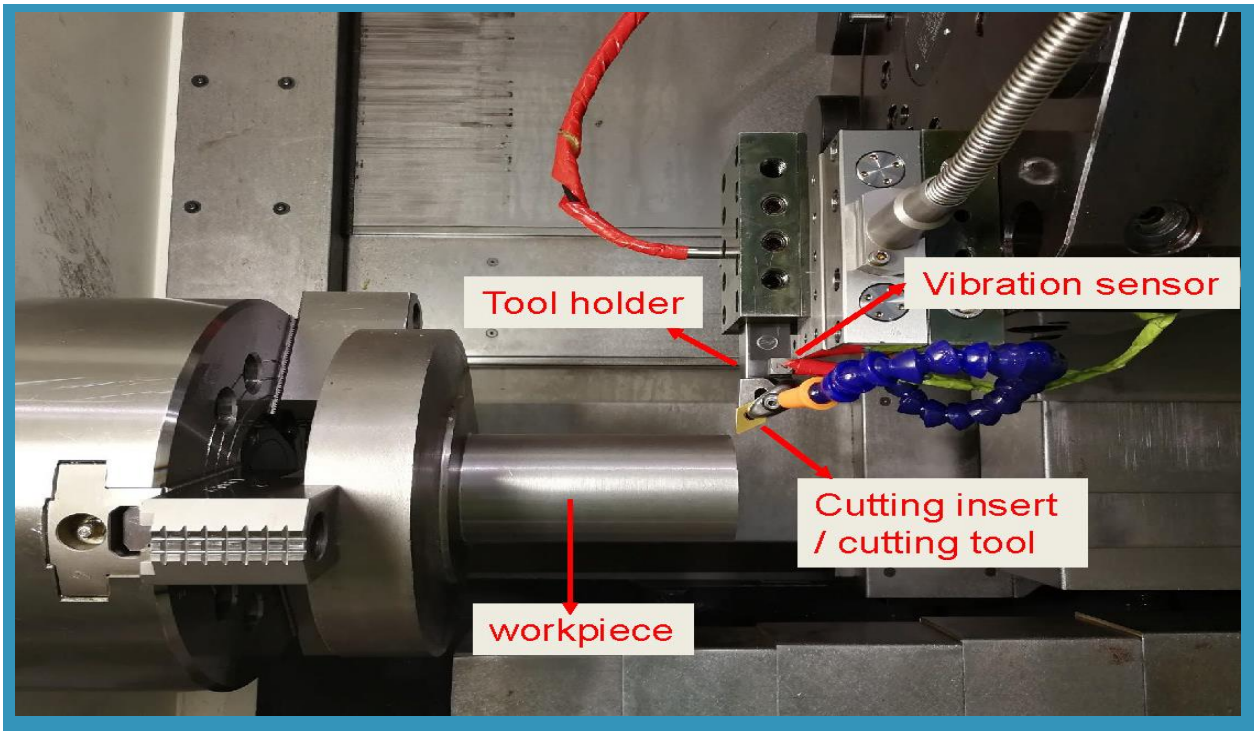
As such, there is an interest for an Industrial Internet of Things (IIoT) solution for the machines to be fully evaluated on how they are actually performing, or even alert in advance based on certain thresholds for in-time maintenance/replacement of parts. This approach will rely on data from connected machines, software to continually check for performance issues and monitors its actual condition. Given its predictive nature, this solution would allow clients to make adjustment for just-in-time maintenance/replacement of parts and avoid catastrophic failure.

The machine monitoring and predictive maintenance solution could help to assess the wear and tear of supplied cutting tools which will allow asset owners to better serve their clients, by accurately advising when to replace the tools, and provide data-backed information on its service-life, optimising tool life and reduce costs. They have previously explored mounting sensors on the tool to capture and transmit data. However, the sensors' wires and close proximity to the cutting tool and workpiece poses significant safety hazards for the users and the work environment.

The second run of **ARTC Startup Challenge 2021** is organised by the Advanced Remanufacturing and Technology Centre (ARTC) in partnership with IMDA and A*StartCentral. The theme for ARTC Startup Challenge 2021 is "**IIoT for Advanced Manufacturing**", and there are three challenges launched.

The Advanced Remanufacturing and Technology Centre (ARTC) is led by the Agency for Science, Technology and Research (A*STAR), in partnership with the Nanyang Technological University, Singapore (NTU Singapore), with a membership consortium with over 80 members.

CURRENT SETUP OF CUTTING TOOLS



PROBLEM STATEMENT

How might we create an industrial **real-time machine monitoring** and **predictive maintenance** solution for industrial cutting tools to optimise equipment lifespan and utilisation using IIoT?

WHAT ARE WE LOOKING FOR?

A prototype solution, free of external wires, that is able to accurately capture, transmit data in real-time for accurate assessment and prediction of equipment health, possibly through an AI-algorithm.

The solution should match most of the following criteria:

- **USABILITY**: Easily mounted and deployed on various cutting machines or tools, to capture and transmit useful data from cutting machines in real-time with high data throughput. It should be able to capture the relevant data parameters cost-effectively such as vibration and force (other feasible data parameters can also be proposed).
- **SAFETY**: Wireless, or free of external wires/cables, to reduce safety risks of power and data transmission cables in the work environment.

- Applicable to a wide range of use cases and parameters, such as machine type, workpiece material, cutting inserts, cutting parameters (speed, feed, depth of cut), type of cut (wet/dry).
- Accurately assess the conditions (wear and tear) of cutting tools and predict the tool wear with 90% accuracy, based on the real-time data captured and transmitted by the miniature, wireless sensors mounted on cutting machineries.
- Learning capabilities to improve its predictive maintenance accuracy over time, through training/historical data and the accumulation and processing of live data.
- Produce a predictive flank wear threshold score, based on tool wear analysis of the cutting tool, in order to forecast equipment service-life and inform the user to replace the cutting tool/insert when needed.
- Allow different users to customize different flank wear threshold limits based on each user's different needs, in order to optimize the tool life and reduce overall cost and waste. Solution should be user-friendly and require minimal training, if needed.

There are no restrictions on the geographical location of the problem solvers who may choose to apply to this challenge. However, the POC/prototype must be demonstrated in Singapore.

POSSIBLE USE CASES

1. James is a plant manager at a XYZ mining company with legacy CNC machines. With this solution, James is able to connect in real-time to all his shop floor machines without huge investment, nor breaching any safety protocols. In addition, this solution will further improve the machine utilisation, avoid catastrophic machine failure, and improve his finished product quality.

2. May operate cutting machine and traditionally depends on tacit knowledge and past experience to identify the cutting tools remaining service-life via visual and sound inspection. With the new solution, she is able to easily monitor a larger number of cutting tools as the sensor sends in real-time machinery data on the important parameters to monitor (eg. vibration and temperature). As the solution is able to accurately predict the remaining service-life and when maintenance is needed, May is able to minimise operational downtime and optimise equipment utilisation.

WHAT'S IN IT FOR YOU

- SGD 50,000 of prize money for each winner of this challenge (see Award Model)
- 2 Year Tier 3 ARTC Membership
- SGD 30,000 ARTC Project Credit
- 4-month Accelerator Programme
- Gain access to IMDA's Technology resources and facility for prototyping
- Co-innovate with ARTC with access to their expertise in developing the solution
- Opportunity to commercialise solution for deployment and adoption by ARTC industry members

EVALUATION CRITERIA

The Applicants shall be evaluated in accordance with the evaluation criteria set out below.

Solution Fit	• To what extent does the proposed solution address the problem statement effectively?
Solution Readiness	• How ready is the proposed solution to go to the market? • Is there any evidence to suggest capacity to scale?
Solution Advantage	• Is the solution cost effective and truly innovative? • Does it make use of new technologies in the market, and can it potentially generate new IP? <u>Optional</u> • To share estimated cost for pilot trial, deployment and software support.
Company Profile	• Does the product have user and revenue traction? • Do the team members possess strong scientific/technical background?

Problem Solvers are required to submit a proposal in the form of a PDF presentation with no more than twelve (12) slides during the Submission Challenge period (the "Submissions") for judging by IMDA & ARTC.

AWARD MODEL

30% of the prize money will be awarded to each selected finalist at the start of the POC/prototype development process, with the remainder 70% to be awarded after completion of the POC/prototype solution, based on milestones agreed between Problem Owner(s) and the solver.

Note that a finalist who is selected to undertake the prototype development process will be required to:

- Enter into an agreement with Problem Owner(s) that will include more detailed conditions pertaining to the prototype development;
- Complete an application form with IMDA that will require more financial and other related documents for the co-funding support.

Teams with public research performers are required to seek an endorsement from their respective innovation and enterprise office, and submit the attached IEO form together with the proposal.

DEADLINE

All submissions must be made by **4th January 2020, 1600 hours (SGT/GMT +8)**. Problem Owner(s) and IMDA may extend the deadline of the submission at their discretion. Late submissions on the OIP, or submissions via GeBIZ, will not be considered.