OPTIMISING PRODUCTION LINES FOR MOULD MANUFACTURING

CONTEXT

Injection moulding is a manufacturing process typically used to produce parts in a large volume. It involves injecting plastic resin into an injection mould to form the product. A typical project could last for a few years with a general workflow as such:

- User Requirement Specification: Receive order from customer with part requirement details such as product details, material type and production volume.
- Design & Fabrication: Design engineer will proceed to design the mould based on the product design provided by customer. Upon customer's approval on the mould design, the mould fabrication process will start.
- Moulding Process: Mould will be tested and qualified, it will be handed over to moulding operation for mass production.
- Post process: Depending on the customer's requirement, various post processing techniques will be conducted on the moulded part. These post processing techniques include ID marking, visual inspection using camera, machining, deburring, etc. Upon completion, the parts are then packed and sealed into a box before shipping.

From the above, it is important to plan and develop the production line automation. This involves mould fabrication, defining the post moulding process required to achieve the customer's requirements. An optimised production line would enable the manufacturer to provide a quicker turnaround to their customer and stay competitive in the industry.

However, this process is currently not optimised and highlights the following inefficiencies:

1. **Manually intensive and time-consuming.** As each product consists of various parts with different shapes and sizes, it usually takes up to two weeks to plan and design the automation line. The lack of a standardised platform also makes it difficult for the team to perform system integration between different automation modules to compare or reference mould templates.

2. **Lack of overview of automation line.** As the production line is designed, there is no process in place to allow for a simulation to be done to create an overview of what the actual production line will look like. This makes it harder to ascertain whether the production line will work in terms of the number of processes involved and the agility of the line.

3. **Lack of flexibility in automation line.** Once a production line is planned, it is fixed based on its design and processes in place which makes it difficult to modify them in situations where a specific process/part is no longer required in the production process. This could be based on the client's sudden change in requirements, which may result in obsoleting a certain step in the production line. This results in having to shut down the whole system to redesign the production line, causing a huge amount of wastage.

4. **Lack of visibility across other production lines.** Each production line is dedicated to a single project. When a project line is shut due to project completion or change in client's request, the entire production line becomes obsolete. The manufacturer is unable to reuse the components that could be used for the other production lines.

Thus, ARTC is seeking for a smart recommender to optimise the planning of flexible, agile and sustainable production line, and reduce the dependence on manual labour. The solution should be able to intelligently recommend the most optimal production line while adhering to a standard of quality assurance and control.

This **ARTC Startup Challenge 2022** is organised by the Advanced Remanufacturing and Technology Centre (ARTC) in partnership with IMDA and A*StarCentral. The theme for the ARTC Startup Challenge 2022 is "**Automation 4.0**", and there are three challenges launched with IMDA's Open Innovation Platform.

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.

PROBLEM STATEMENT

How might we optimise the planning of production lines so that it is flexible, agile and sustainable in the long run?

WHAT ARE WE LOOKING FOR?

A working prototype solution with data analytics and AI capabilities that can optimise the planning of production lines by recommending the optimal production line and components needed. Overall, the solution must reduce the effort and time taken to plan and produce the parts to improve efficiency.

The solution should have the following features:

1. **Smart Recommender of production line based on user requirement specifications**

- Provide recommendations efficiently on the most optimal way to create an automation line during the design phase based on a database which contains historical and current information, such as a library of materials and existing components for usage in production lines.
- Suggest recommended options of modules in the automation line to allow for the most optimal and efficient production line, as well as to allow for modularity and flexibility in the automation/production line, thereby replacing the inflexible Programmable Logic Controller previously used to design production lines.

2. **Automatic identification of moulding challenges**

- Automatically identify potential challenges that might occur during the production phase (e.g. based on simulation). For example, predicting and suggesting an optimal automation line given that the current design/automation process would take too long (not meet production timeline), etc.

3. **Compatibility Analysis across external production lines**

- Ability to analyse within and across production lines to recommend best fit manufacturing techniques, especially when an existing line is decommissioning soon. The match will save material, time and reuse manufacturing components developed earlier.
    - For example, when a production module becomes obsolete in Production Line A, a suitable part of the line is made available to integrate with the Production Line B, saving components and time.
- Integration of the design should be made user-friendly for the operators, either through plug-and-play or others.

Overall Performance Requirements

The problem solver should meet the following performance criteria in their proposal:

- **Extensibility –** The solution should be developed as open as possible to allow for future features to be added. For example, vision-based quality checks, alerts where irregularities occur
- **Accurate and fast** - The solution must recommend optimal production lines in the quickest and accurate manner.
- **Cost-effective** – The solution must be cost-effective by optimising the cycle time.
- **User-friendly** – The solution should allow the various stakeholders and operators to use with ease.
- **Seamless integration** – The solution should be able to integrate and work with existing systems and room for future integration of additional features.

There are no restrictions on the geographical location of the problem solvers who may choose to apply to this challenge. All start-ups are welcomed to apply. However, the prototype must be demonstrated in Singapore.

POSSIBLE USE CASES

1. **Enhanced and Optimised Automation Line Design through Intelligent Recommendations**

Donna works at a mould making company and as part of her day-to-day work, she helps plan and design the automation line for clients. She currently uses digital software, but due to the lack of automated intelligence, Donna and her team take about 2 weeks to roll out the proposal for the automation line.

However, with the new solution in place, Donna and her team can get an optimised automation line as a suggestion in no time. The database comprises a list of existing components and previous automation lines that was proposed and used. The database churns out a suggested list of automation lines that her team can go for, finding the most cost effective and modular options based on historical data and predictive analysis. It also signifies any possible issues that might occur during the automation lines. This is all easily digestible for Donna and her team through the simulated views the solution provides them with. Donna is able to accurately determine the best options and propose it to her clients in less time.

2. Hyper-flexible, Plug-and-Play Automation Line with Multi-usage Configuration

Programming of the PLC system usually takes about 1 or 2 days after clients have given the approval to start on production. This is a time-consuming process as there are multiple moulds for different parts which makes the programming of the production line unique. In situations where clients request a change of the designs, certain parts become obsolete, but the current programming does not allow for immediate configurations which leads to high amounts of waste for unused parts. When reprogramming is needed, it disrupts the flow of the production line as it takes up another 1 to 2 days to be implemented.

For example, if the programming instructions are A-B-C-D-E, and the client's new design requires the removal of step C, the current process is unable to remove C easily and reconfigure the instructions to reflect A-B-D-E.

However, with the new solution in place, Zac, the PLC programmer will be able to easily remove or add variables without halting the entire production based on its recommendation of compatibility analysis. The hyper-flexible reconfiguration allows for Zac to be able to adjust the production line as and when needed which minimizes reprogramming efforts and increases the efficiency of the production without the need of halting the entire system.

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 100,000 A*Star Innovation Voucher
- 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 the sector 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? • 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? • Is the company able to demonstrate financial capability and resources to complete the prototype?

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. Prize money will be inclusive of any applicable taxes and duties that any of the parties may incur.

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 **28th January 2022, 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.