



# PROGRAMS

## PROGRAMS: from implementation to integration

### INTRODUCTION

**PROGRAMS** European research project (project start in October 2017) has entered its final phase. During the last months, the **PROGRAMS** consortium has focused on activities related to the completion of developments, laboratory validation, modules implementation, as well as the integration of the standalone modules towards the setup of the final demonstrators.

The abnormal situation due to COVID-19 has been dealt by the **PROGRAMS** team of professionals via new approaches and adequate technologies facilitating the collaboration among the partners and keeping the developments and their fine-tuning alive. However, the current status of **PROGRAMS** requires physical testing, and thus the project duration has been extended until March 2021.

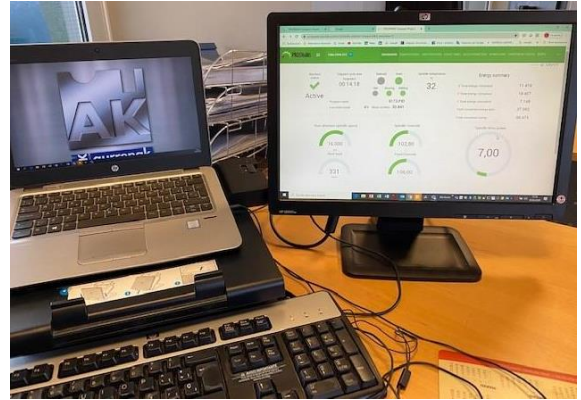
### PROGRAMS MODULES

**PROGRAMS** pilot cases are provided by two SMEs: **AURRENAK**, focusing on milling, and **CALPAK**, focusing on robot assisted welding. The **PROGRAMS** maintenance platform comprises the following modules:

- Equipment Control Module (ECM): enables equipment field data collection, storage and local exploitation.
- Maintenance Service Platform (MSP): for maintenance information collection and sharing.
- Maintenance Schedule Optimization (MSO): a decision support system for strategies and policies selection.
- Behavior Predicting Tool (BPT): provides online predictions of RUL for all the modelled components of the pilot cases, together with an end-of-life probability.
- Failure Mode, Effects, and Criticality Analysis tool (FMECA): assisted procedure for FMECA performance.
- Smart Scheduling Tool (SST): for scheduling optimized maintenance and production activities.
- Advanced System Invariant Analysis (ASIA): allows a data driven real-time diagnosis of machine states.
- Quick RUL: for rapid RUL estimation when machine-learning and data analytics algorithms are not available or trained yet.

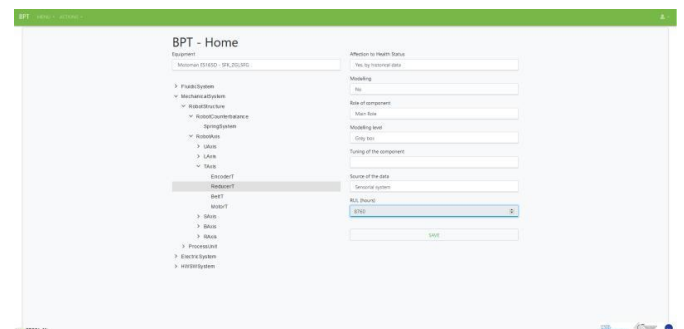
### MODULES IMPLEMENTATION

**ECM:** The ECM **PROGRAMS** module has been completed and deployed allowing to remotely monitor the status of the machines.



Remote monitoring of machines' status

**BPT:** The BPT server and BPT UI, allowing data transfer between the **PROGRAMS** Data Base and modules for predictive maintenance, have been implemented.

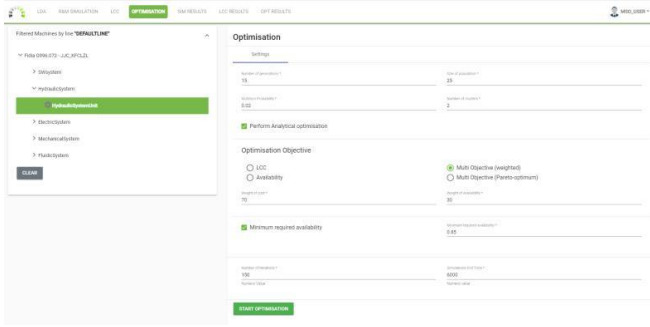


BPT server and UI implementation

**MSO:** The MSO Platform, offering a wide variety of settings to customize the complex maintenance optimization process, has been implemented. The consortium aims to make the tool accessible both for maintenance experts and regular users, hence effort has been made on improving the user experience and easing the use by the provision of tooltips, default and automatically loaded values, as well as a well-organised and clear interface for the user.

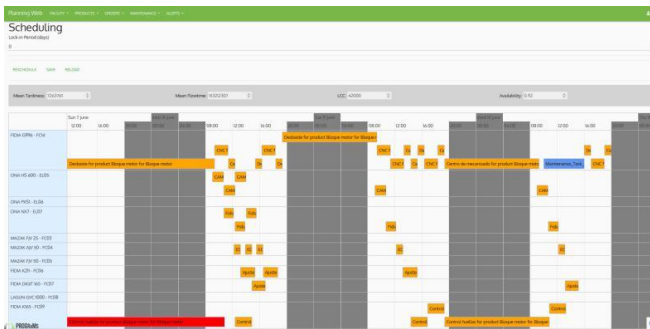


# PROGRAMS



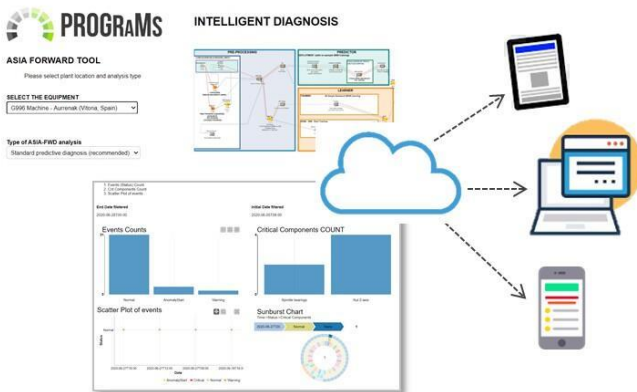
MSO UI

**SST:** The SST module allows for the collection of information from all the platform modules in order to provide a comprehensive maintenance and production scheduling. The module has been completed and is undergoing extensive testing.

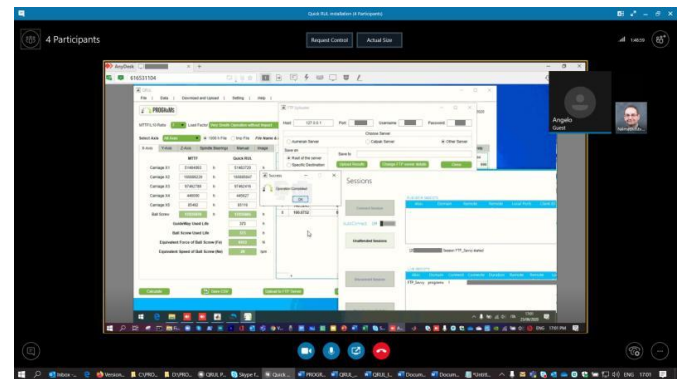


SST implementation

**ASIA:** The cloud deployment and testing of the Machine-Learning tool for evolving diagnosis that identifies the operative “status” of equipment has been extended to the Robot use case. Machine operators, maintenance people and managers can easily access the results of diagnosis via a web dashboard, where the most relevant issues are presented to warn/help maintenance service to activate follow up tasks.



**ASIA: cloud deployment and testing of ML tool**  
**Quick RUL:** The PROGRAMS Quick RUL software module has been tested via remote control. The Quick RUL tool is now able to calculate the Remaining Useful Life (RUL) of selected components from historical load data (such as speed and current of motors, temperature, vibration level). The Quick RUL tool is currently tailored to the FIDIA G996 machine tool components (such as ball screws, linear guideways and spindle bearings).



Quick RUL implementation

## DEMONSTRATORS & TESTING

### AURRENAK DEMONSTRATOR

**PRM workflows:** The multi-level Prognostics and Resources Management workflows, which combine edge/fog and cloud computation in the AURRENAK industrial use case, have been successfully tested.

The adaptive control solution on AURRENAK pilot line has been completed. Therefore, CNC parameters are now tuned based on components condition.



Adaptive control validation



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## CALPAK DEMONSTRATOR

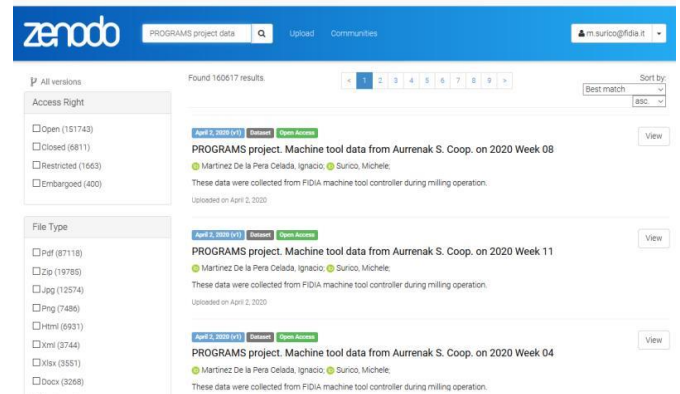
The BPT **PROGRAMS** module has been tested on the CALPAK pilot. Thanks to it CALPAK is now able to automatically retrieve the quality of the welding process and continuously monitor the Remaining Useful Life of the robot's components.



Automatic retrieval of welding process quality and continuous monitoring of robot components' RUL

## PROGRAMS PUBLIC MATERIAL

- The paper study ("Planning maintenance events with Monte Carlo simulation") regarding the methodology used in the PROGRAMS MSO module has been presented at the International Conference on Mechanical Engineering – OGET on April 25<sup>th</sup>.
- 4 different PROGRAMS papers have been accepted for presentation at AMEST 2020, during the Invited Session "Versatile Predictive Maintenance Strategies for the Industry of the Future".
- The Innovation Radar of the European Commission has published on its platform the MSP, Advanced FMECA and MSO innovations.
- Open data collected from PROGRAMS end users pilot lines, Aurrenak and Calpak, is available on Zenodo repository.



Zenodo: Open data from the PROGRAMS pilot lines

## PROGRAMS LINKS

- **PROGRAMS Web Portal**  
<https://www.programs-project.eu/>
- **PROGRAMS Twitter**  
<https://twitter.com/programsEU>.
- **PROGRAMS YouTube**  
[https://www.youtube.com/channel/UCCmwwxFA\\_X7LzfrwKFAZQv9w](https://www.youtube.com/channel/UCCmwwxFA_X7LzfrwKFAZQv9w) .

## PROGRAMS CONSORTIUM



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