

Optimal scheduling for discrete batch processes

Scheduling can have a major impact on the productivity of a process. Its purpose is to minimize the production time and costs, by telling a production facility when to make, with which staff, and on which equipment. Production scheduling aims to maximize the efficiency of the operation and reduce costs. Production scheduling tools usually outperform manual scheduling methods by automatically creating efficient schedules that did not appear as obvious to a human scheduler.



CAP2M is a **generic scheduling tool** for discrete batch processes and is also the product of the CAP2M EU-funded project. It offers the possibility to optimize a schedule using different algorithms all based on a mathematical representation of the problem as a **mixed integer linear program**. All algorithms are based on a **clever decomposition** of the problem which allows tackling **large industrial instances** while still providing a guarantee on the quality of the solution. Those algorithms are the results of the research work carried out during the previous academic EU-funded project CAP-SCHED.

Optimization scope

The system under consideration is composed of:

- several production resources
- raw material, intermediate and finished products

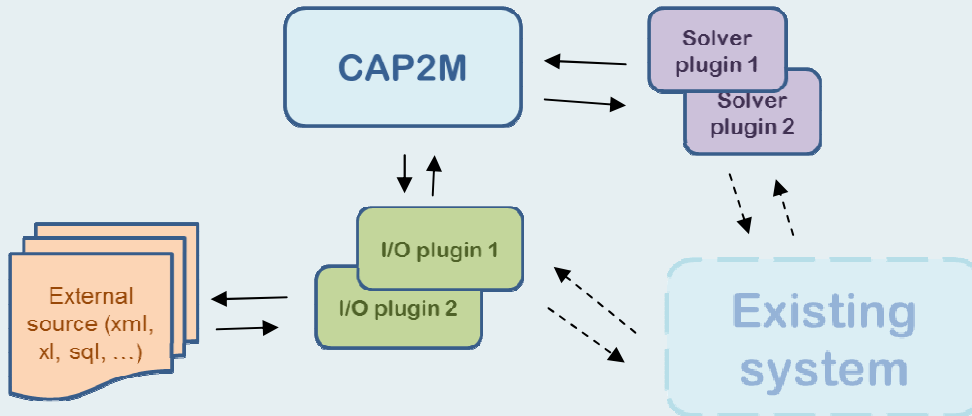
The resources can be organized in **multiple levels** in an **assembly** or **divergent** structure. Each resource has a limited production capacity and the capability to perform operations that transform a number of input products (raw materials for the first layer) into a number of output products (finished products for the last layer). A schedule is given by a set of batches of finished products that have to be delivered at a given date. The optimization will then determine the **sequence** of those batches and the right **resource assignment** in order to make the best possible use of the production resources.

Software architecture



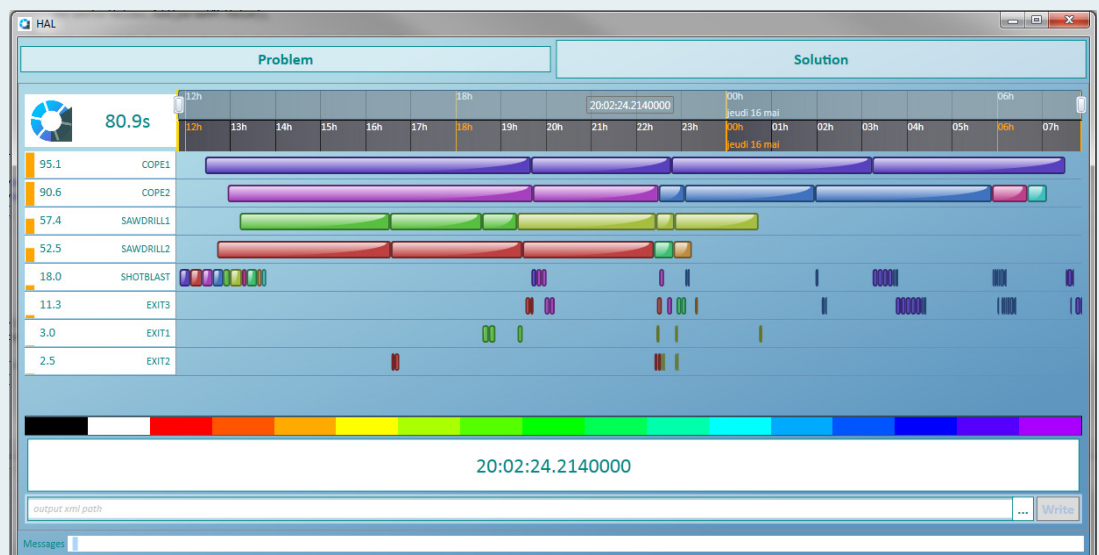
The software is composed of a graphical user interface communicating with two types of **plugins**:

- I/O plugins to read problem source from and write the solution to an external source (xml file, excel file, database...)
- Solver plugins to solve the problem using different possible algorithms



The plugins are .NET assembly that can also be **plugged directly into existing systems** if required.

The graphical user interface contains a **Gantt chart** displaying the optimal schedule as well as the corresponding resource occupations so as to give an overview of the solution before exporting it back to external source.



Benchmarks

In the context of the CAP2M EU-funded project, the tool has been tested on two different case studies:

- Steel bars production
The raw materials are steel bars that are cut, drilled or coped into smaller components, based on fabrication drawings. The type of operations that each batch of raw bars will have to undergo is predefined and depends on the type of desired finished product.
With CAP2M software, the average throughput is increased by about 11% while the production time is reduced by 10%.
- Mechanical valves production
The valve products production process refers to the production of valves, according to the customers design. They transform raw materials into subassemblies which are used to assemble and test the entire valve.

