

## Online Database for Harvesters and Forwarders Productivities: Used Methods and Results

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### Abstract:

*Productivity in logging operations is still increasing thanks to the new generations of forest machines. As a result, logging contractors need up-dated references of productivity in order to better plan and organize their work. To answer this need, FCBA started in 2010 a project in collaboration with forest companies in Massif Central, a low mountainous area in the middle part of France, to create an interactive free online database. This database would provide up-dated data concerning harvesters and forwarders: productivity depending on machines and logging sites characteristics, costs... This paper presents the utilized methodology, the encountered problems then the results.*

*After a survey to know the local forest machine fleet, we chose eleven recent and representative harvesters and nine forwarders. Our initial plan was to use specific software developed in another project to automate the data collection from machines' computers. First, we had to check the set up of in board software and the level of utilization of this software by the operators (were they trained? what type of configuration of assortments and volume do they use?...). Then, during six months to one year, we could really process the data collection of in board files: drf for time machine, prd for production... As the automation of data transfer did not work correctly for all the machines, we also needed to carry out extra production and time data collection on a sample of logging sites. We also completed these data with assessment of machine costs, impacts to the soil and remaining trees.*

*Finally we obtained accurate data about 390 logging sites in 2010 and 2011. All these information were aggregated in an online database opened to professionals to select logging sites taking into account their characteristics, the type of machine, etc, to know their productivity. This is only a first step and we are continuing collecting information, with 30 other forwarders and harvesters. Indeed extra data are still needed to be more representative of the numerous local conditions of machine uses. We will also develop new online tools for the professionals concerning the productivity and the machines costs.*

**Keywords:** harvester, forwarder, productive data, database

### 1 Introduction

In recent years, mechanization has strongly developed in logging operations in the Massif Central area, a low mountainous forestry area in the middle part of France. In 2006, in two regions of the Massif Central (Limousin and Auvergne), the softwood harvesting was already mechanized over 65%, with a fleet around 140 harvesters (Peuch 2006, Leduc 2006).

Concerning more precisely the machines working in softwood stands, along with an increase of the fleet, the productivities of different machines have increased steadily because of their technical development (power and better reliability, embedded computer...). The organization of enterprises and logging sites have also to evolve in order to incorporate new markets for wood and the synergy between the products (sawn/pulp/energy wood). However, it is now difficult to find recent references of organization,

production, cost for all these materials and methods in the Massif Central area, whatever the stands and the logging site characteristics. These are very important points to plan the work, to establish business costs or to prepare an investment in new machines (from 150 k€ for skidder to 450-500 k€ for harvester). All these technical and economical references are requested by both forest contractors and wood suppliers.

To answer this need, FCBA started in 2010 the project “Exploit’MC” in close collaboration with forest companies from Massif Central to create an interactive free online database. The objective of this database is to provide up-dated data concerning harvesters and forwarders: productivity depending on machines and logging sites characteristics, costs... This paper presents more precisely the Massif Central, its characteristics and the forest machines fleet, the used methods, the encountered problems and their solutions, then the results with some screen captures to illustrate the functionalities of the database.

## 2 Study area and local forest machineries

### 2.1 The Massif Central



**Figure 1: The Massif Central in France**

Large as Ireland or Portugal, the Massif Central covers nearly 85.000 km<sup>2</sup> and accounts for 15% of national territory and 42% of the French mountain area. It includes all or part of 22 departments and 6 administrative regions.

Forest covers nearly 2.8 million hectares (Mha) or 36% of the area, for 29% at French level (Abord de Chatillon and al. 2012). Private forests account for 88%, here also above the national level (75%). This forest is young and very diverse (see table below). However, half of the forest is composed of monospecific stands.

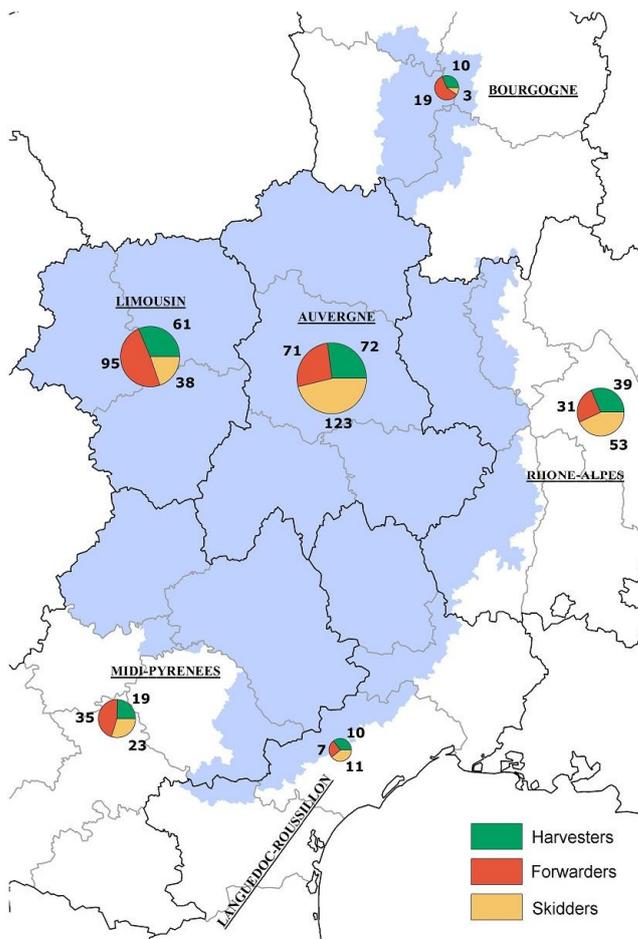
**Table 1: Surfaces and annual growth for the main species, in Massif Central (Abord de Chatillon and al. 2012)**

| Species                                | Oak     | Beech   | Chestnut | Scots pine | White fir | Spruce  | Douglas fir |
|--|---------|---------|----------|------------|-----------|---------|-------------|
| Surface based on the main species (ha) | 739.000 | 277.000 | 277.000  | 268.000    | 169.000   | 158.000 | 272.000     |
| Annual growth (Mm <sup>3</sup> )       | 2.75    | 1.3     | 1.5      | 1.2        | 2.1       | 2.1     | 3.6         |

The total standing volume is 497 million cubic meters (Mm<sup>3</sup>), one fifth of the national volume of standing trees. Hardwoods represent 64% of forest area but only 51% of this volume. Coniferous trees, especially Douglas fir, have generally a better quality and a higher unit volume than hardwoods. 40% of this resource is considered rather difficult for harvesting because of the slope, the skidding distance... The annual biological growth is 17.6 Mm<sup>3</sup> of which 14.55 for the 7 main species (see table above).

The official harvest is between 7.9 and 8.5 Mm<sup>3</sup>/year, between 2004 and 2009 (about 39 Mm<sup>3</sup>/year at national level), which volume is added to the self-consumption of firewood by about 4 Mm<sup>3</sup>. Official harvest focuses mainly on softwoods with more than two thirds of the volumes. This harvest could and should be increased by 30% to meet the national strategy objectives (+ 20 Mm<sup>3</sup>/year by 2020).

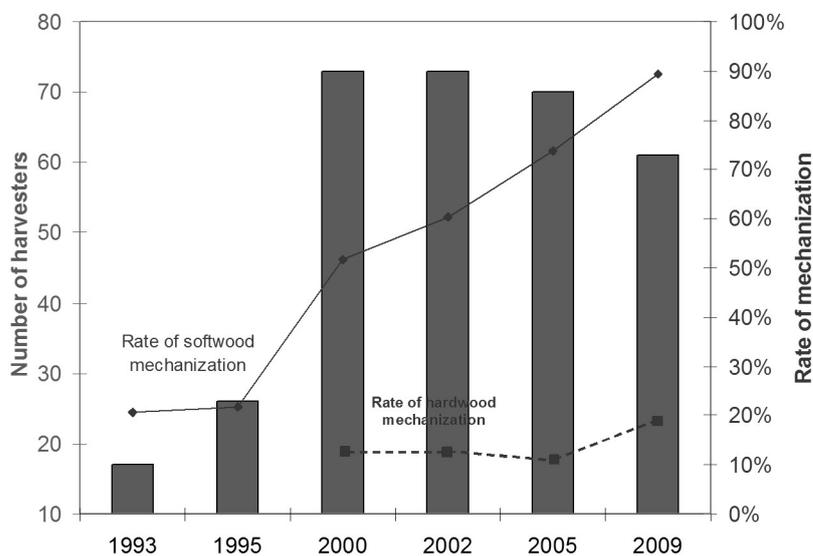
## 2.2 The forest machines fleet in Massif Central



**Figure 2: Forest machines fleet in the Massif Central**

Within the project Exploit'MC, FCBA carried out firstly in 2010 a socioeconomic monitoring concerning logging companies in the Massif Central. It included a detailed survey of logging contractors and wood suppliers which have forest machines (harvesters, forwarders, skidders...) in order to have a precise inventory of the fleet located in the massif. In addition to the description of each machine, the survey included key points about their use: number of drivers, annual production, type of cut... The survey concerned also the companies (business structure, number of machines, activity area...) and their human resources (driver training, experience...).

297 mechanized companies were listed in the Massif Central for 720 machines (211 harvesters, 258 forwarders and 251 skidders), that is to say 20% of all forestry machines operating in France and more than a quarter of harvesters. It is a relatively old machine fleet with about 40% of harvesters and forwarders over 7 years old and 72% of skidders over 9 years old. Mechanization has increased strongly to harvest the storm damaged forests after 1999. Since the fleet has been renewed, mainly with high power machines, but at a slower pace, with even a slight decline in the number of machines in recent years in some regions of the Massif Central.



**Figure 3: Evolution of the mechanization in Limousin, one of the Massif Central regions**

The socioeconomic monitoring concerning logging companies, coupled with other studies on the key factors of business success (Cacot and al. 2010) and many actions of consulting, highlighted that these companies have a good technical mastery for the logging operations, the heart of their business, but a lack of involvement in management, particularly in the development of balance scorecards, assessment of machine production and calculation of cost prices for machines and logging sites. From this review, FCBA and its partners had the idea of making available a database for professionals with costs and productions of the logging sites, selecting initially harvesters and forwarders in softwood stands, field of study that represents the majority of the harvested volumes of the Massif Central.

### 3 Material and methods

#### 3.1 Initial expected methods: the use of ExploTIC software

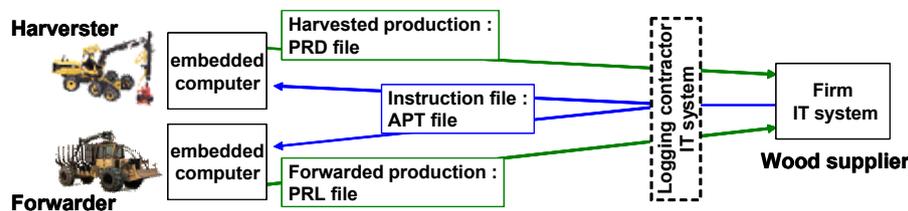
Our initial plan was to use specific software developed in a collective project ExploTIC, carried out in Aquitaine (South-West France) with wood suppliers, forest contractors, machines manufacturers and coordinated by FCBA (Arraiolos and al. 2011). ExploTIC started from the diagnostic that functionalities of information tools within the harvesting machines were completely under-used by both the contractor and the supply companies.

ExploTIC mission was to provide tools and solutions for operational production data transfer between harvesters, forwarders, contractors and wood supplying companies in order to better handle organizational issues, e.g.:

- ⇒ increasing data exchange quality and reliability between field and office with any machine working in the “Landes de Gascogne”,
- ⇒ decreasing wood supply companies’ employees road travel of 50%,
- ⇒ improving machines utilization rate.

The delivered ExploTIC software enables:

- ⇒ field data creation and exportation in a Stanford format for non-computerized machines’ operators,
- ⇒ Stanford bucking instruction (APT files), harvester (PRD files) and forwarder (PRL files) production and monitoring data (DRF files) importation and aggregation inside a unique database for machines and logging managers,
- ⇒ connection to other databases through an opened SQL engine.



**PRD File :**

*Global production for one site (without time monitoring)*

|  |        |
|--|--------|
| <b>Site no 22345 from 11/08 to 11/16</b> |        |
| Trituration 210                          | 250 m3 |
| Caissage 240                             | 328 m3 |
| Billon 210                               | 272 m3 |

**Figure 4: Example of the use of ExploTIC for the transmission and collection of prd file (data production) (Arraiolos and al. 2011)**

All these data could be used for the creation of the Exploit’MC’s database by collecting automatically the production of each machine per day and logging site.

**3.2 Encountered problems and final methods**

But to be fully operational, a campaign to train machine drivers and their managers was launched in Aquitaine on the tools developed in the project ExploTIC. In the Massif Central, these training have not (yet) taken place and we were faced with several challenges:

- ⇒ part of the machines fleet was relatively old with embedded computer incompatible with Stanford data exchange or not generating this type of file (prd, drf...),
- ⇒ operators with a highly variable knowledge of embedded computing (configuration of the machine, calibration of the head...), some having a very good level but for most a low level; so their use of embedded computing was incompatible with the type and accuracy of the data required for the project (non-standardized product configuration, random calibration of the head, only one logging site created in the software since the start of the machine...).

Finally, we were able to use the tools developed in ExploTIC to automatically retrieve the data generated by embedded computers (drf for time machine, prd for production) for a small part of assessed machines (about a third, only for harvesters) but mostly we have had to use more "traditional" methods for the

collection of machine production and time studies. These more conventional assessments were carried out with the followed plan:

- ⇒ choice of machines representative of the fleet in the Massif Central (see Table 2), in collaboration with drivers and entrepreneurs;
- ⇒ record of machine characteristics (age, power, option ...) and drivers (experience, training...);
- ⇒ accurate assessments of about 10% of logging sites for all the machines, including time studies, calculation of the cubic volume and record of the sites characteristics by FCBA; these assessments allowed in addition:
  - for harvesters, to measure the differences between the volume calculated by the machine and the real one (by assortment and species),
  - for the forwarders, to measure the load (m<sup>3</sup>) depending on the types of forwarded logs,
  - to provide operators with a monitoring production sheet and show them how to fill it;
- ⇒ global assessments, for 6 months to 1 year per machine, based on data complied by the drivers for each logging site, checking the validity of such data and taking stock with them during regular accurate assessments.

In addition to information on the machines and operators and based on the harmonized protocol AIR3-CT94-2097 (CTBA 1999), the list of data collected on each site is:

- ⇒ the location (department, commune),
- ⇒ the start and end of logging operations,
- ⇒ times (machine hours, machine productive hours MPH<sub>5</sub> only for accurate time studies), the time spent in failure or maintenance, and other hazards,
- ⇒ the species majority and secondary (often mixed stands),
- ⇒ the type of cut (first, second... thinning, clear cut),
- ⇒ the surface,
- ⇒ the slope,
- ⇒ the unit volume of the trees and the conformation of the trees (branchiness for harvesters),
- ⇒ the skidding distance (for forwarders),
- ⇒ the number of assortments.

## **4 Results**

### **4.1 The assessed machines and logging sites**

By taking into account both the need to have a panel of representative machines in the Massif Central, the desire to assess preferably new machines compatible with the ExploTIC tools and for which production data are scarce, and the difficulties we had to face to automate the data collection, we finally monitored 9 forwarders and 11 harvesters.

**Table 2: Assessed harvesters and forwarders, into parenthesis the initial expected number taking into account the machine fleet in the Massif Central**

|            | Size / Power                          |                                     |                                |
|------------|---------------------------------------|-------------------------------------|--------------------------------|
|            | Small-Medium                          | Large                               | Extra large                    |
| Harvesters | 1 Valmet 911<br>1 Sampo<br>2 (2)      | 4 JD 1270<br>2 Ponsse Ergo<br>6 (7) | 2 Valmet 941<br>1 MHT<br>3 (2) |
| Forwarders | 4 JD 1110<br>2 Ponsse Wisent<br>6 (4) | 2 Valmet 860<br>2 (4)               | 1 Valmet 890<br>1 (2)          |

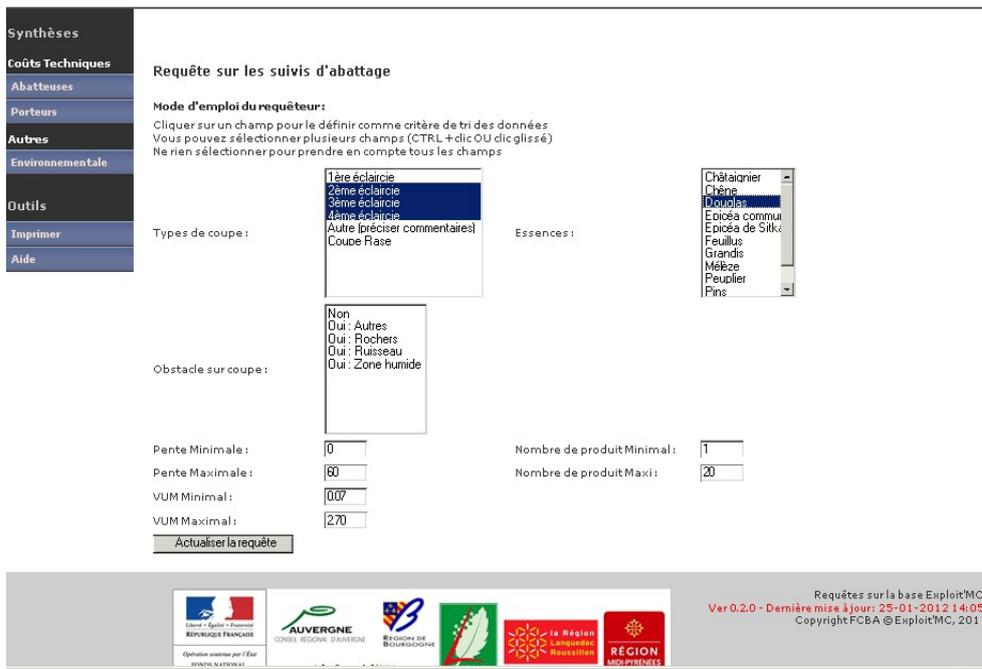
All these machines were monitored for 6 months to one year. Finally we collected data production for over 390 logging sites.

**Table 3: Number and kind of assessed logging sites productivity**

|            | 1 <sup>st</sup> thinning | 2 <sup>nd</sup> thinning | 3 <sup>rd</sup> and 4 <sup>th</sup> thinnings | Clear cut | Other (storm damaged forest...) | Total |
|------------|--------------------------|--------------------------|---|-----------|---------------------------------|-------|
| Harvesters | 66                       | 41                       | 18  | 126       | 22                              | 273   |
| Forwarders | 45                       | 15                       | 7   | 51        | 2                               | 120   |
| Total      | 111                      | 56                       | 25  | 177       | 24                              | 393   |

#### 4.2 The database and the requests

All these information were aggregated in an online database for which we firstly defined the prescription and the requests that can be done. This database is opened to professionals to select logging sites taking into account their characteristics, the type of machine, etc, to know their productivity ([www.exploitmc.fr/Beta\\_test](http://www.exploitmc.fr/Beta_test)). We present here 3 screen captures which show the requests and the results:



**Figure 5: Example of request for the harvesters: choice of the kind of cut, the species, the slope, the presence of obstacles, the number of assortment, the average volume**

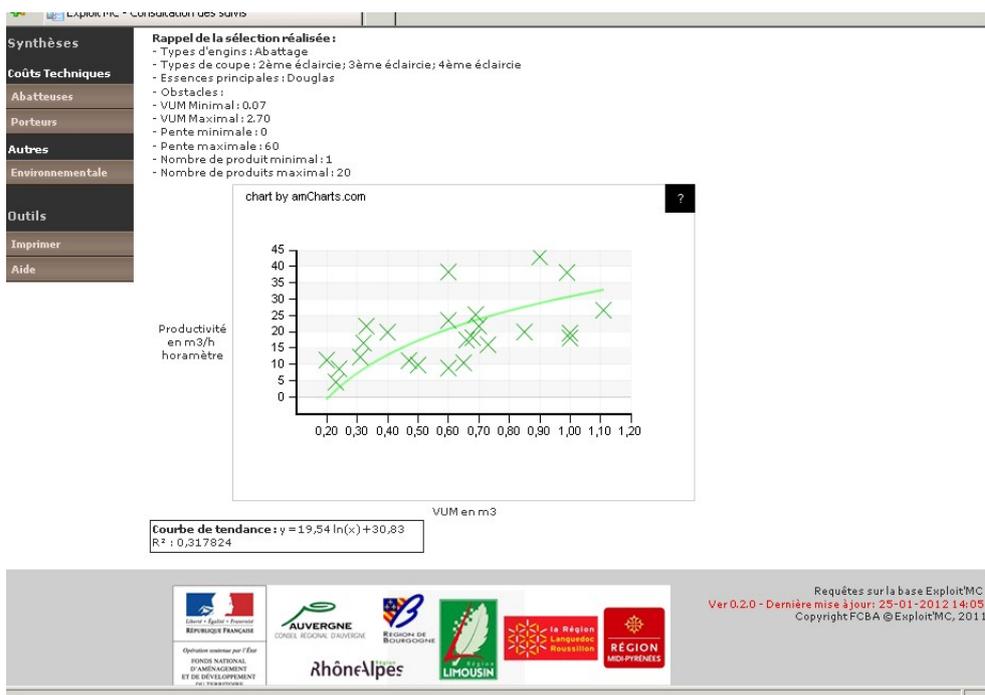


Figure 6: Example of result: the productivity (m<sup>3</sup>/machine hour) depending on the average volume (m<sup>3</sup>) for harvesters in thinning in Douglas fir

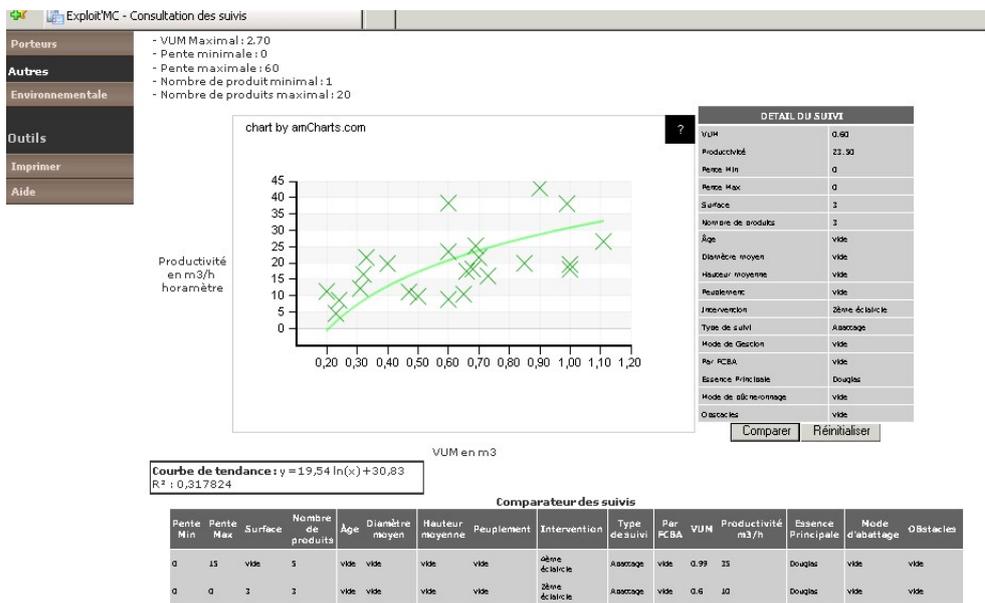


Figure 7: After each request, we can select one or more logging sites to know their characteristics and better understand the differences of productivity

## 5 Discussion and conclusion

Despite the number of assessed logging sites, we observe a great variability between the data of productivity because of the important number of parameters: machines, operators, species, slope, kind of cut... Moreover the cost prices calculated and collected by FCBA for half of the assessed machines were synthesised but are not linked to production data.

The first phase of the project Exploit'MC ended in 2011 and the second started in January for two years with the following objectives:

- ⇒ to continue the data collection with 30 new monitored forwarders and harvesters, in order to increase the number of references and precision of queries of the database,
- ⇒ to improve the online tool: improve usability, modify the query fields (machine size, grouping species...)
- ⇒ to add features requested by professionals who have already tested the database: developing an online tool for calculating the machines and logging operations costs in connection with the production data and with the possibility to compare with the cost data collected by FCBA.

In parallel, we will test, still in the project Exploit'MC, new materials and working methods for the harvest on steep terrains where the forest resource is abundant. At least we will update the socioeconomic monitoring in 2013 concerning logging companies and including the survey of forest machines. A specific task is scheduled to transfer to professionals all the results (publications, demonstration days...).

Complementing this work, it is also expected to launch in the Massif Central the deployment of trainings to ExploTIC tools, which will allow to collect production data more easily from machines and logging sites, but primarily to provide professionals with tools to improve monitoring and management of their business.

The project Exploit'MC is supported by:



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