

# Scheduling, s.r.o. - Plastic Production Manual - Version 1.0

End User Manual  
Plastic Production Scheduling

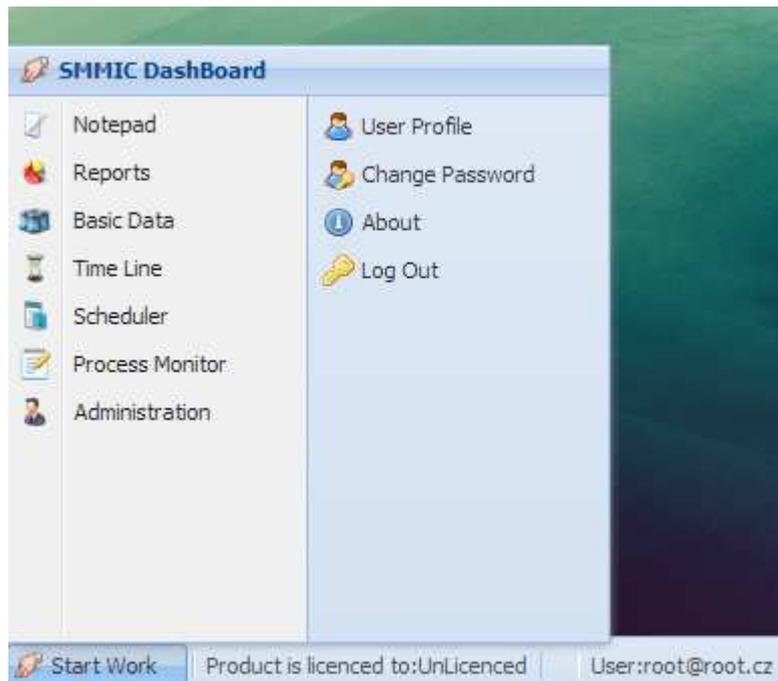


## Content

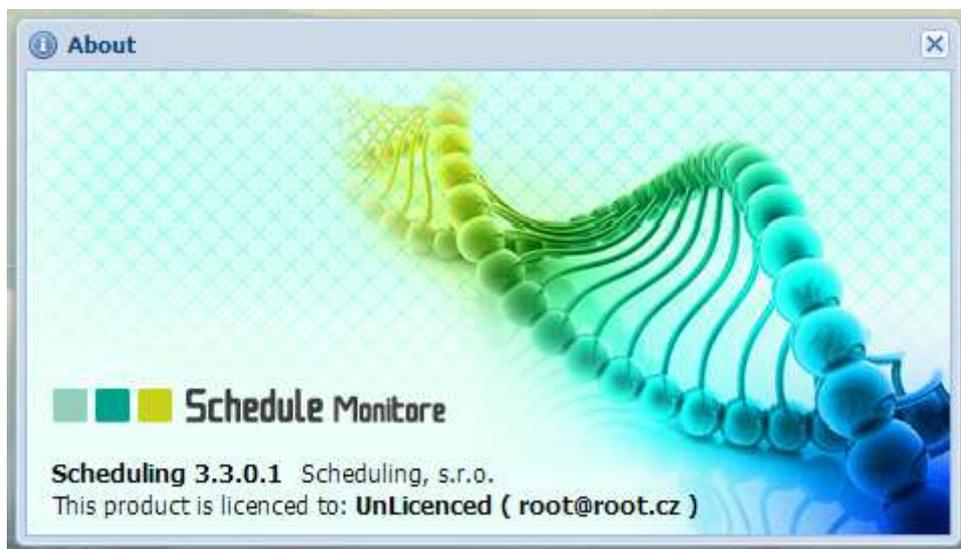
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# 1 Content

The document describes software for supporting and planning plastic production. The product is based on the genetic algorithms and deterministic logic which is allowing users to find out scheduled production on the machines. The software started as science study and with good prove of concept ends as end to end software. The final schedule can be used as plan for production or support for the decisions of the leaders or managers.



The main page contains working desktop similar as is well known in Microsoft windows. Particular modules of the application can be found directly on the desktop area or in the start menu as is shown on the picture. These modules are described in the following chapters. The application allows setup languages mutation, change of password, user profile or displays information about product.



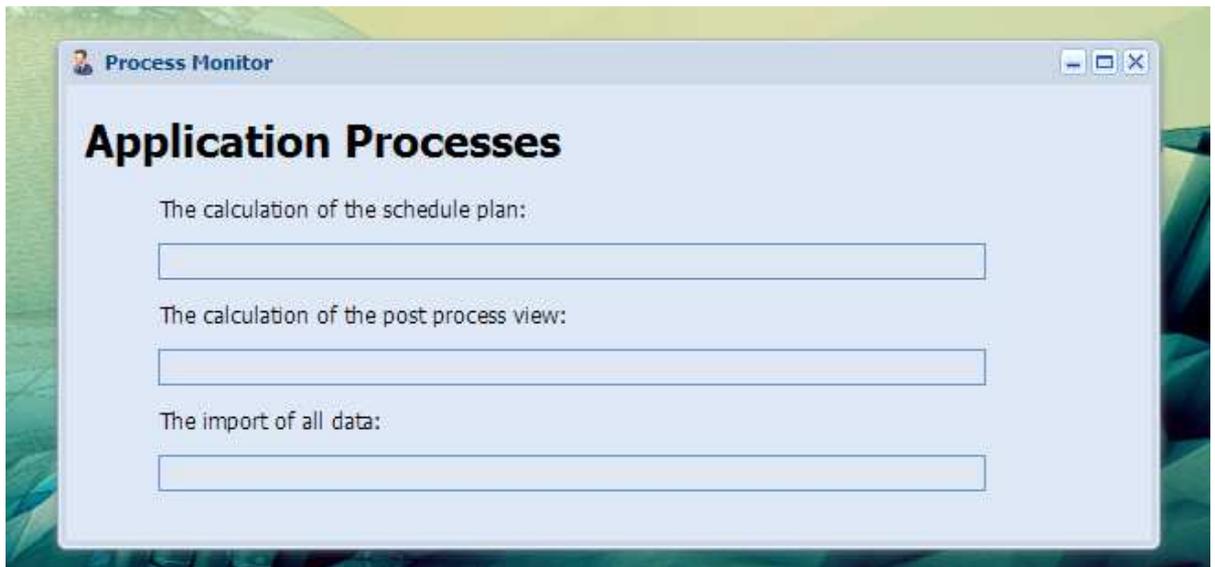
## 2 Import of basic data for scheduling

### 2.1 Purpose of the module

Base on this module is the end user able to upload the data of the plastic production to the application and later used this information for the concrete planning. The concrete planning is provided by scheduler which is using genetic algorithms. The data defines so called priorities which are used in the constrains and also in logic which establish schedules. The modul allows users to edit, update or erase data. Data can be imported from the defined excel structure or by SSIS packages from different systems which are used allong different companies and organizations. These support of SSIS packages or excel structure can be developed based on the agreement with concrete customer. The format and structure of the data as well as the constrains and logic can be changed based on the customer business case.

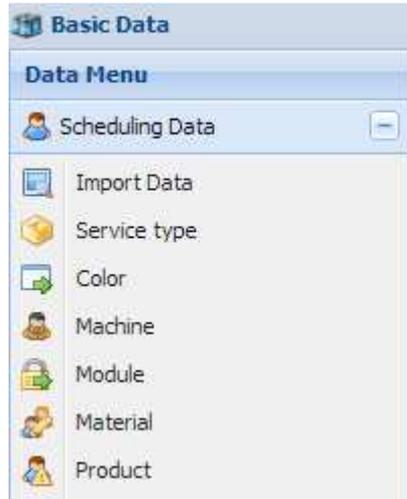
### 2.2 Process monitor

The process monitor is used for monitoring of long term proceses. We have three types of long proceses: Import of basic data, Calculation of the plan, The advanced view of the plan. All proceses are shown in one screen which can be run by clicking on the start menu – Process monitor or the screen is automatically shown once end user starts the long process.



### 2.3 Basic data

This modul contains several input formulars for editing, inserting or deleting particular information. The formulars also allow users to manage settings for the scheduling algorithm and also setup of the working hours, holidays. These settings directly affect the final shape of the scheduled plans in the Time Line or in the export.

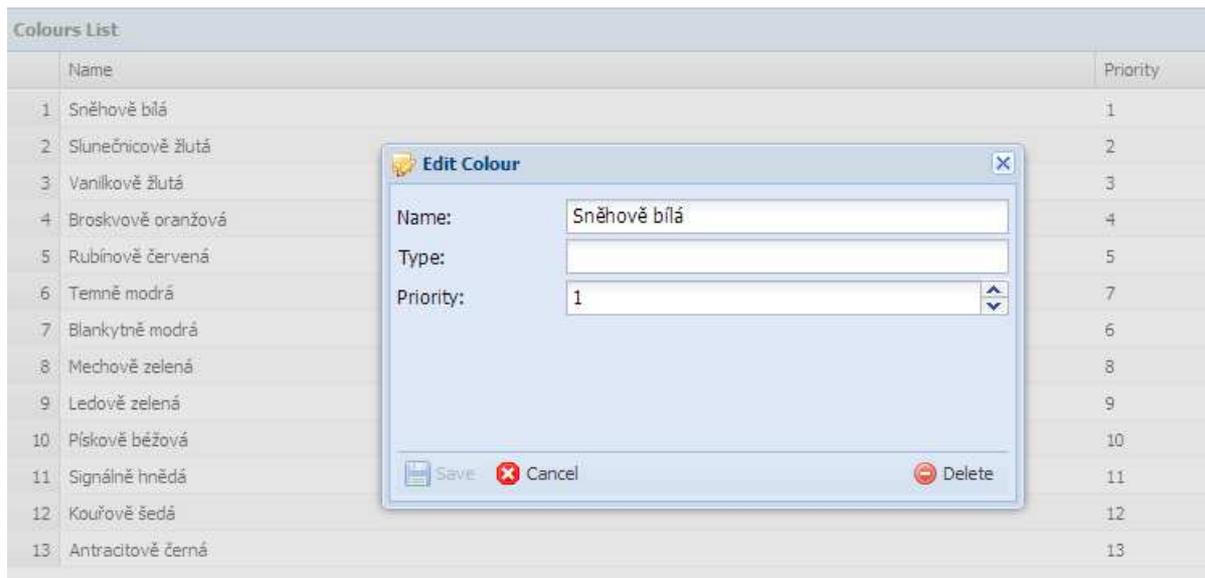


### 2.3.1 Scheduling data

The item in the menu „Import Data“ allows end users to import basic data to the application. This action can be performed based on the microsoft excel file or by SSIS package can be run. These will initial data and prepare them for daily use. The basic data can be erased as it is presented on the picture bellow.



The other items in the menu represents possibility to update, insert or erase records which are imported or added manually. This list contains „Service type“, „Color“, „Machine“, „Module“, „Material“ and „Product“. All formulars have similar form which displays list of records and possibility to manage these records. This is shown on the picture bellow.



The records can be edited by few different ways. Once end user will click on the icon add, folder or red delete icon the popUp window will be displayed and end user can perform specific action. The list of records allows end user to quickly edit record by double clicking on the concrete row. The row will be changed to the edit mode and record can be changed. As it is visible on the picture bellow the color has property Priority which can be changed. All the tables like materials, machine or products contain this property. This property is used during the calculation of the specific schedule.

The item “Material” contains dependency on the colors. The specific material can contain different colors. Once the material is selected the list of colors for this material is loaded to the list. The functionality on this form is same as previous.

The similar dependency formular can be found under item “Product”. The product has dependency on the machines and additional times. This form contains also comboboxes where can be picked other dependencies like service, material and others.

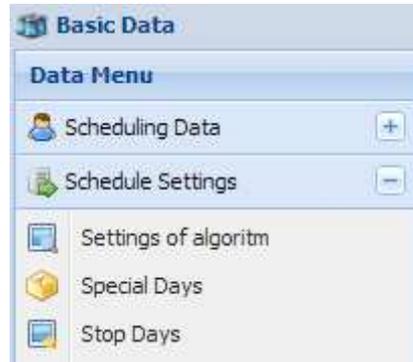
Materials List		
	Name	Drying
14	PC/PEEKIN 300 BK 102	
15	ABS MAGNUM 3453 NATURAL	
16	TPE BERGAFLEX BFI G 65A-3E1211 NATUR SO	
17	PA6/66 FR BERGAMID AB700 UF SCHWARZ	
18	PC LEXAN 940 701 CERNY	
19	PC LEXAN 141 R 111 GLASKLAR	
20	PC LEXAN 923-WH5D193 bílý	
21	PA6/66 GRILON TS VO CERNY 9834	
22	PC LEXAN 923 NATURAL 11221	
23	PC XANTAR F 22UR	
24	PBT VALOX 451E-7001	
25	PC LEXAN 121R-71277 TRANSPAR.KOUŘOVÝ	
26	PC/ABS CYCOLOY C2950 96235 SEDY	

Page 1 of 4 Ready

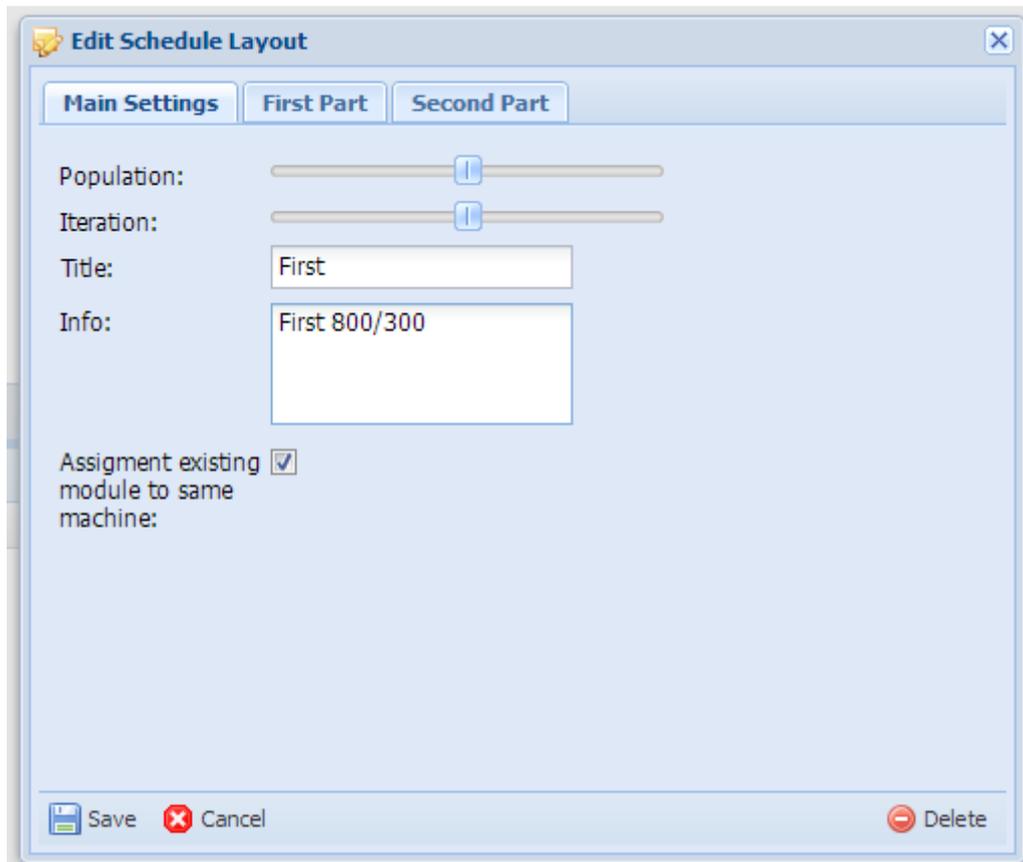
Colours List	
	Name
1	Sněhově bílá
2	Slunečnicově žlutá
3	Vanilkově žlutá
4	Broskvově oranžová
5	Rubínově červená
6	Temně modrá

### 2.3.2 Scheduling properties

The second part of the menu provides possibility to change and manage behavior of the genetic algorithm and also the final shape of the plan. The first item is Settings of algorithm which contains setup of the scales and based on these scales the result schedule is created.



The individual parts of dialog allow end users to setup settings of the algorithm. Here is the list of the properties and their description.



**The list of the settings and theirs description:**

**Population:** Determine number of plans of one iteration. During every iteration is generated specific number of plans. These plans are scheduled differently and also evaluated based on the scales which are presented in basic data.

**Iteration:** This is setup of the number of iteration which are performed during the calculating of the final optimal plan.

**Assignment of existing module to same machine:** One module can represent more products in product catalog. For this reason is absolutely necessary to assign such products one follows by other.

**Machine Priority:** Once the product is on the machine where is higher priority the plan has better evaluating.

**Earlier Deadline:** The products which have sooner deadline are produced earlier.

**Not Over Deadline:** The plan where deadlines are met is better evaluated.

**Equal priority:** The evaluation in case that products of same priority follow one by another.

**The less priority second:** The evaluation in case that product with less priority will be assigned after product with higher priority.

**The less priority first:** The evaluation in case that product with higher priority will be assigned after product with less priority.

**Same module:** The evaluation on case that products are on same module one followed by another.

**Same material:** The evaluation in case that products have same material.

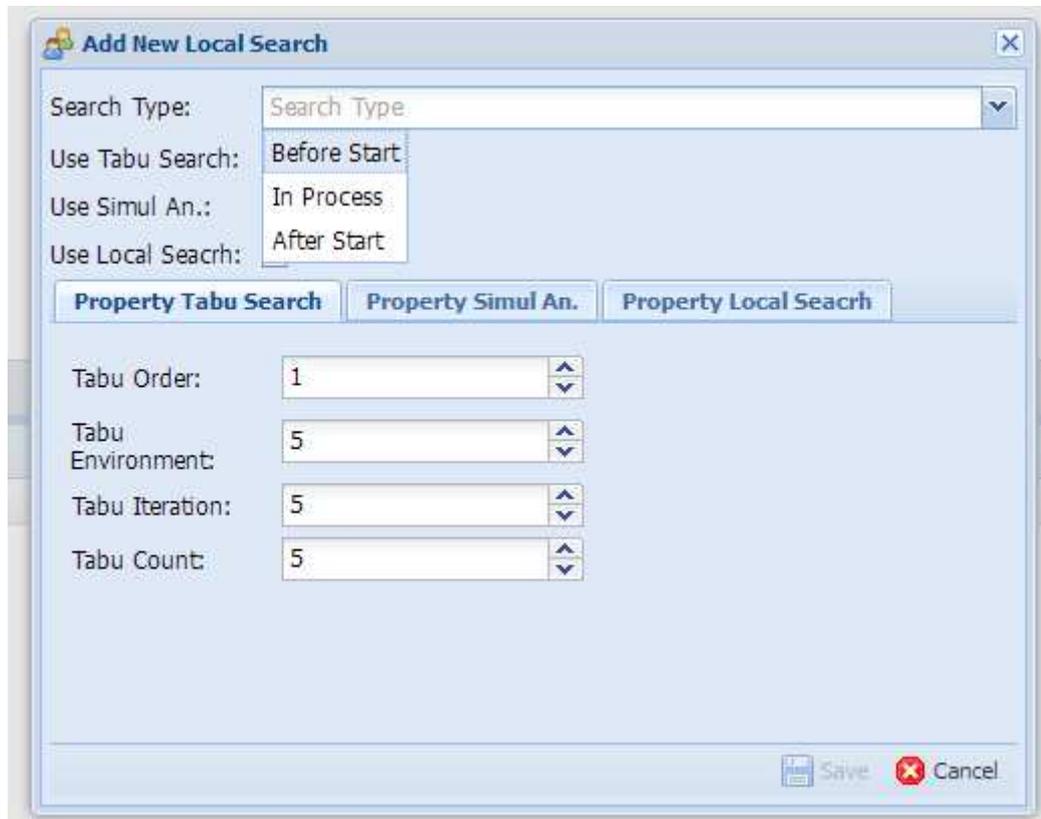
**Same type of material:** The evaluation in case that products have same type of material.

**Color difference positive:** The colors are in correct order.

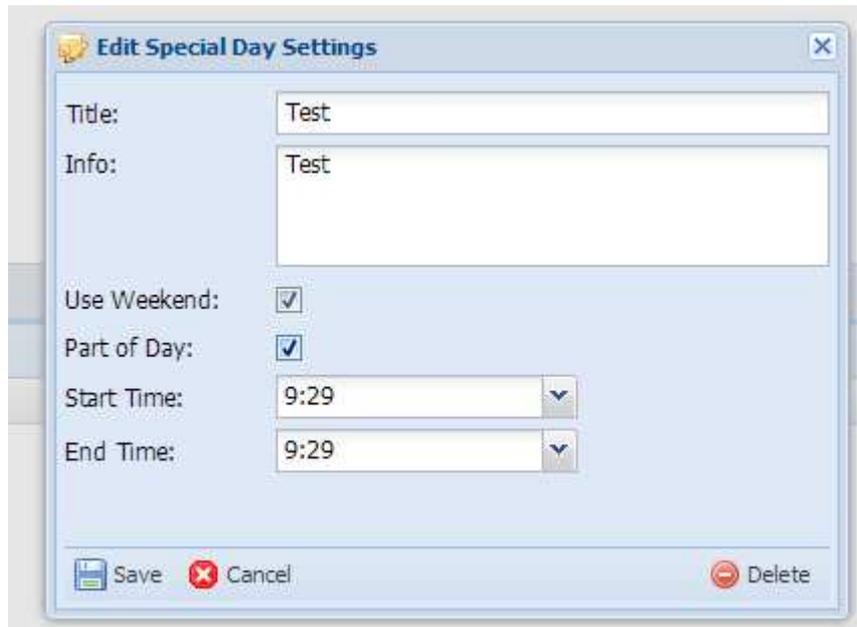
**Color difference negative:** The colors are not in correct order.

**Color difference similar:** The colors are same.

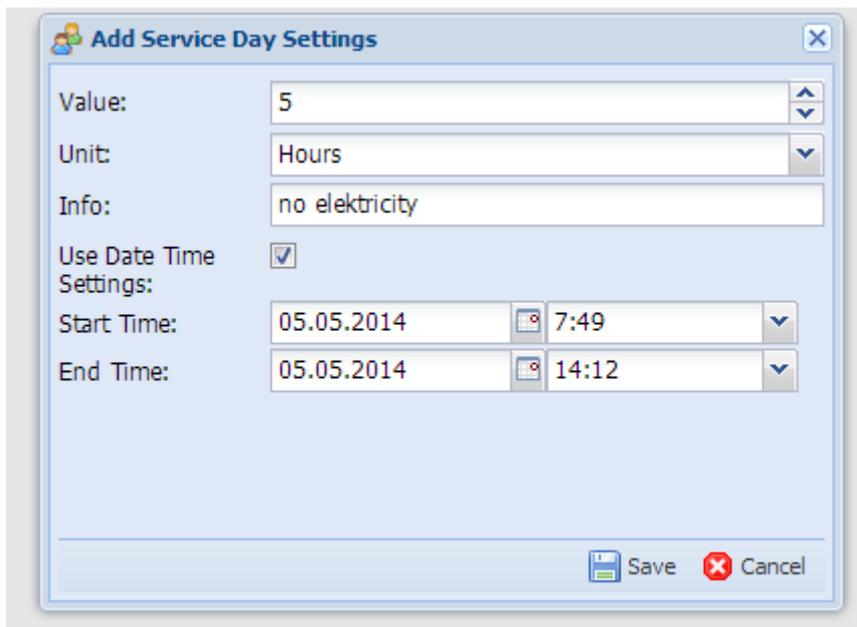
The application allows also add other more simple heuristic methods which can be performed before start of genetic algorithm after or during the process. The methods are Tabu search, Local Search and Simulation annealing. More about all heuristic methods can be found in our case study.



The special days allow to setup working hours, holidays, special days or planned stops of production. These settings are later applied and presented in the final plan in Time Line or in export.



The stopping times are related to the scheduled plans and can be added once some unpredictable event occurs.



### 3 Scheduler wizard

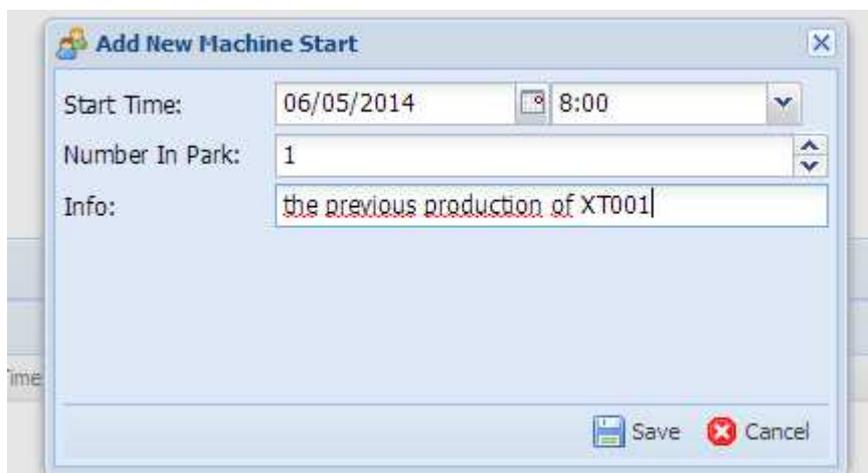
#### 3.1 Purpose of the module

The purpose of this module is to create concrete plan of the production. The concept of the form is schedule wizard which contains five different steps. The final step provides possibility to start the calculation of the plan.

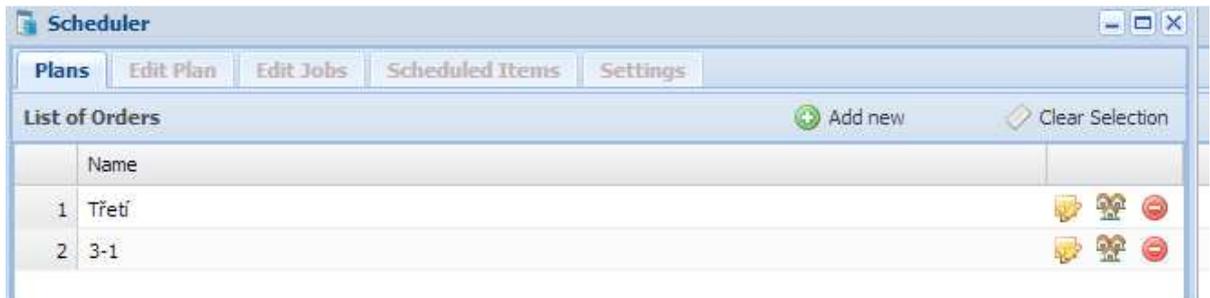
- I. Orders and Starting times
- II. Edit Order
- III. Edit Products
- IV. Records in the plan
- V. Settings of the algorithm

#### 3.2 Orders and Start times

The order defines the start of the production plan. In respect that the concrete production on each machine does not start on same day and at same hour like 8:00. The wizard provides possibility to setup different start for each machine. We can take the concrete case that plastic production will start to apply the scheduled plans to the production. They will find out that they have already something on the machines in the current production so they will need to connect the plans produced by software with the reality in the production. This is the reason why this functionality or possibility is presented in the application.



The concept of the order allows adding dynamically products and creating new plans based on the new product production requests. This can make extreme case that one order will have more then few thousands products in place and can meet limitation of the web browser. We strongly recommend making new order every 3 or 6 month to avoid this situation.



The particular orders can be edited, inserted or deleted. The new order can be created by button “Add new” or by next step on the bottom of the screen. The icon of the folder allows to go to the second step of the wizard to edit concrete order information or settings. The icon of the houses allows going to the third step of the wizard of the concrete order. The red icon will delete order with all connected information. Once the row of the order is clicked the list of the start times on each machines is loaded. This selection can be cleared by clicking on the icon Clear Selection. The double click provides again the quick editation of the order.

### 3.3 Edit orders

The second step provides edit mode for the concrete order. In this case can be changed the name of the order or added description for this order. The start time is used in case that the concrete machine does not have starting time defined.

**Scheduler**

Orders Edit Order Edit Jobs Schedule records Settings

**Edit Order**

Name:

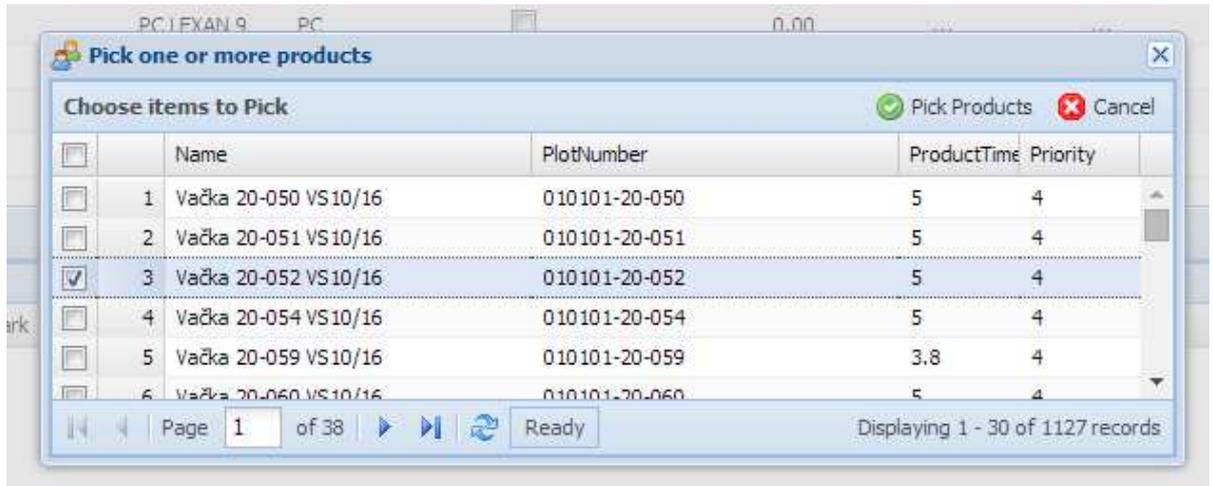
Start Time:

Info:

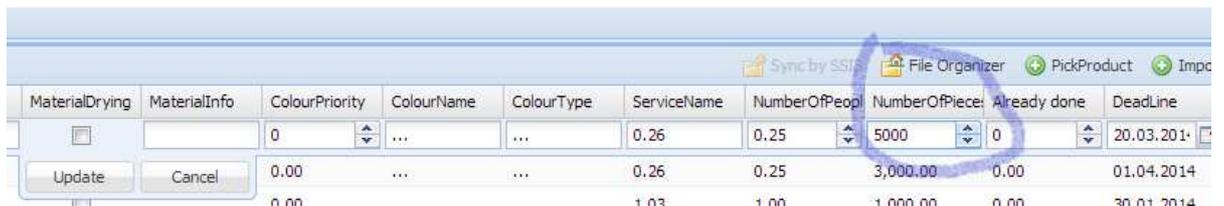
### 3.4 Edit products

In this step the data from Basic data module are copied based on the end user selections or by the automatic process of import of the ordered products. This functionality helping to the end user map and take all information from basic data. So they do not have to be filled every time again. The form looks similar to the product form in basic data but has more different functions and purposes. The list of functions on this form is following: Import of the products from the basic data, maintenance of the files, and synchronization of the produced products with the order.

The first possibility how to define product in the order is to pick the product from basic data:



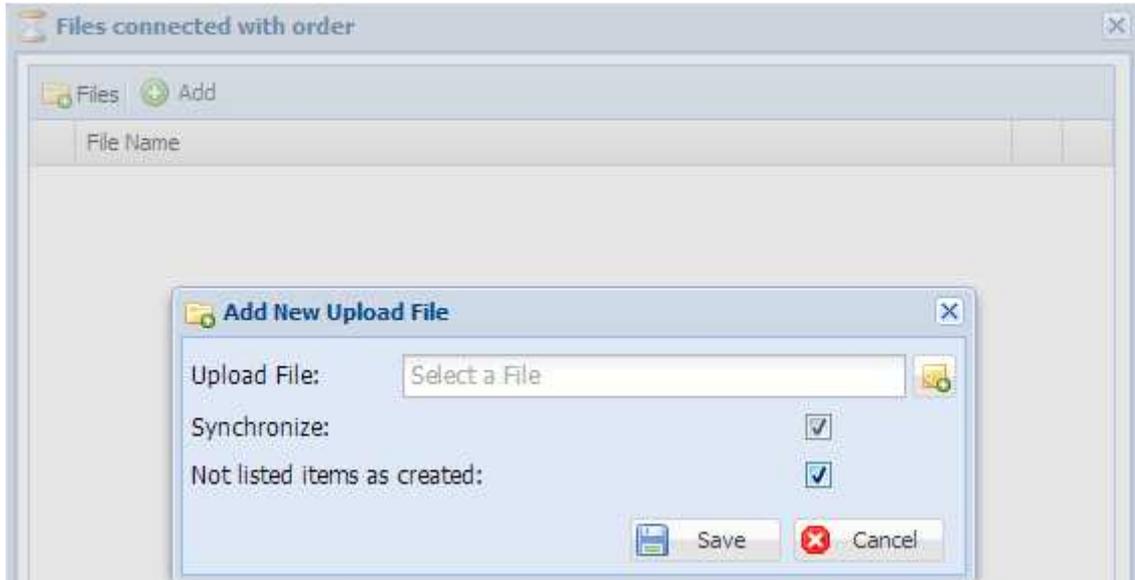
As it is shown on the picture bellow. It is absolutely necessary to fill few columns in case of manual picking product in the basic data as it is Number of pieces to produce and deadline or the specific color:



The second and easier possibility is to import products from excel or by SSIS package from the company IS:



The file manager has function for update of the already produced pieces of the concrete products. There is also possibility to automatically make not founded products in the file or by SSIS package as already produced. The file manager also allows to upload pictures, documents or any type of the file which will be connected with the order.



The functionality can be provided by excel or by SSIS technology.

The following picture represents list of products after the import:

The screenshot shows the "Scheduler" application interface. It has tabs for "Orders", "Edit Order", "Edit Jobs", "Schedule records", and "Settings". The "Products List" table is displayed with the following data:

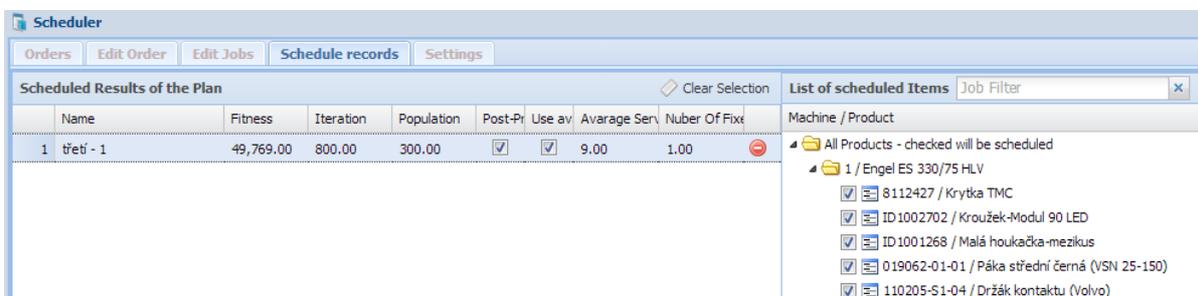
	Name	PlotNumber	ProductTime	Priority	ModuleN
1	Vačka 20-05...	010101-20-...	5.00	4.00	VS-688-
2	Vačka 21-10...	010101-21-...	5.00	4.00	VS-688-
3	Jezdec (VSR...	010342-15	1.90	4.00	VS-688-
4	Jezdec	110112-09/N	2.63	4.00	DS-688-
5	Vičko jednoz...	110210-02	12.50	4.00	DS-688-
6	Krytka (dvoj...	110330-06	13.00	4.00	DS-688-
7	Vičko-Modul...	ID1002146	25.00	3.00	TE-688-
8	Zátka-Modul...	ID1002147	10.00	3.00	TE-688-
9	Pačice LED	ID1001259	22.50	3.00	TE-688-
10	Těleso-žluté ...	013312-01-02	29.00	4.00	VS-688-
11	Páka střední...	019062-01-01	27.50	4.00	VS-688-
12	Páka velká č	019063-01-01	51.00	4.00	VS-688-

Below the table is a navigation bar showing "Page 1 of 4" and a "Ready" status. The "Machines List" table is partially visible below:

	Type
1	Engel 200/45 HLV
2	Engel e-max 310/100

### 3.5 Plans

This part is for managing already scheduled plans. In case that the order does not have any plan all products are unassigned to any machine. Once end user will click on the concrete plan the tree on the right side of the screen will display products assigned to the specific machine. Once the user would like to have the starting position of the screen he can click on the button Clear Selection and all products will appear unassigned. In case that user will do the selection of already created plan he can pick products which should stay on the machine unchanged and reschedule the plan again. This functionality happening automatically for products which has already some of the pieces produced. The application will find these products and will unpick them to fix them on the machine. The products can be fixed also by hand as was already mentioned. Once the end user will go to the next step and will start planning the fixed products will stay on the concrete machine.



The second picture represent one machine where two products are unassigned which means that these products will be fixed and will not be changed by another scheduling process.

Machine / Product	Order
<ul style="list-style-type: none"> <li> <ul style="list-style-type: none"> <li>All Products - checked will be scheduled</li> <li> <ul style="list-style-type: none"> <li>1 / Engel ES 330/75 HLV</li> <li> <ul style="list-style-type: none"> <li><input type="checkbox"/> 8112427 / Krytka TMC</li> <li><input type="checkbox"/> ID1002702 / Kroužek-Modul 90 LED</li> <li><input checked="" type="checkbox"/> ID1001268 / Malá houkačka-mezikus</li> <li><input checked="" type="checkbox"/> 019062-01-01 / Páka střední černá (VSN 25-150)</li> <li><input checked="" type="checkbox"/> 110205-S1-04 / Držák kontaktu (Volvo)</li> <li><input checked="" type="checkbox"/> 110205-S1-03 / Vložka (Volvo)</li> <li><input checked="" type="checkbox"/> 930693-02-02-01 / Víčko oranžové (Lékovka TYP 03)</li> <li><input checked="" type="checkbox"/> 930693-02-01-01 / Víčko žluté (Lékovka TYP 03)</li> <li><input checked="" type="checkbox"/> 930693-02-03-01 / Víčko zelené (Lékovka TYP 03)</li> <li><input checked="" type="checkbox"/> 110205-S1-01-01 / Těleso zásuvky (Volvo)</li> </ul> </li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>All Produc</li> <li>-</li> <li>0</li> <li>1</li> <li>2</li> <li>3</li> <li>4</li> <li>5</li> <li>6</li> <li>7</li> <li>8</li> <li>9</li> </ul>

### 3.6 Settings of the algorithm and start of the scheduler

This part is last step of the wizard and provides possibility to start the scheduling process. The plan has several settings which can be changed on this form. The form contains possibility to select algorithm layout which will be used during calculation. The name of the plan. The number of fixers, the number of people in the production or the mode of displaying the final plan in the time line. The fixer is person who can assigne the moule to the machine and start the production. The company can

have one or more people with this expertise and this will change the waiting times for the start of the production. The property of the average people will also show if the production has enough people for starting the production. The process can be started by button Start.

The screenshot shows the 'Scheduler' application window with a 'New Schedule' dialog box open. The dialog has several sections:

- Alg. Layout:** A dropdown menu set to 'První'.
- Used Machines:** A dropdown menu currently showing 'Engel ES 330/75 HLV,' with a list of machine models below it, each with a checked checkbox:
  - Engel ES 330/75 HLV
  - Engel VC 330/80 Spex
  - Engel 200/45 HLV
  - Engel e-max 310/100
  - Engel ES 80/25 HLS
  - Engel 80/25 HLV
  - Engel ES 330/70 HL
  - Demag 200-600
  - Engel ES 650/125
- Name of new Plan:** A text input field containing 'First'.
- Number of Fixers:** A text input field containing '1'.
- Use Post Process:** A checked checkbox.
- Use Average Service:** An unchecked checkbox.
- Average Service:** A text input field containing '5'.

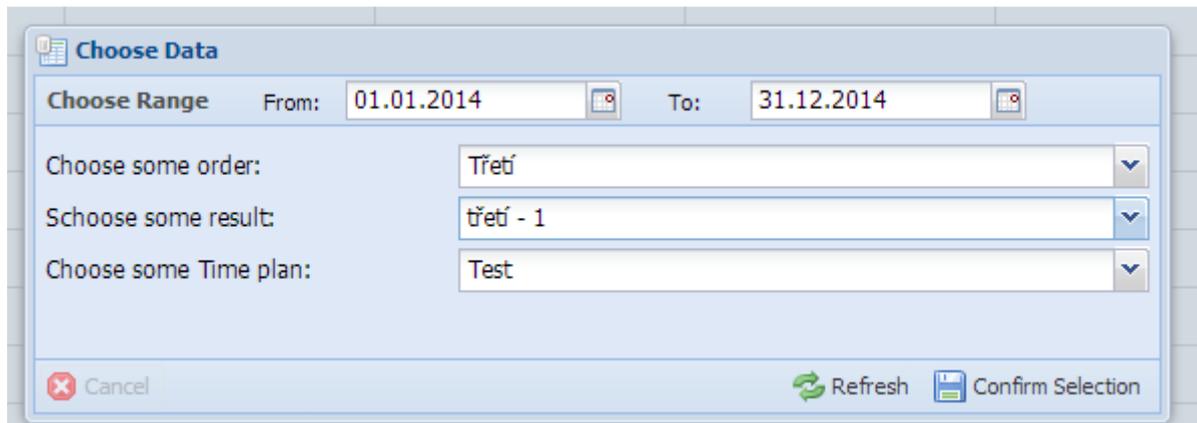
At the bottom of the dialog, there are two sliders for 'Population' and 'Iteration', both set to a low value. A 'Start' button is visible on the right side of the dialog.

The form also contains settings of the layout of the algorithm which was described in details in the section basic data.

## 4 Time Line

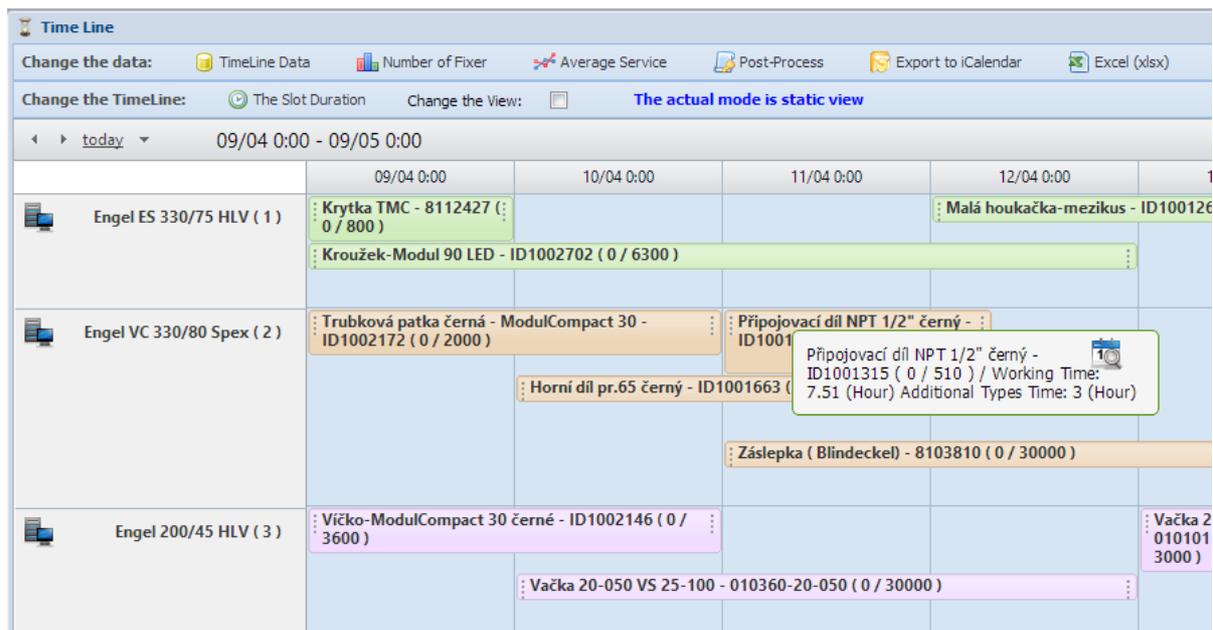
### 4.1 Select Plan

The first step for the Time Line is the selection of the concrete plan which should be displayed. The list of the plans can be filtered by time range and order. Here is also possibility to select the time plan which will be used for displaying the selected plan. The time plan represents the setup of the working hours, holidays etc as was described in details under chapter basic data.



### 4.2 Basic view of the plan

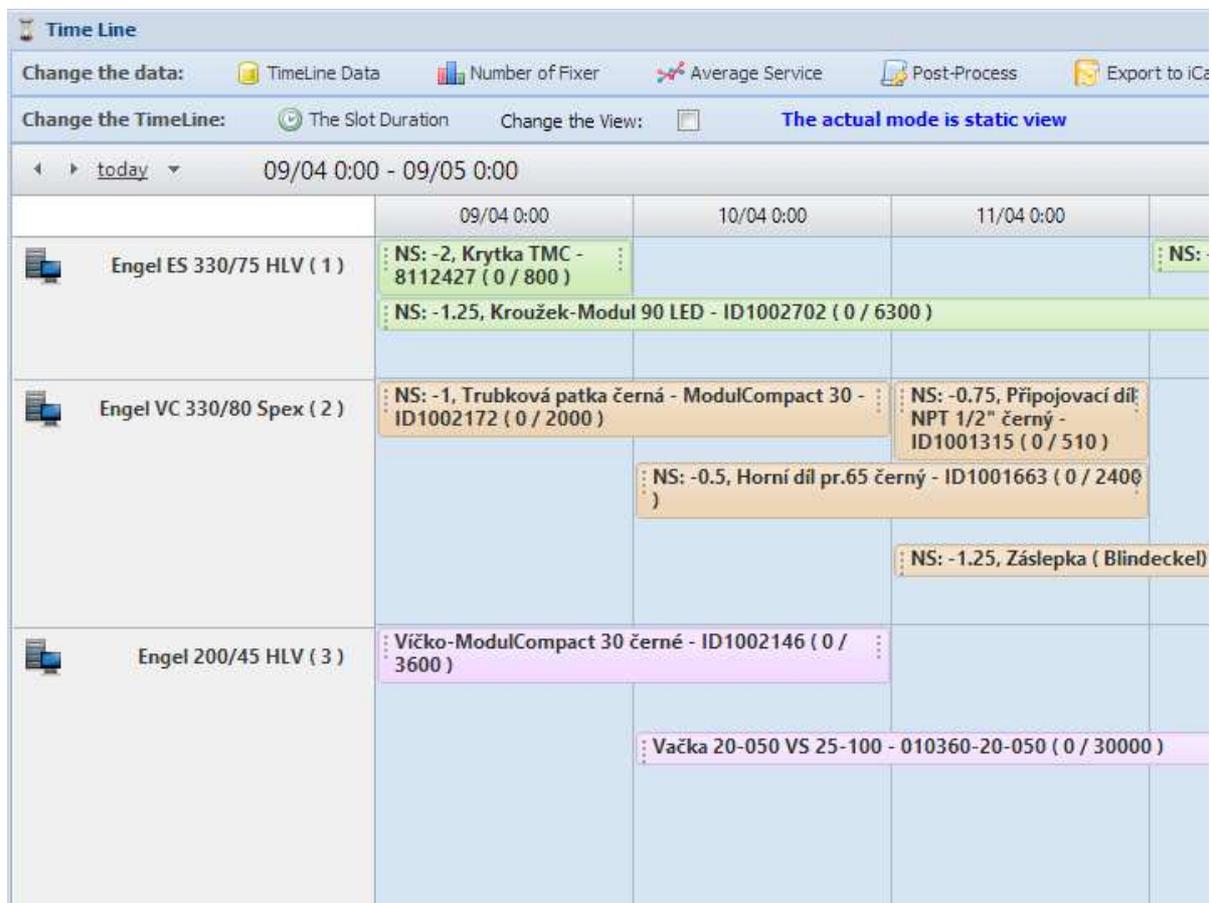
The basic view is displayed once the plan is selected and also the post process is not setup for the plan. The plan counting with the number of fixers and the plans are longer or shorter based on the availability of the fixers. In case that is also picked and setup average service the plan will not extend time lines but will only add the shortcut "NS" which means that no service is available.



The picture shows also the structured title after mouse is above the time line. The bellow picture represents the setup of the average service.



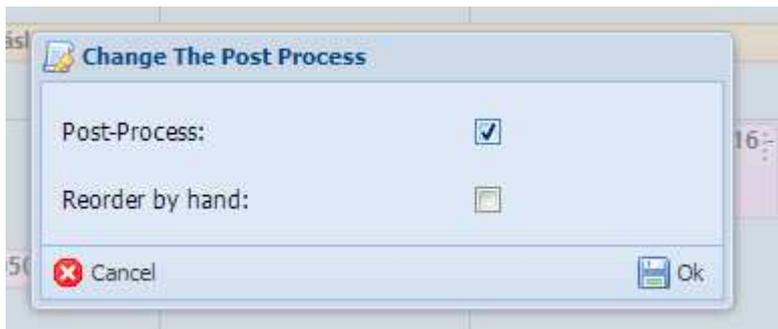
Once the dialog is confirmed the plan is displayed also with the shortcuts as is visible in the bellow picture represented by "NS".



This information will not show us how the plan will be extended so for this reason we have advanced view of the plan.

### 4.3 Advanced view of the plan

Once the average service is missing is needed to know how the production will be long and on this base will be able to predict the time delivery of the produced products to the customer. The advanced view was created for this purpose. The advanced view can be enabled by allowing post process. This can be setup by the dialog widnow in Time Line module or on the settings page in wizard.



The post process is in two different modes:

- A. Post Process without possibility of drag and drop
- B. Post Process with drag and drop

The post process is searching the combination of the time line that will allow starting the production. This action is based on the switching the products on one machine between each other. In case that for example the product on fifth position will allow the production on the first position on the same machine the algoritm will switch these two products. In case that such combination is not found the stopping time is added to the time when the production can start.

The post process without possibility of drag and drop will not allow any drag and drop of the products.

The post process with possibility of drag and drop will only extend the production time by stopping times and will not do the change of combination of the products on the machine.

The following picture represents the extension of the product by the stopping time. This mode will respect the average service in the production.

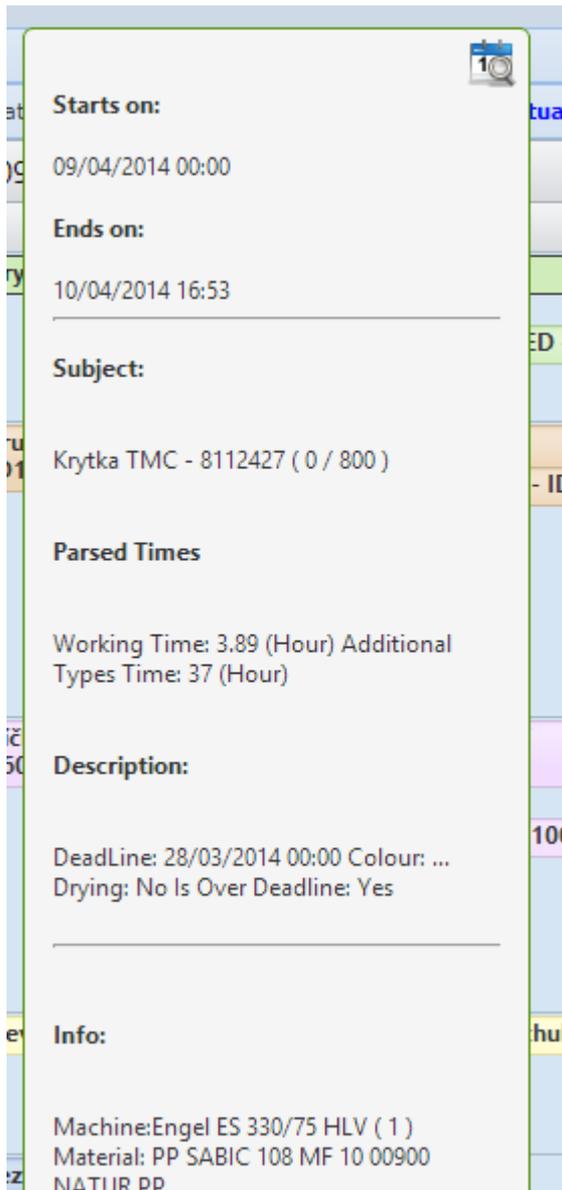


Once the end user will disable post process mode the view is changed to the basic view and all changes are reverted back to the basic view. The basic mode uses results from the scheduling process. This is applies only in case that plan was not changed by drag and drop in the basic view.

The drag and drop change in the post process is saved only in this mode and is reverted once this mode is disabled.

#### 4.4 Concrete functions of the Time Line

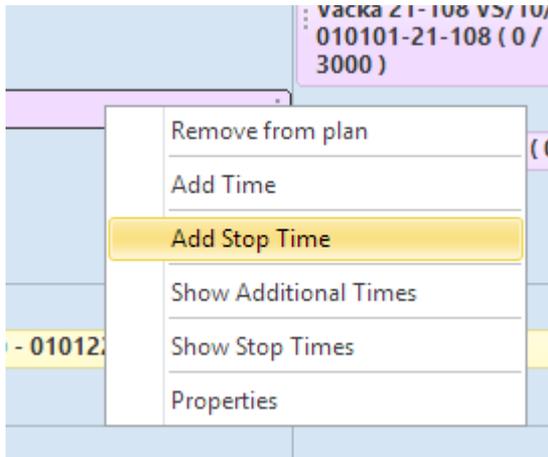
The Time Line contains several end to end functions which will be described here. The first of them is the detailed information about the product and his times. This is displayed by left clicking on the product time line.



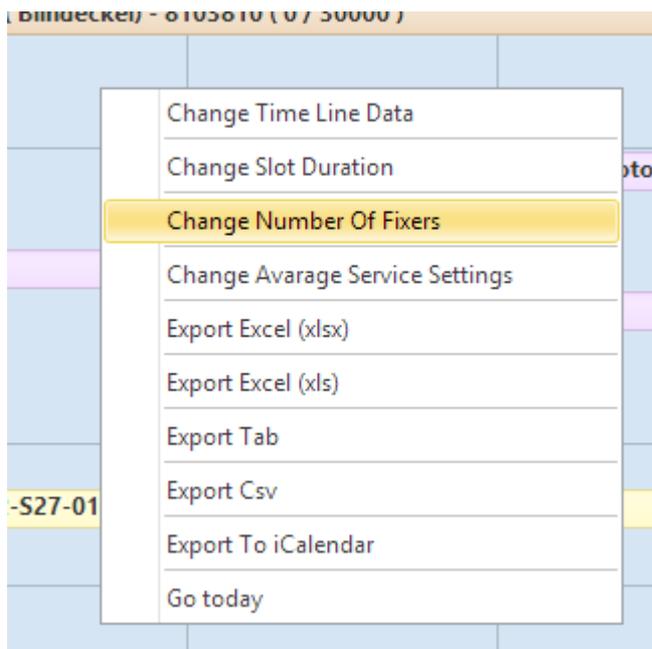
The screenshot shows a detailed information window for a product time line entry. The window is titled with a calendar icon and the number '10'. The information is organized into several sections:

- Starts on:** 09/04/2014 00:00
- Ends on:** 10/04/2014 16:53
- Subject:** Krytka TMC - 8112427 ( 0 / 800 )
- Parsed Times:**
  - Working Time: 3.89 (Hour) Additional
  - Types Time: 37 (Hour)
- Description:**
  - DeadLine: 28/03/2014 00:00 Colour: ...
  - Drying: No Is Over Deadline: Yes
- Info:**
  - Machine:Engel ES 330/75 HLV ( 1 )
  - Material: PP SABIC 108 MF 10 00900
  - NATUR PP

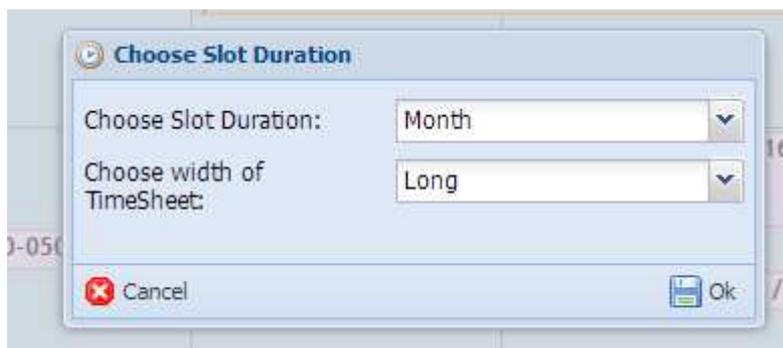
Once end user will right click on the product time line the context menu will be displayed where will be found several product and schedule properites associated with this product.



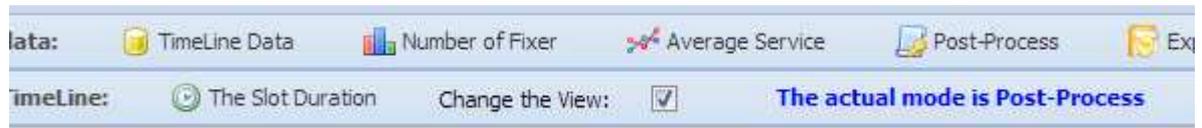
Once end user will click on the right mouse button on the empty space on the Time Line. The context menu of the functions which can be also found in the header of the module. These functions are export to the excel format data and properties or time line views changes.



The view can be changed by selecting slot duration or width of the time line.



The pick button will change the mode of the view and will display the time line of concrete product with different parts.



The time line of the product consist of the time for fixer, additional times, no service times or production time.



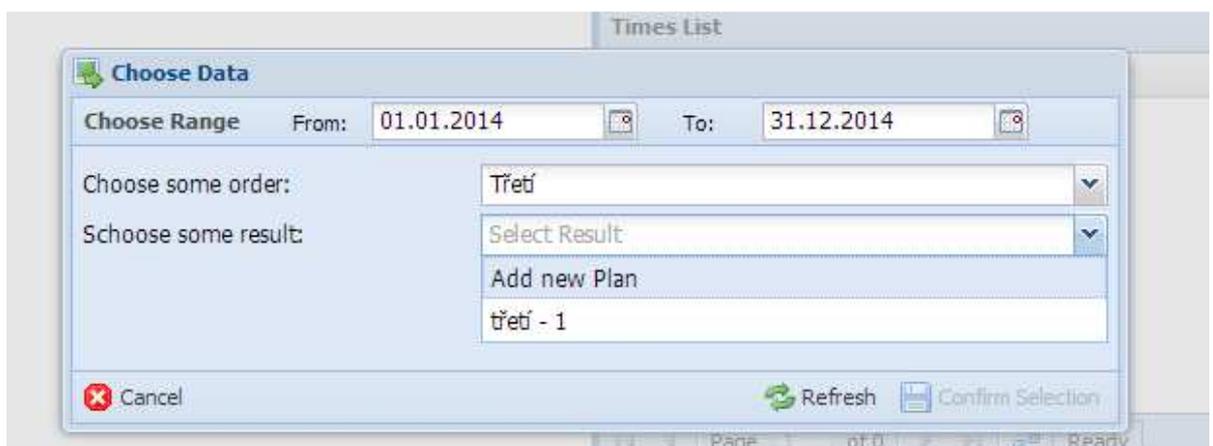
## 5 Reports and manual planning

### 5.1 Manual editing of the plan

This part is for custom or manual planning of the existing or new plans. The end user can also add new plan to the existing order and create the schedule by hand. The existing plan can be also opened and manually adjusted. The form allows adding or importing products or synchronizing with already produced pieces as it is known from the wizard. Change the product order in the plan or the placed the product to the different machine by drag and drop functionality.

Name	Machin	Order	Plot Number	Material Name	Color Name	S
Engel ES 330/75 HLV	1					
8112427 / Krytka	1	0	8112427	PP SABIC 108 ...	...	:
ID1002702 / Kro.	1	1	ID1002702	PC LEXAN 943 ...	...	C
ID1001268 / Mal.	1	2	ID1001268	ABS STAREX S...	...	:
019062-01-01 / P.	1	3	019062-01-01	ABS MAGNUM ...	...	C
110205-S1-04 / .	1	4	110205-S1-04	PA6/66 GRILO...	...	C
110205-S1-03 / V.	1	5	110205-S1-03	TPE E HYTREL ...	...	C
930693-02-02-01	1	6	930693-02-02-...	PS SYNTHOS P...	...	:
930693-02-01-01	1	7	930693-02-01-...	PS SYNTHOS P...	...	:
930693-02-03-01	1	8	019062-01-01 / Páka střední černá (VSN 25-150)			:
110205-S1-01-01	1	9	110205-S1-01-...	PC LEXAN 141 ...	...	C

The picture shows the possibility to add new plan to the system and create the schedule manually.



The following picture allows users to change the properties of the concrete product.

**Product detail** Save Del

Name:	Páka střední černá (VSN 2)	Material:	ABS
Plot number:	019062-01-01	Color:	Select color
Product Time :	27.5	Module:	VS-688-03585
Product priority:	4	Service:	0.52
Total Number:	300		
Current Number:	0		
Deadline:	28.02.2014		

**Times List** +

	Name	Value	Unit	Is Fixer Time	
1	Time of preparation form	160	Minutes	<input checked="" type="checkbox"/>	
2	Time of preparation colour	20	Minutes	<input type="checkbox"/>	

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**Machines List** AddMachi

	Type	NumberInPark	Info	Priority	
1	Engel ES 330/75 HLV	1	Min. height: 250, Technica...	1	
2	Engel VC 330/80 Spex	2	Min. height: 150, Technica...	2	

## 5.2 Overview of the plans

The report represents possibility to show the information about the concrete plan by the pivot table well known from the Microsoft excel.

## 5.3 Overview of the orders

This is simple report which shows overview of the orders in the system.

## 6 Gloss

Term	Description
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