Advanced optimization methods of automated cyclic processes
Description for general public

The effect of digital revolution that began in the twentieth century is the use of more or less sophisticated electronic devices in virtually all areas of business and private life. The digital revolution in the XXI century is driven by the realization of Smart idea. It applies to products ranging from the household equipment (televisions, kitchen appliances), buildings (intelligent buildings), to urban design (smart cities), etc. The main benefit of using Smart ideas is more interactive and greater economy (in terms of energy, time, cost, etc.). The main executors of Smart idea are electronic devices or devices of other types, controlled digitally. The systems gain intelligence from the use of advanced data processing algorithms that are the subject of intensive research conducted by the scientists in the field of computer science. Achievements in computing undoubtedly significantly increased capabilities in areas such as telecommunications, medicine, economics, chemistry, physics, etc.

There is currently observed an intensive development of management support systems in production systems. The scope of these changes is so significant that there are more and more talks carried out on the fourth industrial revolution called Industry 4.0. The idea of intelligent factory assumes direct influence of the client on the course of the product manufacturing process in the company. The main barrier to the development of such advanced systems supporting production planning is the need for continuous change plan in response to emerging customer orders. The created plan must not only meet the requirements of the customer but also maximize the economic objectives of the firm. Due to the amount of data determination of such plan determination by a man is impossible.

The aim of the project is to show how to find and use specific properties of different mass production models to design dedicated, highly efficient (time and memory) optimization methods.

Production systems manufacturing consumer goods for mass-market such as household appliances, automobiles, electronic equipment, clothing, etc., carry out the production of a variety of models or families of similar products (the so-called multi-assortment production), in medium or long runs, with the gradually varied in time product mix, in fact, in the cyclic mass manner. From the technological side, these systems are fully automated or semi-automated. Modern systems of this type meet the market demand either by:

1. non uniform periodic change in the production mix (whose range varies accordingly to complement the current inventory), or through
2. providing the right mix of assortments according to the orders and policies of manufacturers for on-demand delivery.

Qualitative and quantitative composition of the mix depends on the flow of customer orders, and the latter depend on policies and marketing. Assuming the technical ability to implement both of these solutions, the second approach is financially more attractive because it eliminates or reduces the storage of finished products, thereby decreasing logistics costs. In addition, minimizing the cycle time for a fixed set of tasks in a cycle, increases the efficiency of the manufacturing system and increases utilization of machines. Further improvement of the efficiency of the system functioning can be obtained, among others, by eliminating or reducing the storage of semi-finished products in indirect warehouses or between stations, reducing setups, or by more precise portioning of products batch. This leads to conditions well-known in practice and literature as "prohibition of storage between-posts" (no store) or "restricted storage area, the so-called buffering" (limited storage). Similar conditions are also limiting of products waiting times (limited waiting time), setups (change over time), etc.

The result of the design work will be the development of a methodology for solving difficult-to-optimize problems of cyclic scheduling, so far unrecognized in literature, and often found in automated production processes.