In the PhD thesis algorithms of car sequencing in a paint shop are considered, taking into account the existence of a buffer, with limited capacity and specific structure, located on a production line. The main problem associated with development of these methods is the need to ensure that the sequencing methods work based on limited current information and short time horizon for which the production plan is known. For this reasons, the decision making process, related to determination of the transport line for cars entering the buffer and selection of cars transported to the paint station, is complicated. It is important that these decisions are made in real time. In addition, it is necessary to include in the optimization criteria both changeovers of painting guns resulting from changes in paint colors, as well as occurrence of periodic cleaning made in order to ensure good quality of painting process. The literature review carried out in the thesis confirmed the existence of a research gap in the field of effective methods of car sequencing in the painting process.

Four methods of car sequencing are proposed. The first one, called the reference algorithm, is based on the assumption that the sequence is determined once, at the beginning of production, based on a long-term production plan, and does not change until it is performed. The second concept is based on the use of sets of priority rules to determine the position of loading and unloading conveyors. The next proposed approaches use elements of game theory. Three theoretical algorithms were developed, in which decisions are based on determining the Nash equilibrium in pure strategies. The last presented method is a follow-up algorithm (called FuSA) – the buffer unloading takes place in accordance with developed execution plan, i.e. an unloading sequence of several cars is determined.

In addition, the analysis of developed in the literature methods and tools, supporting the search for a solution to the sequencing problem in the paint shop, allowed to indicate both a methodical gap in this area, as well as a low usefulness of known solutions. This was the motivation to adopt a virtual commissioning methodology for the needs of testing the sequencing algorithms proposed in the thesis. The developed software and hardware method allowed for virtual commissioning in order to control the buffer. This confirmed the first thesis considered in the work: The proposed simulation environment enables the use of virtual commissioning for the buffer control system, used on car production line in paint shop.

The results of experiments showed that the algorithms based on a set of priority rules are the worst in terms of considered quality indicators. In turn, the best results were obtained for the proposed follow-up algorithm FuSA, what confirmed the following thesis: The developed sequencing algorithm provides an efficient solution to the problem of minimizing the number of painting gun changeovers. The complexity and the number of tests carried out on several data sets confirmed that: The use of virtual commissioning enables verification and evaluation of correctness and effectiveness of the proposed car sequencing algorithms.

Further works will focus on testing developed sequencing algorithm using buffer with a different structure, e.g. MIMO (Multi-In Multi-Out) – buffer with several input and output lines. There is also a concept of using machine learning methodology to create a new car sequencing algorithms dedicated for paint shop.