Tamás Rick:

Resource and cost optimization of product development process with respect to the product structure

PhD dissertation

THESIS

The novel, scientific results of research work detailed in the dissertation are summarized in the following theses:

Thesis 1

Constructional design is an iterative activity, hence it can only be modeled efficiently with a tool that can describe and handle this property [RHB06], [RiG05].

Therefore, I worked out a design structure matrix based process modeling method that considers the product structure and is applicable for the schedule optimization of design processes according to the cost and time aims.

The model takes learning – that occurs when repetitive tasks are carried out – into account in order to reach a better approximation, hence repeated tasks require less time, i.e. less cost.

Thesis 2

An efficient tool of the product structure based optional sequence planning of constructional design processes is a genetic algorithm. I used an integer code for the genetic algorithm, and the chromosome of the individual is represented by the sequence of design tasks. I have drawn the following conclusions with respect to the task-specific characteristics of the genetic algorithm [RHB06], [RiG05], [BGT05]:

Better half selection is not efficient in case of high complexity tasks, hence tournament selection should be used.

Among the crossover operations, the full crossover developed by me is more efficient compared to the uniform crossover.

If the sequence of constructional design processes is planned with genetic algorithms, it requires higher mutation probability, in this case 80%, and as opposed to the high value, this value is proven not to result in a random search. However, examinations revealed that the probability of crossover should be set to 60% for the sake of efficient search.

I have found – based on the examination of the probability of random selection, i.e. aging – that it influences the convergence of search to a great extent, hence it should be kept at a low value. Based on the investigations, this value should be 10% in case of sequence planning of constructional design processes.

Through the sequence planning of design processes, I have revealed that there is a relation between the size of the task and the size of the population regarding the efficiency of search.

The size of the population should be ten times higher than the dimension of the design structure matrix, and this way a stabile search can be carried out.

I have pointed out based on the calculation rate of the genetic algorithm developed for the sequence planning of constructional design processes that if the complexity of the task grows, the algorithm can approach the optimal solution within polynomial time.

Thesis 3

I have proven through the sequence planning and optimization of constructional design processes according to more aspects that different sequences can be created if the weighing factors of the characteristics (cost and lead time) are changed, hence a design process suitable for a given purpose can be created [RGB05].

Thesis 4

I have given a linear programming solution for the resource scheduling of constructional design processes so that it that can handle the splitting of tasks, however in case of large tasks, its efficiency is not adequate [BRG06].

Thesis 5

I have worked out the multi-variable heuristic model for the resource scheduling of constructional design processes in a way that it can schedule the resource environment of constructional processes efficiently with the use of the examined policies – policies that filter the number of interruptions, completeness, waiting, as well as the dominant resource need ranking and predictive policy [BRG06], [BGT06].

The efficiency of the policy depend on the resource environment, hence the possible solutions should always be checked with the combined use of policies.

Based on the results, the schedule prepared by the predictive policy has the shortest lead time in case of a given task and resource environment, if the time period of the prediction is the same as the average task length.