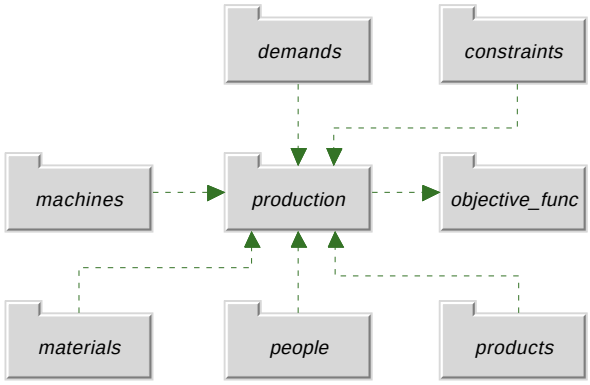
UML BASED INDUSTRIAL PROCESS OPTIMIZATION

UML

UML is a third generation object-oriented modeling language that was accepted as an international standard by the Object Management Group. Its characteristics:

- well defined mathematical semantic,
- well defined graphical syntax,
- support for different views (system-environment relationship, logical structure, behavior, implementation structure),
- visualization,
- reusable designs

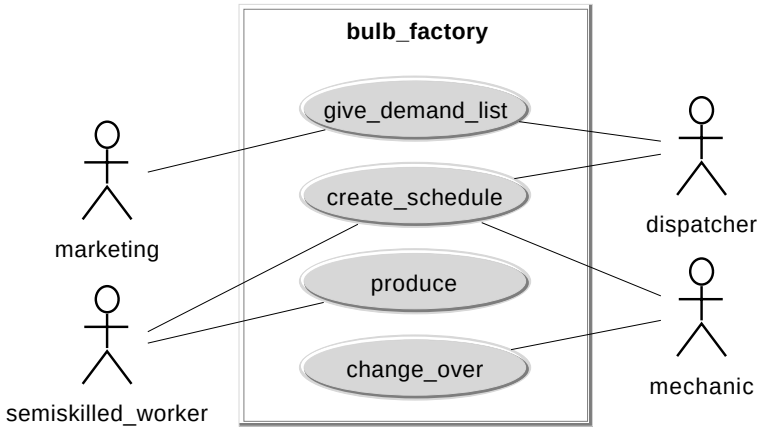
makes the language very useful for modeling and evaluation of industrial processes.



The Package Model

HIDE

Within the "HIDE – High-level Integrated Design Environment for Dependability" No. 27439 ESPRIT joint European project a prototyping system was developed in co-operation with University of Pisa and University of Erlangen. The system allows to evaluate UML models from many aspects. The core technology behind the idea is a set of two-way transformations: UML modeling tool ⟷ relational database ⟷ mathematical evaluation tool. It means in one direction automatic model evaluation and automatic visualization of results in the other direction.



The Use Case Model

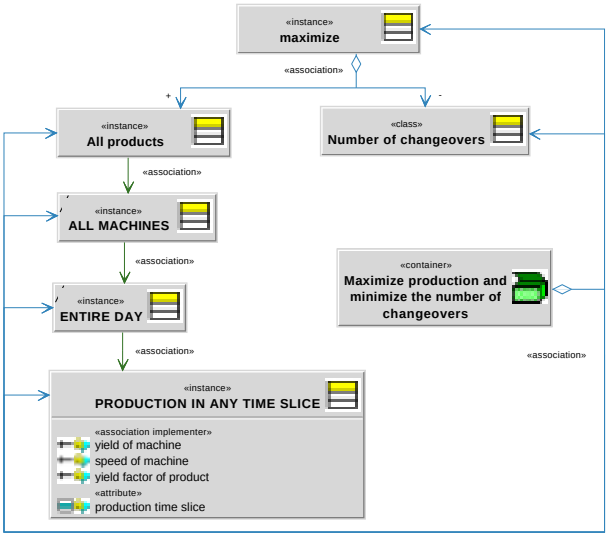
Process of evaluation

Based on the HIDE technology industrial process optimization consists of the following main steps. The relation between system and environment (users) is described by the use case model. The static description of the process is given in form of class diagrams. The dynamic description, that is not fully elaborated at the time, is done by using activity diagrams. The next step is to formulate the conditions of production in form of constraints: material constraints, human resources constraint, maximal yield, etc. For modeling we support RationalRose and Innovator.

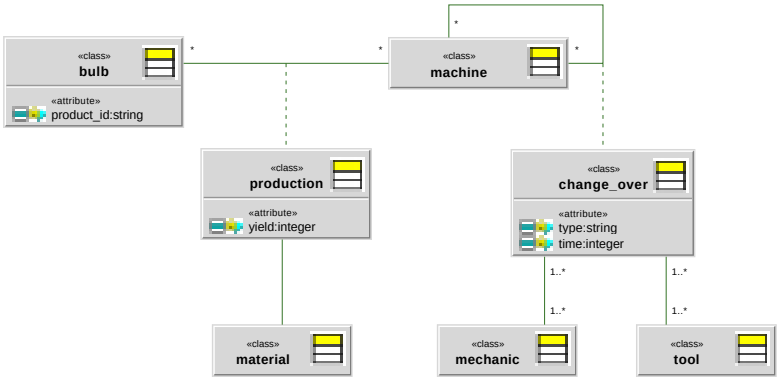
The second step of the evaluation is the filling in of the relational database. For this task any database manager software can be used that understands SQL, we use Oracle. The mathematical optimization input model is generated from the database by simple query and filtering. Currently we use lpsolve and Cplex for optimization.
The third, final step is the back-annotation of results through the data base into the model and the UML tool in order of visualization.
The biggest advantage of this method is that data acquisition, database design, and mathematical optimization can be done by using the same model. Therefore data consistency is maintained and the model can be reused during the development of production.

Case study

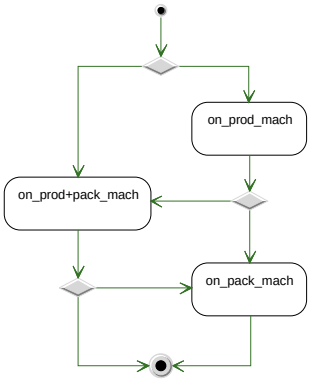
We made a successful case study for the daily programming problem at GE's Nagykanizsa bulb factory: The marketing provides a demand list for the production. The dispatcher makes the daily programming of the machines and the semi-qualified worker supports the production. The static model of the production associates products and machines and shows the required mechanics and tools for the change over as well as the production speed of a machine.
The dynamic model of the production gives the production process: production $\longrightarrow$ packaging. The objective function is the maximization of the production, i.e. the earliest finishing of the demand list and the production of the most possible bulbs in a day, as well the minimization of the number of change overs.



The Objective Function

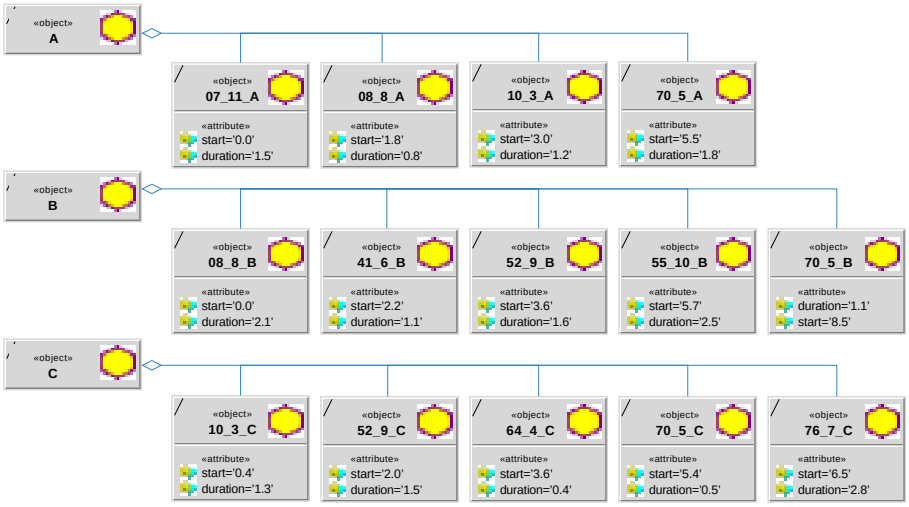


The Static Model



The Dynamic Model

The result of optimization is back-annotated into the UML model; the machines get associated with the demands that are attributed with starting time and duration. The pauses among demands define the change overs.



The Result of Optimization

Contact person: dr. András Pataricza, associate professor e-mail: pataric@mit.bme.hu
H-1521 Budapest, Műegyetem rkp. 9, Hungary Phone: (+36 1) 463 3595 Fax: (+36 1) 463 2667