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Design Pattern Enabling the Flexible Integration of Effects into a Basis Flow Model

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The assessment of the long-term safety of a deep underground repository for radioactive waste requires a comprehensive understanding of the system and appropriate numerical tools. RepoTREND is a final repository simulator being developed by GRS for simulating

- the release of contaminants and
- their transport through the near-field and far-field to the biosphere, including
- the estimation of the radiological consequences for man and environment.

It will be applicable to different concepts of final repositories in different host formations.

In a typical repository simulation the model area is extremely heterogeneous. Neighbouring grid elements can essentially differ with respect to their properties and the relevance of the effects that have to be considered additionally to the underlying basic processes, such as the two-phase flow in porous media. Such heterogeneities can lead to the necessity to vary the basic equations over the model regions. For instance, the rock convergence dynamically changes the pore volume in some region. The convergence process is controlled by a number of additional factors, and the change of the pore volume is described by a nonlinear differential equation that has to be integrated into the global equation system for the relevant region. The relevance of effects depends on the environment parameters and may change during the simulation time. For example, rock convergence gets irrelevant as soon as a final value of porosity is reached.

During a simulation of the processes in a repository for radioactive waste, numerous different effects have to be considered. Specific challenges in developing the structure of a simulator program are to enable a flexible choice of effects for different regions of the modeled area, their combination during a simulation and an easy way to extend the program by new effects.
The paper presents a concept for realizing these requirements by flexible introduction of effects into the simulation. The concept consists of the following steps:

- Define a family of *Effects*. An *Effect* class encapsulates the related parameters und effect-specific routines for pre-/post processing for a time/iteration step.
- Define a family of *Expert* objects that capture a current system state (relevant effects, basic model) and encapsulates the interaction of relevant *Effects*. These *Expert* objects have to be dynamically selectable corresponding to the current system state in the relevant regions. *Expert* objects enable the loose coupling of data structure. By using *Expert* objects the explicit dependency between *Effect* objects can be avoided. This concept enables the interaction of objects to be varied and modified independently of the objects themselves.

This concept ensures the implementation of new effects in an easy way according to the predefined pattern, flexibility, transparency and reusability in extending and developing the program.

References

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