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Description of Research Seminar: Multi-Objective Decision Support for Hierarchical Production Planning of Wood Recycling Cascades

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Research Seminar

offered by Sybille Dhring (ES-UGOE10)

in March 2013,

in Auckland, New Zealand

Subject: Multi-Objective Decision Support for Hierarchical Production Planning of Wood Recycling Cascades

Problem: Against the background of climate change and the scarcity of fossil fuels, renewable resources have gained considerable importance in Germany. However the rising demand of biomass is opposed by the limited availability of cultivable land as a limiting factor. There is therefore a massive use competition between the material and the energy use of renewable resources. An approach for an efficient resource and land use is the cascade utilization, where we want to maximize the material use followed by the chemical and the energy use.

In this context particleboards are of major importance in Germany. They consist of wood chips which are glued together at high temperatures. Applications for these Particleboards can be found in the furniture industry or in interior design. At the end of the life cycle they can be recycled. Using the thermo hydrolytic cleavage 90 % of the fibres of the particleboards can be recovered and used for further production processes. Due to stability reasons only up to 30 % of recycled fibres can be used for the production of new particleboards. The rest however can be used in biorefineries or in the wood pellet production.

As in such production networks, both strategic and operational planning tasks need to be answered, the hierarchical production planning (HPP) is suitable for describing the conceptual relations.

Main Results: The basic idea of the HPP is to split the overall planning task based on time and / or functional criteria into a hierarchy of sub-models. These are coupled with a few controlled interfaces. Finally, by matching the partial models, an optimal solution is conceded. The procedure has the advantage of reducing the problem complexity, which enables us to solve practice-related problems. In addition a reasonable degree of abstraction of the planning task is reached.

A HPP system generally consists of a set of vertically oriented levels that work together to find a solution to the overall problem. Each level communicates with at least the respective immediate upper and the direct lower level, if any. Thereby the higher level has the right of instruction, since their decisions are superior in content and timing. Their results provide the framework for the decision space of the lower level. Taking these requirements into account, the subordinate level solves the planning tasks and reports the results to the upper level. Based on this feedback, the upper level attempts to anticipate the system's behaviour in order to find an optimal solution of the overall problem. So, we consider an organization as an interaction of decision makers, whereby their decision processes are defined as sequences of decision models.

A crucial point in the decision process is to select the next model M. An interaction at some state k is described by the influence both processes exert on the other's decision model, though before influencing the other's process one will anticipate the possible effect of this influence. The top level anticipates the base level in estimating the base model $\hat{M}_k^B$ and determines reactions for this model as a function of possible hypothetical instructions. This results in the anticipating function $AF_k^T(IN_k)$, where the hypothetical reactions are used to calculate the optimal instruction IN_k^*, which is communicated to the base level. The instruction is now a factual signal and no longer hypothetical. For the base level is the situation analogous, resulting in a factual reaction R_k^*. This exchange of signals constitutes a negotiation process which ends up with the final decision IN^{**}, which becomes public and leaves the system.

Participants: Students and researchers from UOA.