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Process simulation improves development of harvesters

Increasing global competition in harvester production demands innovative products within ever-shorter development times. Classical product development with repetition of the cycle solutional concept – experimental model – trials – interpretation of results, has reached its limits in this context. Using the simulation technique for the development of harvester core functions offers faster and more creative product development.

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Literature

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Carefully planned marketing strategies, but mainly a customer-oriented product range, are necessities for a leading position in global combine harvester manufacturing. These products must meet the following demands:

- a variable range for special customer requirements
- suitability under wide application conditions (resale!)
- high standard of reliability
- ease of maintenance and service
- good cost-benefit relationship over working life

On the whole such demands are met by technologically-leading products proven in practice and these two descriptions represent a special challenge in development, especially that of combine harvesters because the application of progressive technologies also mostly brings with it a higher risk when applied broadly by customers. Developments indicate, however, that there is hope that through the application of simulation tools, a more rapid and better optimisation of the procedural-technical processes as core functions in the combine will be possible [1 – 4]. Simulation is encouraged not least by the very fast development of computer capacity which itself represents the basis for practical simulation models.

Orienteering examples of the development referred to here include the FEM (Finite-Element-Method) calculation system and multi-body simulations for solving kinematic/kinetic problems. Their good reputation is certainly due to their broad application base as well as the urgent need for such applications. At the same time their broad use in nearly every development department also indicates that the ground is prepared for the simulation of the real procedural-technical core tasks.

The aims and effects of, as well as the requirements from, simulation of procedural-technical processes in harvesters, and its possible role in product development are presented in the following excerpts.

Current situation and problems in product development

The procedural-technical processes taking place within harvesters are characterised by a large number of not yet recordable mathematical/physical functions. Development performance so far is thus mainly due to the very widely based experience of the constructors and which, for a large number of reasons, cannot be infinitely extended.

An improved or new function in a combine is realised through an interaction of intuition and experience, with the experimental model used as proving criterion. This leads often to an undesirably long development time through the repeated cycle of solutional concept – experimental model – trails – interpretation of results.

The experience of the developer – who often is under time pressure – can also, however, act as a „brake“ on the introduction of new, progressive ideas in that too many „unknowns“ lead to function risks that must be avoided. The result can be that future-oriented innovations remain undiscovered.

Aim and effects of the simulation technique

Thus there is a demand for a tool to support the constructor in the development of certain combine functions and to which the following requirements apply:

- rapid and cost-effective testing of technical solutions for achievability and fulfilment of required aims
- extending the construct's knowledge base
- visualisation of procedure progression in order to accelerate the finding of solutions through improved insights into the procedure

These are requirements to be met by the simulation technique as a development tool for the simulation of procedural-technical processes in the harvester. Simulation should be understood here as the model representation of the process in mathematical relationship, its solution and the resulting visualisation.

The effects expected through the introduction of simulation of the procedural-technical process are as follows:

- reduction of development times
- higher solutional quality through:
  - greater variance of investigated solutions
  - reduction of wrong decision risks through

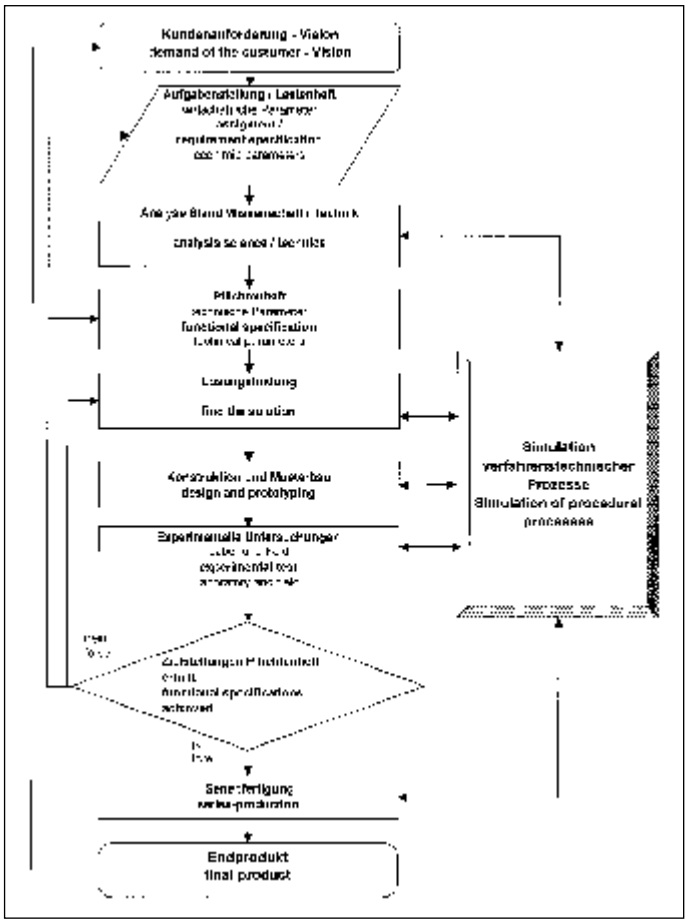

Fig. 1: Product design with simulation-technology

more comprehensive testing
- reduction of material input and production costs
- long term reducing effect on trial costs per task

Integrating the simulation technique with development

In product development the simulation technique should perform the following tasks (according to [2]):
- support in generating solutional variants (knowledge basis)
- limiting number of advanced variants
- giving more exact requirements for dimensioning and construction
- pre-optimising specification parameters (working and construction parameters)
- processing of application strategy and application values of the parameter for expanding experimental investigations
- a possible platform for the automation of the process and the entire harvester machine

In *figure 1* is shown a possible linking of the simulation procedural-technical process within production development. While the simulation technique is displayed alongside the development process this should only run „alongside" the real development in the start phase and later must be an integrated part of the product development.

Here, it can be imagined that parts of the simulation technique can already be used in the analysis of science and technology, e.g., in the form of the analysis of applied processes.

The main use of the simulation technique will certainly be in the finding of solutions (generating) and in experimental investigations the results of which produce the data for validating and defining the model used for the simulation with which in the next step improved predictions can be applied in the finding of solutions.

Requirements from the simulation technique

There's no doubt about the positive effects of the simulation of procedural-technical combine harvester processes. However, there are still a few hurdles to be crossed before the successful application of this development tool.

Thus it still requires substantial input in the development of useful tools from the scientific fundamentals. Here institutes and universities are urged to work together with industry and software producers because a very important prerequisite for the broad use of the simulation process is the availability of commercial software. Only a few industrial enterprises have shown themselves willing to take over software that has been developed at an institution. Experience shows that such „island solutions" do not keep up with the necessary development of hard- and software.

Trouble-free communication between the simulation software and the CAD software applied by the company in question is necessary for good acceptance of the simulation tool. If one requires the procedural-technical process of geometric models for the simulation, these should be available from 3D CAD or interactive work should be possible between the software tools.

Also utilising the data derived from experimental investigations should (where required via databanks) require no great effort so that the system remains practical. Communication should be designed so that it is as easy as the integration of FEM calculations in CAD software nowadays.

Finally all users and system service people have to be trained in the use of these simulation tools. After all the success of the company depends on their knowledge and readiness in this context.

Limits for simulation of procedural/technical processes

The simulation of procedural-technical processes serves to support the developer and is not to be regarded as a complete substitute for laboratory investigations and field research. Rather, it represents the link between the actual construction work and the processes taking place within the combine. The development-relevant alterations in the process should be tackled experimentally and used to define the simulation model.

The question now is how precisely a simulation model can reflect the processes, and the effort required for this? It can be absolutely reasonable to tackle only certain parts of the process with a simulation model and to cover the procedural-technical surrounds only purely experimentally. The part to be simulated must fulfil two important requirements: it must be able to be modelled by the available simulation technique in practical terms and should represent an important problem point in the development. If the process part is easily accessible for the constructive design there is no reason for a big simulation input – unless this process section is required in the simulation of a larger procedure.

Summary

Future application of simulation of procedural-technical processes within the harvester will enable an important increase in the efficiency of product development. The hardware conditions for introducing such simulations are increasingly improving. In that a simulation tool for harvesters is still far away from being as widely based as, e.g., the FEM calculations, cooperation between institutes, industry and software companies is required for its successful introduction.

Further, the simulation technique can only be as good as the data used in generating it. For this reason the simulation technique initially requires comprehensive data material as well as the suitable model. From this it follows that the success of procedural-technical simulation will follow its intensive application in enterprises.

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