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Modern CA techniques in education

The educating of engineering students with modern CA techniques represents an effective technology transfer especially for increasing the innovation capacity of small and medium sized businesses.

The professor for agricultural machinery, TU Dresden, introduced into the study „General and constructive mechanical engineering“ an obligatory tutorial subject „Designing with CAD systems“ including main points:
- presentation of complex relationships and the development tendencies,

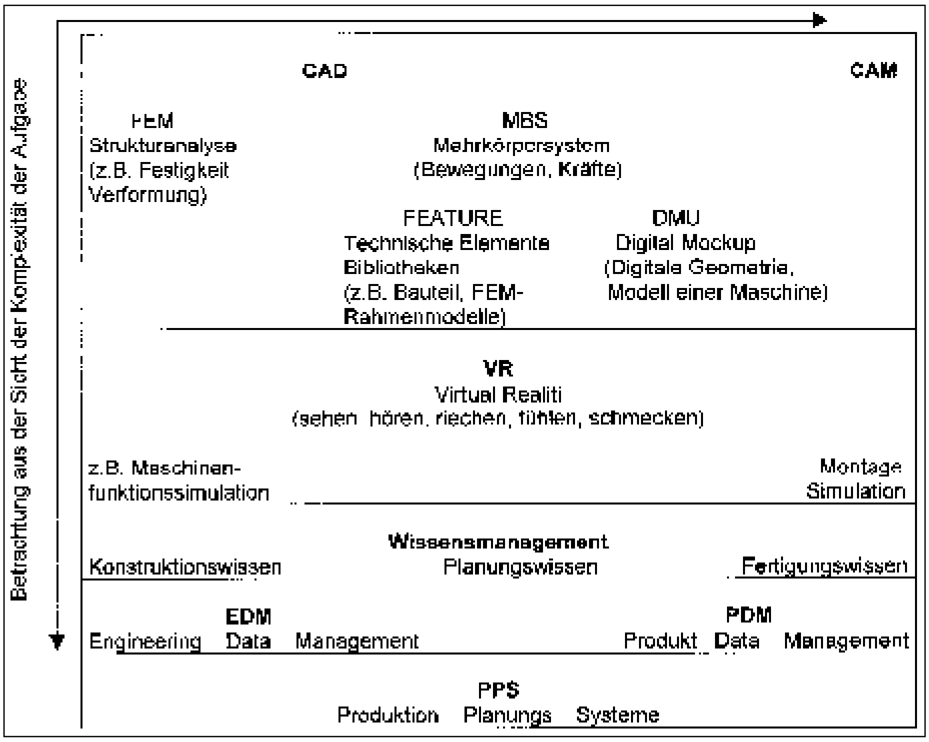

Fig.1: Classification of the CA-techniques in the product development process

- analyses for effective application of CA techniques in development processes,
- application of skills and abilities through applying CA techniques in the development processes

Educational targets and strategies were given on selected examples
- for arranging CA techniques in the product formation process
- towards construction with CA systems.

Arranging of CA techniques in the product formation process

Observations from the aspect of general applicability of the product formation process
Development target is increasing support of the total product development process through CA techniques. Main development factors are:
- increasing integration (complexity, general applicability through the process)
- increasing the degree of automation (interface-free work)
- increasing flexibility (product variants, assembly variations).

Depending on the level of development achieved, different points of view have evolved between technology leaders (methodologists, software developers, automobile and aircraft industry) and smaller and mid-sized mechanical engineering enterprises (SME) regarding the use of CA techniques in product formation processes.

Current focal points amongst the technology leaders are:
- EDM, PDM, future technology, VR, knowledge management (*fig. 1*)
- focal points of publications are the integration of all components and the identification of ways and solution possibilities towards expanding application limits.

Important questions from the point of view of the SMEs are:
- how can the border area between economical solutions and unprofitable, but possible, CA techniques be determined?
- how can changeover from 2-D to 3-D CAD be effectively realised?
- which task areas should be integrated?

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Fig. 2: Due to their better technical facilities in design, CAD systems are replacing the drawing table. CAD systems are changing now from 2D to 3D

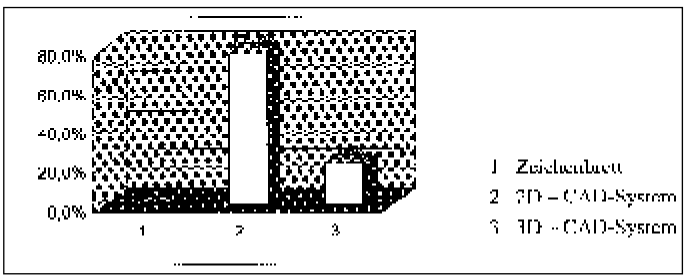

Fig. 3: Bearing case (frame) 1

Fig. 4: Bearing case (frame) 2

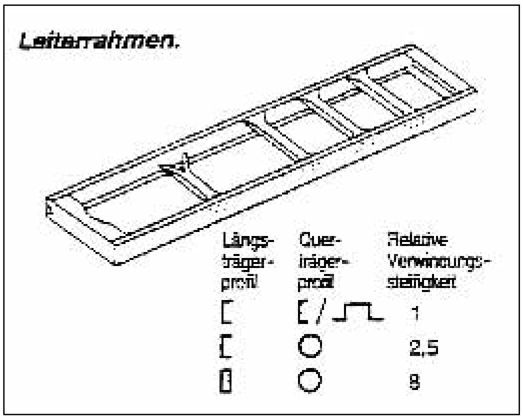

Fig. 5: Ladder frame

Trends from surveys [3]
Through new investigations in the form of surveys on trends in the CAD/CAM market, these statements taken from the questions and related experiences can be supported.

The modification of existing constructions forms the main action field of the constructor despite the increased proportion of new constructions compared with to results from earlier surveys.

The changeover from 2-D to 3-D CAD systems represents, in the medium-term, the focal point of CA-technologies (*fig. 2*).

Main usage is expected to be through variant construction (3-D parametric).

The importance of company-related and product-related own-inputs for profitable application of CA techniques is not sufficiently recognised.

Designing with CA systems – a more economic way towards simulation and virtual engineering

The core task of the constructor in training and in action is a broad variant investigation with the aim of optimising
- the principles
- the design, and
- the manufacture of a product.

For such tasks the following CA tool development level has to be aimed at (e.g. Pro/E)
- 3-D parameter technique
- integrated structural analysis (FEM), and
- integrated simulation (MBS)

The evidence of economic use through introduction of new CA-systems must be demonstrated through analyses in concrete production for concrete products and the extent of CA techniques application based on the example of actual development tasks.

With very far-reaching aims for the application of CA techniques (virtual reality), there are important surrounding problems to consider.

The realising of complex solutions requires:
- that factual knowledge as well as regular knowledge is to a great extent formalised,
- that with input parameters, target parameters and surrounding conditions with several contrary aims, a target area must be described with which demonstrably better results are achievable compared with the results to be reached through subjective comparison observations and the intuition of the constructor.

The processing of far-ranging targets (VR) leads to a better process understanding towards further formalising of regular and factual knowledge, towards better presentation and advertising possibilities, but often not to immediately provable product improvements through the relatively high input CA techniques.

Because of this, as focal point for the demonstration of new CA technique usefulness for SMEs and in construction, training tasks are to be chosen that lead to a direct acceleration of the product forming process or to immediate product improvements. This strategy creates the requirements for economic realisation of more complex aims.

Discussions on chosen examples

3-D variant construction of bearing cases
The example bearing case 1 (*fig. 3*) can be produced from the bearing case 2 (*fig. 4*)

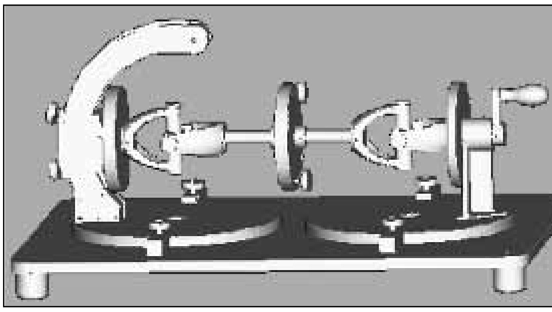

Fig. 6: Universal joint model

through parameter changes.

Input estimations: (teaching example)
Volume model basic solution 3 h
Blueprint model basic solution 3 h

Additional argument:
- 3-D volume model directly changing to technical model RPT (e.g. „steriolytographi“)
- utilisation of basic solutions (volume model, blueprint model) for further variant development.

Frame construction for agricultural implements and vehicles
Starting point for frame constructions is establishment of aims for given application conditions (loadings, e.g. distortion-stiff or distortion-soft frames required?) and knowledge of the relationships (*fig. 5*) for creation of starting solutions. The optimum solution is chosen with the help of a structure analysis (draft calculation, beam model).

Input estimations for construction:
Beam model basic solution 3 h

Additional arguments:
- usage of basic solution for further variant investigations
- development of framework libraries (knots and similar)

Universal joint model
The universal joint is used often in agricultural machinery but their application can result in unevenness in revolving movements and power transmission.

These movement relationships can be demonstrated on test beds (*fig. 7*).

Project for visualisation of Pro/Engineer data in Internet
Through a simulation (kinematic model) the same results are possible and additionally an important simulation expansion under working loads.

Input estimations for the constructor: (fig. 6, universal joint model) kinematic model after 3 h
Component group construction after 3 h
Simulation-capable component model 3 h (DMU)

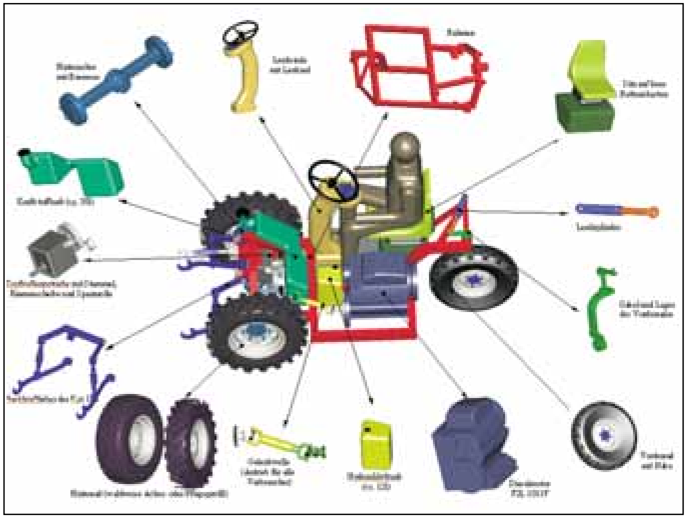

Fig. 7: Small tractor (DMU and future)

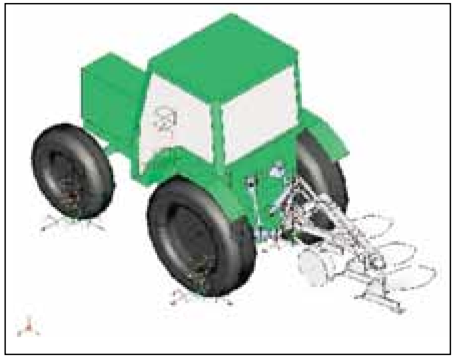

Fig. 8: Construction of simulation models (Mechanica – model for tractor implement system; tractor: John Deere 6400; implement: plough

Additional discussion:

The model is to be offered in Internet as simulation model or DMU.

Concept development for a small tractor
Project work 300 h

Aimed for partial targets:

- high manoeuvrability
- working direction can be selected between forwards and reverse drive
- broad functionality (farming and construction)

Remarks on the man model:

A simple 3-D man model for this purpose was more quickly produced than the solving of the interface problem with an older version of man model software.

Model system tractor-implement for load determination [1, 2]
The model system tractor-implement was produced for load determination under different driving conditions with consideration of steering play on cobbles (*fig. 8*).

Processing time four years (dissertation). The major input effort comprised the determination of dimensions and matching the model to the real system (model improvement). It was so shown that values measured in the calculated and the real system were largely in the same region.

So far, constructors have not used this system because no proof is yet possible that the model values are better than the estimated values for the solution of the construction task. The reason for this situation is that the input parameters (application conditions, driving surface, implement combination) vary widely.

Literature

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