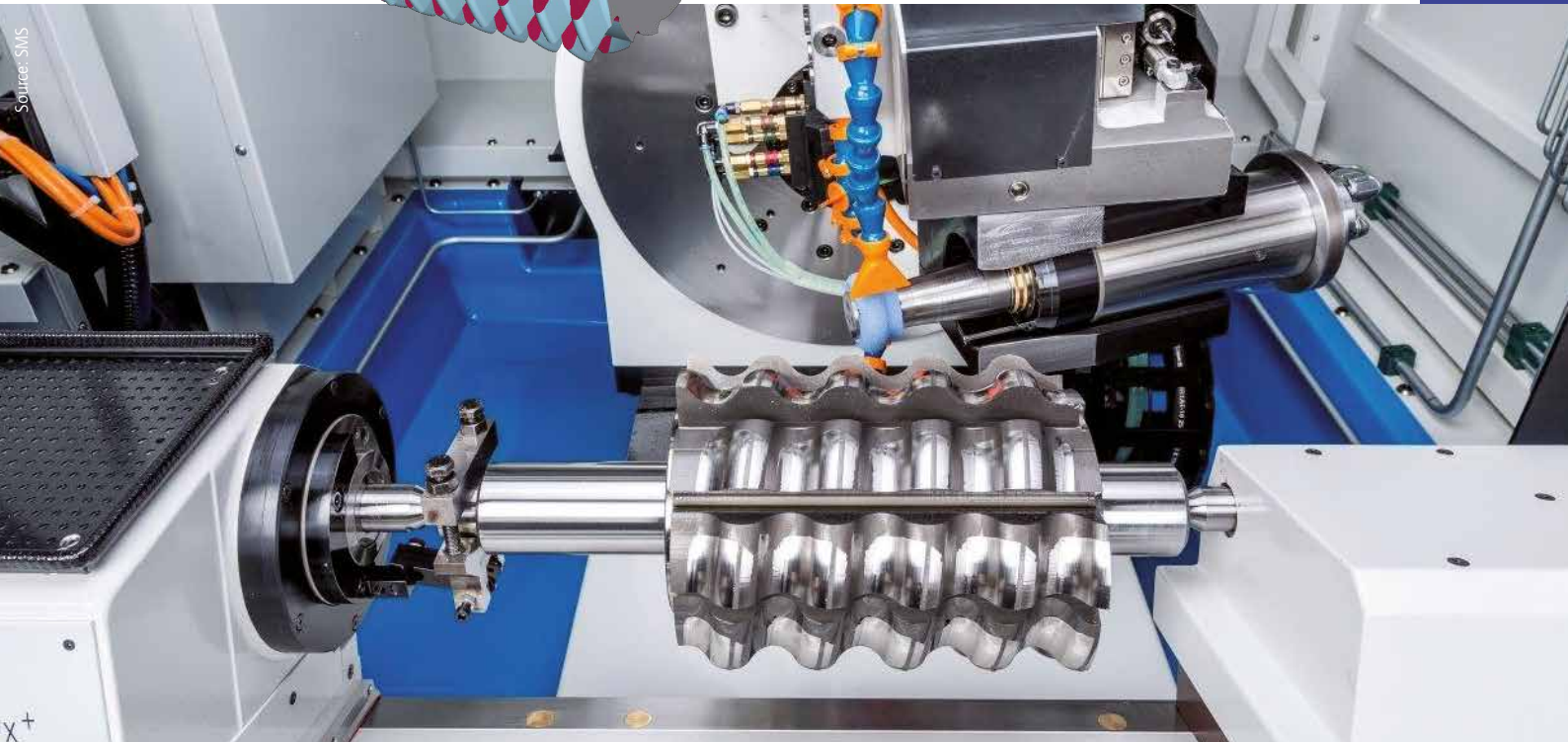
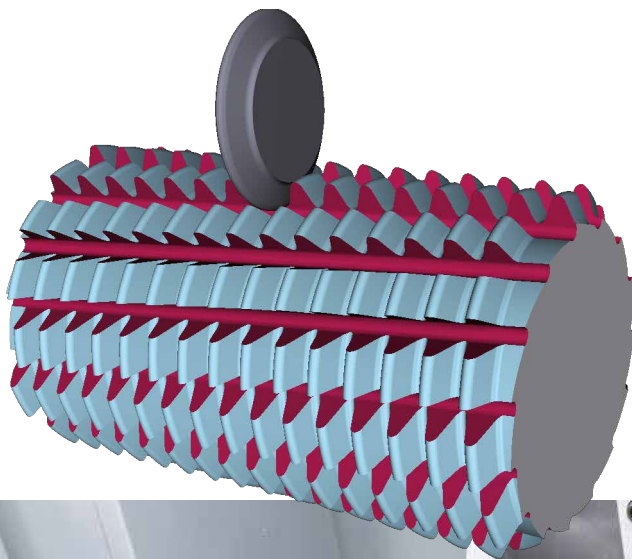


PTM – Precision Tool Manufacturing

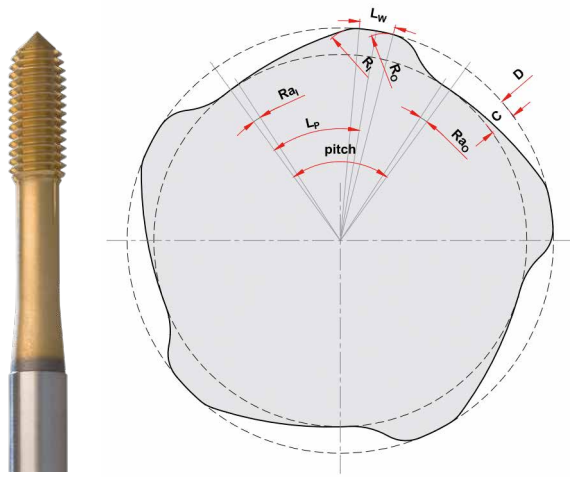


Engineering substitutes empirical methods: that's what ESCO's software-system PTM stands for. Tool development, feasibility analysis and production automation on the basis of precise mathematical representations of geometrical and kinematic parameters lead to exact, reproducible and easy-to-analyse results.

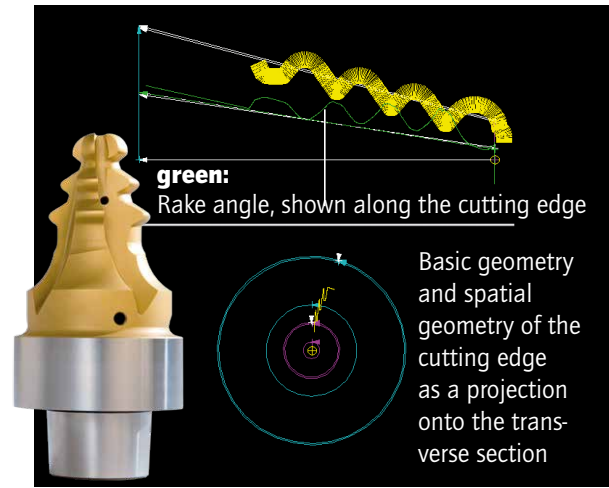
PTM, a virtual machine tool

In the process of manufacturing precision tools, involute gears, splines, serrations or complex precision parts in the field of machine tools, plant engineering and automotive industry, tool design and process engineering are challenges in terms of both technology and economy. In addition, there are high quality requirements, partly at the limit of practicability. Trial-and-error methods are inappropriate not only for economic reasons. ESCO has

the ideal response to the challenge: The PTM software, executable on a conventional PC, comes as a virtual machine tool, by means of which you can perform, in qualitative and quantitative terms, the essential development steps and feasibility analyses prior to manufacture. At the core of PTM there is a library of kinematic models, which exactly map the degrees of freedom and axis motions of the respective machining processes. Starting from the geometry of the workpiece and the basic para-



1 Parameterization of the relief curve of a forming tap



2 "Conical" profile cutter: Graphical display to review profile and rake angles

meterization of the process, PTM computes the form and/or path of the tool, immediately followed by a simulation of machining kinematics that reveals possible feasibility problems. Parameter variations allow to perform limit analyses and process optimization.

Modular design for flexibility

PTM is a strictly modular system. Following the operating sequence, workpieces and tools are selected and interlinked by manufacturing operations. The scope of a user's PTM system is defined by the range of workpieces and the machine tools on-site. PTM is capable of growing with increasing requirements concerning the range of workpieces, machine tools and/or processes – largely by adding standard modules, but also by new solutions created in ESCO's system development and/or customization for special applications.

Special solution or standard?

As a rule, a „flexible standard“ in the form of sensibly expanded part parameterization describes the majority of the variants of a part family. In PTM, a standard screw thread, for example, is generated from the basic parameterization at the touch of a button: Thread type, nominal diameter, number of threads, thread hand, pitch and tolerance field will be sufficient for an unambiguous description. Upon switching the thread type to „Special profile“ after standard parameterization, PTM enables all relevant geometry parameters for fast and straightforward "parametric redesign". A trapezoidal thread, e.g., is converted into an asymmetric self-locking thread profile. Just as easily, the process-relevant relief curve of a forming tap can be described and varied by a handful

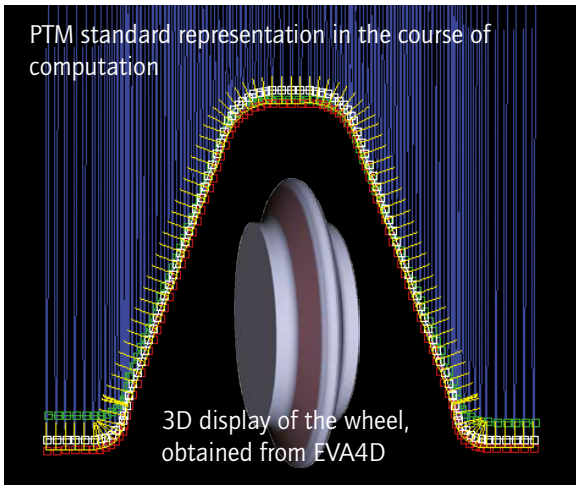
of parameters (Fig. 1). Where parameterization is not possible, the geometry to be machined can be read in via system-integrated standard interfaces to third party products. The subsequent processes of soft or hard machining of workpieces and tools can be used in any case, regardless of whether they have standard or special profiles.

Ensuring process reliability, visible and interpretable results

Process simulation in PTM can be performed bidirectionally: have a tool computed to match a workpiece, or vice versa. As a rule, the procedure for a new job is as follows:

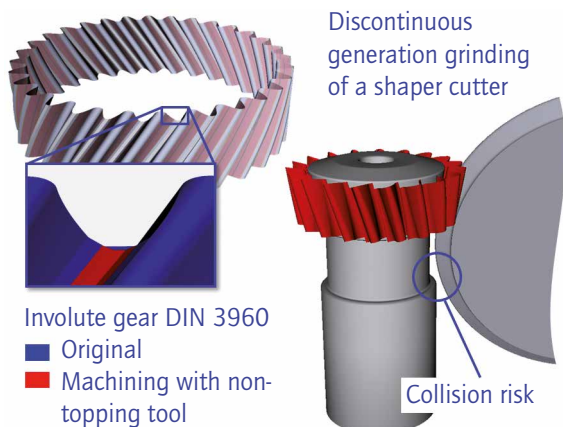
- Description of the workpiece geometry
- Simulation of the machining process to compute the matching tool and/or its path
- Using the computed tool in a machining simulation, with a feasibility analysis; if necessary, parameter variations to optimize marginal conditions
- Transfer of the data/programs to the shop floor.

In each of these steps, PTM supports the user by checking the data entered for completeness and plausibility. Computation results are displayed in graphical form, with additional information and any critical regions highlighted in colour. Fig. 2, for example, shows the rake angle curve for a conical profile cutter after the definition of profile and flute. Fig. 3 is the graphic representation of the results after the computation of a relief grinding wheel for hob manufacture. The 2D PTM standard graphics show the results with μm -accuracy. The displayed profile can be directly used for detail analysis with CAD-like means such as zoom function, coordinate display etc. The result

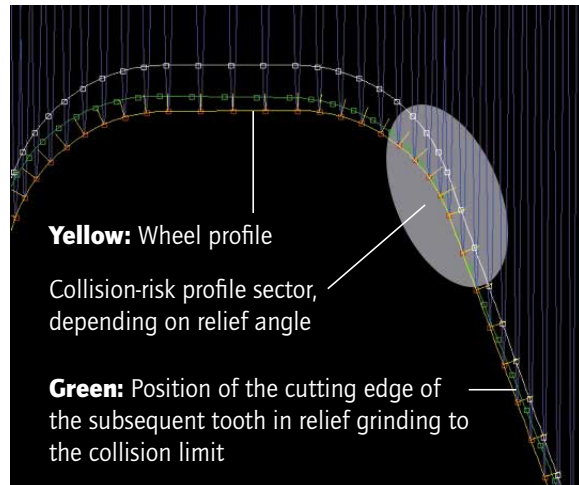


3 Relief grinding of a hob: Graphical representation after the wheel profile computation for the purpose of review and analysis

geometries and additional information, highlighted with different colours, afford users a quick analysis of substantial marginal conditions of a process, e.g. in connection with quantitative information displayed in parallel for assessing the collision behaviour (Fig. 4). If the PTM system configuration includes the EVA4D visualizing tool (ESCO Visualization Application 4D), further vivid analysis capabilities – part geometries, machining kinematics, collision problems between tool/tool socket and interfering contours/attached parts – are available also for complex parts and processes (Fig. 5). With these performance features, PTM enables feasibility analyses and the provision of reliable process data in a resource-saving way – before the actual use of material and machine tools.



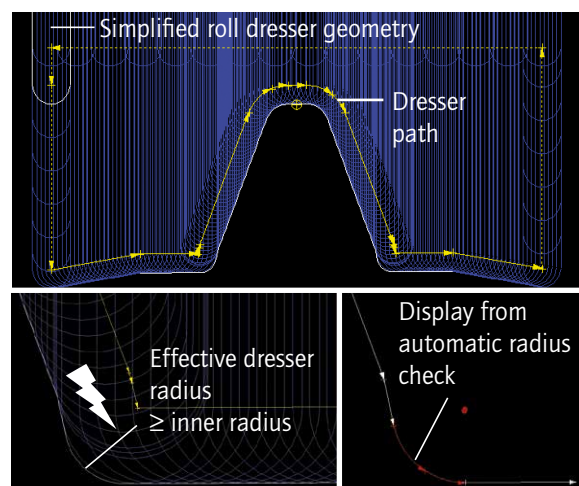
5 Visualization and analysis with EVA4D



4 Graphic analysis of collision conditions after wheel computation

From the virtual to the real machine tool

At first, all computation results obtained in PTM are neutral with regard to machine tool and control system. Linking to the usually heterogeneous machine tool park of a company is preferably effected via intelligent post-processors. The results are conventional NC programs or geometric or path data in a machine-compatible XML format. In this last preparative step before starting the real process, the focus of the software is on its ease and certainty of operation as well. Fig. 6 illustrates the graphic checking of an automatically generated NC subroutine for dressing a profile grinding wheel. Top part: The dressing cycle selected; bottom part: the result of the feasibility analysis. In this case, the effective radius of the dresser is too large.



6 Dressing simulation with feasibility analysis





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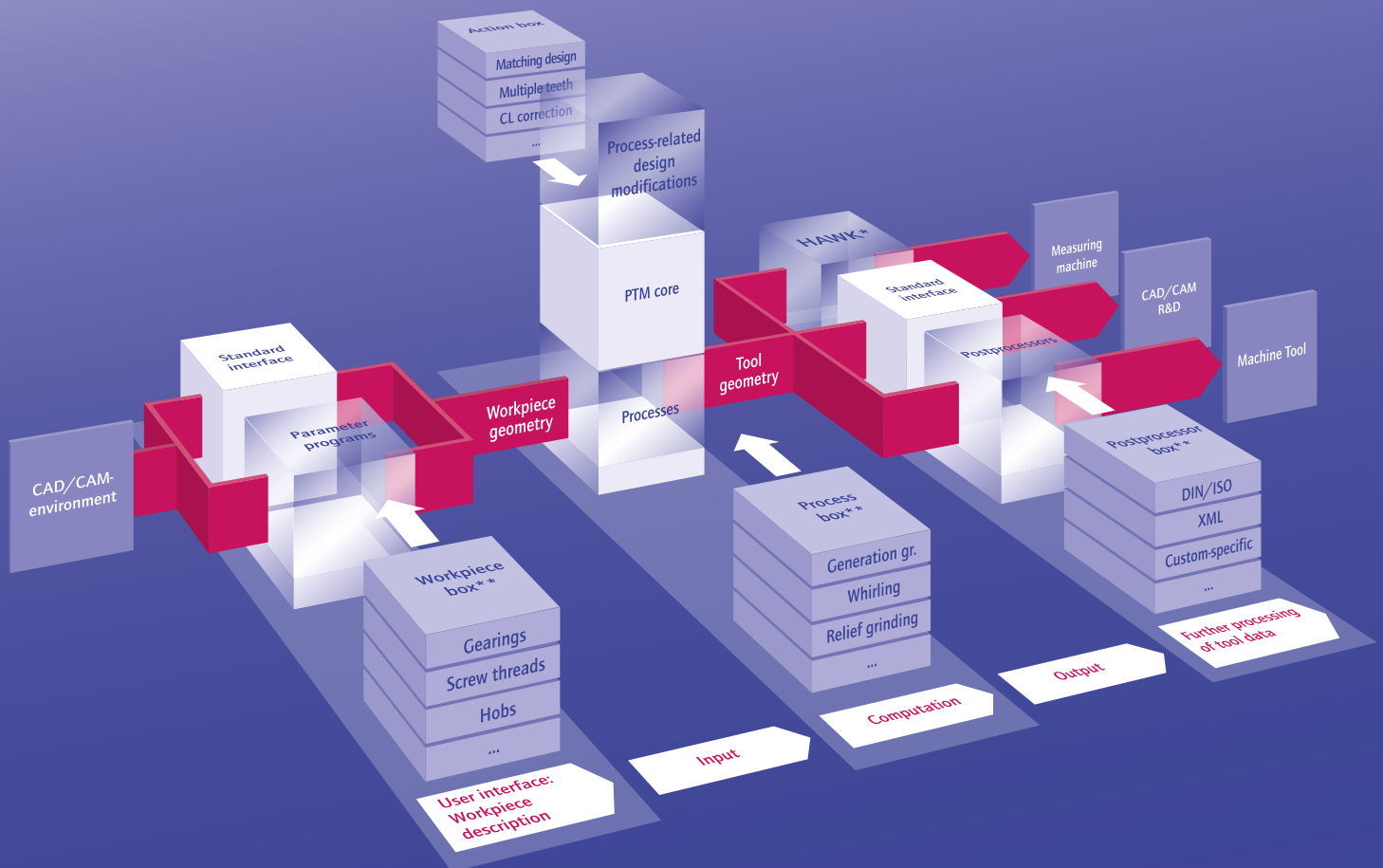
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PTM as Part of Integrated Production Processes



ESCO software products can generally be installed either self-sufficiently or as homogeneous components of an integrated manufacturing solution.

Due to the consistent data concept and internal interfaces, PTM directly communicates (optimally in a closed loop) with HAWK, ESCO's measurement and evaluation software. In tool manufacture, for example, HAWK ad-

opts the tool data created in PTM, performs the measurement and returns the deviations measured to PTM for automatic correction. For linking to company-internal IT solutions such as CAD/CAM systems or product databases, ESCO's standard XML interface is available. As an alternative or a supplement to this interface, esco will provide customized and/or application-specific solutions to integrate PTM into the company's IT environment.