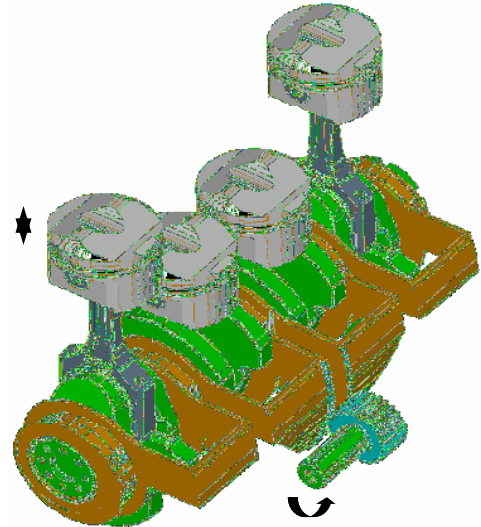


Cost Engineering / Cost Studies

Independent of targets regarding performance, emissions, fuel consumption and durability, production costs are always an important factor for a successful engine concept.

Thus, cost engineering is a very important topic during engine development projects. At FEV, a close co-operation between engine designers and production engineers from the beginning guarantees the consideration of product cost and mass production capability during the design and development work. There are different kinds of projects where the power of this alliance has successfully been applied:

- Development of new engines and new production simultaneously:
The most effective production system is proposed and worked out in detail in parallel to the engine design. The result is a highly competitive engine which fits perfectly to the chosen production system
- Development of new engines for a given production facility:
Based on the given manufacturing and assembly line an engine concept is derived that meets performance targets and clients specifications. The carry over machining and assembly steps are identified as well as required new tools and production processes. The machining, assembly and investment costs are predicted and can be compared to the costs and engine specifications of a "clean sheet" development
- Development of advanced technology:
The success of new technology (e.g. FEV's Variable Compression Ratio system) is highly dependant on a production feasible and cost effective design. Such industrialization phases comprise proposals for series production design/manufacturing and a prediction of the system production costs



FEV's Variable Compression Ratio system, proven for industrialization

A further issue for the alliance of experienced designers and experts from production and cost evaluation are cost studies on existing series production engines. The purpose of these studies is to identify design modifications which can lead to a substantial reduction in the production costs.

The scope of the assessment is the complete engine including the supplier parts, which represent a large share of the total engine costs and may feature a high cost saving potential.

In general, the spectrum of proposals includes simple detail changes, as well as comprehensive modifications in the engine concept. Based on experience with similar projects, up to 100 modifications are proposed which finally lead to a cost reduction convertible into production of 2 % to 5 %.

Typically, these studies comprise the following steps:

- Based on the engines and the related production drawings design modifications are collected aiming at a distinct cost reduction due to simplification
- Subsequently, these recommendations are worked out in more detail and evaluated with regard to:
 - influences on engine properties
 - influences on machining and assembly processes and the resulting cost reduc-

tion potential (classified in groups, e.g.: < 1 EURO, < 3 EURO, < 6 EURO, > 6 EURO)

- expenditure for the adaptation of the existing design
- With this preliminary collection of ideas, the engine production lines (machining and assembly) are visited to understand the manufacturing concept for a better evaluation of the feasibility of the proposed measures, and for deriving further cost reduction proposals.
- On basis of the specified measures worked out, a workshop with the client is conducted where experts from production, purchase, design and testing take part. During this workshop, all proposals for improvement are discussed and commonly reviewed with regard to client's specific boundaries concerning production, company philosophy, etc. In addition, all proposals are evaluated with respect to:
 - measures already applied or agreements on implementation already given
 - measures immediately realizable
 - measures to be followed by more detailed investigation
 - modification effort
 - acceptance due to company philosophy

Based on the knowledge gained during the workshop, the following analysis for understanding a cost reduction is typically recommended:

- Additional discussions with suppliers or a visit of their production lines if supplier parts turn out to have a promising high cost reduction potential
- Detailed investigations of economically and strategically interesting modification proposals. This includes:
 - more detailed design
 - determination of the influence on engine-specific properties based on FEV's comprehensive engine data base
 - calculation of cost reduction based on the more precise information of design and production boundaries.

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