Volume 2

Rudolf Och

SPLINES
LOCATION OF SPLINE AXIS

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The Author

Graduate Engineer (Dipl. Ing., FH) Rudolf Och was born in Bamberg, Germany in 1951. After graduating in mechanical engineering he founded FRENCO GmbH in Nuremberg, Germany in 1978. In the beginning, the company only engaged in the development and manufacture of spline gauges. Over the years, however, the business was extended to include the full spectrum of gear and spline metrology. This development is supported by numerous inventions.

The author was a member of the American Standards Institute for Splines ANSI and has been Chairman of the German standards committee AA 2.1 since 1993. During the chairmanship, the German term for spline (Passverzahnung) was officially introduced and all relevant German standards were revised. The international standard ISO 4156 was also completely revised under German leadership by the responsible standards committee ISO/TC 14.

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Splines

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Position of the Spline Axis

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1. Preface

Splines are a difficult technical ‘marginal area’ within drive technology. They are neither addressed during vocational training nor in degree courses. Experts in the matter are accordingly few and far between. This book describes and explains the position of the spline axis. Both, methods to determine the axis as well as different views and their consequences are outlined. Various clamping methods are also addressed. Even though this difficult subject is supported by many pictures, it remains a difficult subject.

This book is a compilation of individual documentations, which were compiled over a period of 30 years from the author’s experiences. It was revised as a whole before print and reflects the status quo of standardisation.

No responsibility is accepted for the accuracy of the information in this book. It must be noted, however, that technical developments are a continuous process and knowledge, standards and rules are subject to constant changes.

June 2008, Rudolf Och

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2. Positional Tolerances (formerly OFD 01)

Positional tolerances of splines are similar to positional tolerances of diameters. In addition to diameters, splines also have teeth along their circumference which complicates their handling considerably. Positional tolerances on diameters are not easy to deal with; positional tolerances on splines are difficult to deal with.

The minor or major diameters of splines are not usually subject to tolerances, but instead the tooth flanks or alternatively the pitch circle diameter are. Relevant standards do not provide any guidelines for the tolerancing and the subsequent inspection of tolerances which leads to a great deal of uncertainty. This book tries to explain the resulting problems and proposes methods as to how they may be solved. A number of standards outline positional tolerances. Splines are treated similarly to diameters, which works in some cases but does not work in others. A basic knowledge of positional tolerances and standardisation is a prerequisite for anyone dealing with the issues concerning splines.

Standards for positional tolerances:

DIN 7150	Inspection of plain workpieces – Elements with cylindrical and parallel measuring surfaces (= ISO R 1938)
DIN 7162	Dimensional and geometrical tolerances; envelope requirement
DIN 7182	Dimensions, deviations, tolerances and fits - Basic concepts
ISO 128	Technical drawings, general principles of presentation
ISO 1101	Technical drawings, geometrical tolerances
ISO 1660	Technical drawings, dimensions and tolerances of profiles
ISO 2692	Technical drawings, geometrical tolerancing, maximum material requirement
ISO 5459	Technical drawings, geometrical tolerancing, datums and datum-systems
ISO 7083	Technical drawings, symbols for geometrical tolerancing
ISO 8015	Technical drawings, fundamental tolerancing principle

2.1. The Reference Basis Circle and Cylinder

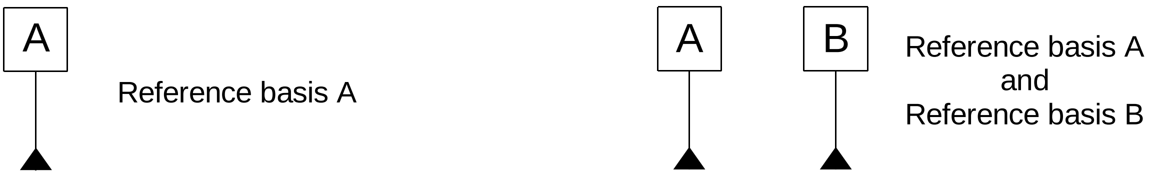

Fig 1: Reference basis

The reference basis is usually a diameter A and B. The position of the spline is then toleranced to these diameters. In the case of internal splines, however, the teeth are often specified as reference basis. The reference sign is then usually drawn at the pitch circle. The reference basis is of fundamental importance for all quality inspections. Every inspection must metrologically originate from the reference basis. The mechanical or arithmetic alignment, relative to the reference basis, must be specified on the inspection plan.
When considering this issue it is important to closely examine all possible relations using the example of the diameter.

2.1.1. Circle (in one plane)

A circle is the theoretical simplification of a shaft or bore, viewed in a certain measuring plane. In practice there are no error-free circles; such circles only exist in theory or in mathematics. Metrology only deals with circles that are subject to errors - in the form of manufactured items to be inspected. Different methods can be used to determine the position of circles with and without errors. Error-free circles can be identified clearly and without any discrepancies using any method. Different measuring methods used on circles with errors will inevitably lead to different measuring results.

(Black centre lines to aid orientation)

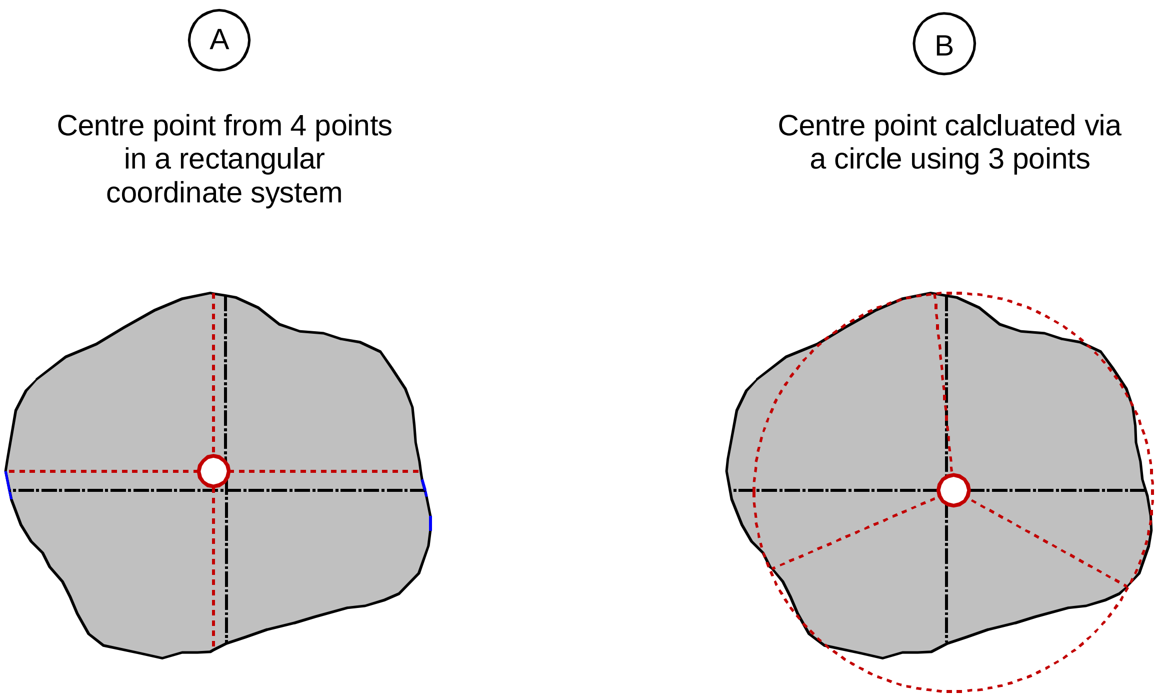

Fig 2: Circle in one plane