From the Workbench

The Watch Movement

Part 1

Venturing inside the engine house, QP investigates the foundations of movement architecture

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A watch's movement is its heart and soul, as well as being the focal point of the watchmaker's art, skill and ability. For that reason, *QP* is tightening the focus, as we unravel the complex inner-workings of the movement. Our starting point is the "birth" of a new watch movement and the manufacturing of the most basic component: the baseplate or *platine*.

The back of Officine Panerai's Luminor, demonstrating a movement with a highly personalised finish.

Watches and cathedrals used to share one similarity in their conception and construction: both were normally drawn out full size by the watchmaker and architect, the first on paper, the latter upon the ground itself. True, the watchmaker did not have to move stones weighing several tons, but he did have the additional burden of the accurate turning and engagement of gears to contend with, often on several levels and within a miniscule area. Once drawn out, these paper gears would be cut out as well, and provided with pins to function as axles so that they could be turned and engaged just like a functional watch in order to check if all calculations and ratios were correct before the time-consuming work of actual construction began. If all was well, the next step entailed the transfer of this information to the actual metal in order to insure the accurate location for drilling, cutting and the forming of all the necessary parts. Unbelievable as it may sound, this technique was used by several watch manufacturers right up until the first quarter of the 20th century, and it gives a quite literal meaning to the term "hands-on development" in the context of complicated timepieces from the "Great Houses" of previous centuries!

Modern design

Today, however, to the exclusion of only a mere handful of artisans, the computer reigns supreme, and no watch factory worth its salt could survive without at least one of a number of CAD-type programmes specifically designed for watch construction.

It all starts with an idea – which could originate from the sales department, an inventor or even the president of the company – such as the creation of a man's watch with a special date window and moon phase, or a new type of chronograph. The sky is the limit. The final size of the watch, a most important aspect of the design, is also defined right from the outset. It is then up to the engineers to complete the given task and make everything work perfectly within these constraints.

The first step is to create a three-dimensional model on the computer. The software can then model the entire workings of the movement, allowing engineers to add or remove gears or whole complications, test the amount of play between the parts, adjust them and even make prognoses about the final accuracy of the actual movement under normal conditions, all with a keyboard and the click of a mouse. But do not be fooled into thinking that human skill has been eliminated; quite the contrary is true. Computers are only dumb machines, and the success of the design is all down to the designer and engineers' ability to work, think and conceptualize in three dimensions. The engineers must still first have the ideas in their heads before the software can be set up to provide visualization. It goes without saying that this method of designing means new developments can be achieved in a mere fraction of the time it took only 25 years ago. These developments have enabled the industry as a whole to bounce back from what seemed to be terminal decline. The radical changes that have occurred over the last quarter-century due to factors such as labour cost and consumer expectation have made CAD the only viable way forward for watchmaking. The electronic technology that nearly killed mechanical horology turned out to be its saviour.

The baseplate

The real beauty and technical prowess of this computer-generated assistance is best appreciated at the moment when the actual production phase of the watch begins. All the data compiled from the definitive design contain localized 3D information about every single gear, hole and

This is a drawing of the baseplate with all the layers above it removed. The red dots show where jewels are to be inserted later. Every hole, countersink and opening is recorded electronically in three dimensions and to fractions of a millimetre, ready to be sent to the cutting/drilling machines. This is the foundation of the watch's movement and requires the highest accuracy. An error of even a hundredth of a millimetre on the baseplate can, in extreme cases, lead to a failure of the whole movement.

Here we see a prototype baseplate for the Sonata from the movement side (back) of the watch. This particular movement requires a highly complex baseplate, which is correspondingly complicated to produce. Around the outer edge we can see typical perlage finishing. This is done by hand using a small bit made of hard rubber, much like a pencil eraser, which as it turns gently "rubs" the circles into the metal. It takes a great deal of training to achieve the required placement and regularity of these little perlage circles.

(Above) The dial side of the baseplate, finished with Geneva stripes.

(Right) Without expensive and highly specialized machines like this, many beautiful timepieces would never have made it from the drawing board to the wrist. In this machine, the drilling takes place in the enclosed cabinet under a stream of oil to provide cooling. Some of these machines are even able to check the drill-bits' diameter with lasers in order to insure that they are regularly replaced when worn down.

space for axles, screws, bridges, barrels and the hundreds of other parts with an accuracy comprising fractional parts of a millimetre. This information is then sent in the blink of an eye to special computer-controlled cutting machines, which are usually, but not always, located in the same building. The machines are tooled with the required sizes of drills and cutters accordingly, and work begins. One of the first parts to be manufactured is the baseplate of the movement. Round metal blanks with the diameter of the particular movement are fed into these machines, which are able to accurately and quickly cut, drill and thread hundreds of areas on this tiny surface with high speed and pinpoint accuracy using the design information.

The movement baseplate serves as a kind of blueprint for what is to come, since parts can of course only go into the movement where space and openings have been created. Visually unassuming, it is literally the foundation onto which the gears, bridges and all other parts will slowly be built during the next few months. Hold it in your hand and you would not give it a second thought: a little roundel of metal, roughly the size and thickness of a 10-pence piece, drilled through with dozens of holes like a miniature Swiss cheese for a doll's house. But look closer and you will see a highly complex 3D object. Every single hole has highly exacting dimensions corresponding to a particular purpose and function. A number will later be filled with jewels that protect the ends of pivots to which the gears are attached, containing tiny droplets of oil for smooth functioning. Others may hold screws. Larger holes cleared from the plate will house the mainspring barrel and gears for the winding mechanism. A watchmaker looking at such a baseplate will undoubtedly be able to tell you a lot about the watch without even seeing an actual gear or spring.

To top this off, a high-grade *platine* will be finished by being deburred by hand to ensure no miniscule bits of metal remain behind in the tiny holes, and the whole will be finished with so-called *perlage*, *côtes de Genève* or any of several other visual finishes, even in those places that no one will be able to see again. And this is just the start… O

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