Kintaro Hattori in 1881 founded the company that was to become Seiko.

A JOURNEY IN TIME. THE REMARKABLE STORY OF SEIKO

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A Journey in Time. The Remarkable Story of Seiko was written at the instigation of Seiko Watch Corporation to fill a void in the English language literature about the past, present and future of the company. The author, John Goodall, is a journalist who has spent most of his working life writing about watches and the watch market – for nearly 20 years as the editor of the leading British trade newspaper, which was then called *Retail Jeweller*, and subsequently as the editor of a watch magazine for enthusiasts. For the last 10 years, he has been a freelance journalist writing about watches for high quality magazines and national newspapers. His articles have been published in the USA, Italy, Germany, France, the UK and Japan.

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Humble Beginnings Create a Sound Foundation

Few people in the Western world today are aware of Japan's rich heritage of watch and clock making, and yet the remarkable success of the Japanese horological industry in the last 50 years is a continuation of Japan's fascination with time down the ages. At the heart of the major modern success story lies Seiko, a brand that owes so much to three generations of just one family – Hattori.

The innovative spirit that has led them to achieve so many world firsts with their timepieces, and to build one of the world's most important watch businesses, is an apt tribute to earlier generations of Japanese horologists.

Japan's first timepieces owed much to the ingenuity of Chinese inventors. Water clocks were one of the first forms of timekeeping and were in use in China in the first millennium AD. In Japan, the arrival of Buddhism in the mid 500s and the concurrent decline of the Yamoto Court set the scene for the introduction to Japan of the technology to produce water clocks. The Japanese government remodelled itself on the principles of the T'and Dynasty, introduced by Confucius, and by AD 671 Emperor Tenchi had created the first water clock in Japan.

In China, the scholar Sung made a pioneering breakthrough when he completed the "Cosmic Engine" around 1090. It is believed by some scholars to be the first clock in recorded history to have been regulated by an escapement.

After this great leap forward it seems that the art of complex mechanical clockmaking was lost in East Asia until mechanical timepieces were eventually imported from Europe.

Before Japan adopted the Western time system, special clocks displayed the time according to the lunar system that was in use for several hundred years. Many, like this example in the Seiko Institute of Horology, had two verge and foliot mechanisms, instead of the single escapement used in the West.

In the late 1100s, the Edo family of the Taira clan established a fishing village which has evolved into the vast metropolis called Tokyo, with a population today of around 12 million – and 30 million within a radius of 30 miles. Around 150 years after the village was established the first weight driven clocks were created in Europe, large iron structures that were only accurate enough to justify an hour hand – but they marked the start of timekeeping as we know it today.

In Nüremburg the spring was added to mechanical clocks in the early 1400s, making possible the production of table clocks. As manufacturing techniques advanced, it became possible to make small components with some degree of precision and pocket watches became a reality for the first time.

From 1500, Germany and England were the world's main centres of watchmaking, and during the next 100 years France also developed a watchmaking industry. In the middle of the 16th century watchmaking started in Geneva after reforms introduced by

A wall clock displaying time according to the lunar system that was used in Japan before 1872.

Jean Calvin banned the wearing of jewellery and forced goldsmiths, jewellers and some other craftsmen to turn to the new craft of watchmaking. (At that time all watches were pocket watches – wristwatches were not made on a commercial scale until engineering advances made it possible to produce small enough components accurately.)

While these developments were taking place in Europe, Japan suffered from the feudal rule of the Samurai from the 1100s to the 1300s, and this was followed by two centuries of incessant warfare perpetuated by the Daimyo, or Samurai, lords. During these turbulent times there was little technological progress in Japan, although many classical Japanese traditions started in this period, among them the tea ceremony and sumi-e painting.

A Jesuit missionary, Francisco de Xavier, "discovered" Japan in 1549 and in 1551 he gave the first mechanical clock in Japan to Yoshitaka Ouchi, one of these Daimyos. It was Hideyoshi Toyotomi (1536-1598) who restored peace to the nation. In his lifetime he was considered one of the greatest of the Japanese, and he was made a Shinto deity shortly after his death. Soon after Francisco de Xavier introduced the first mechanical clock to Japan, a Japanese Christian mission that visited the Pope in Rome returned home with a clock for Hideyoshi Toyotomi. Other mechanical clocks soon followed.

Around 1600 a combination educational-vocational school was set up by Christian missionaries in Nagasaki Prefecture. It taught students how to make clocks, organs and astronomical equipment. This was almost 100 years before Daniel Jean Richard established watchmaking in Le Locle, in Switzerland.

By 1617, after the unification of Japan's warring states, there was a crackdown on Christian missionaries. By 1635, Japan began to close its doors to foreign influences and Japanese natives were forbidden to travel overseas. Most foreign trade ceased by 1639.

As the country became more isolated and imports came to an end, clockmaking thrived in Japan for the next 300 years. The castle town of Edo became the centre of the country's clockmaking industry and its masters, such as Sukezaemon Tsuda, developed wadokei timepieces that were unlike any the rest of the world had ever used. These clockmakers were employed directly by the Shogunate during the Edo Era (1603-1868).

The Edo Era

Wadokei were extremely complex because of the nature of the Japanese system of time, which used the lunar calendar. For timekeeping purposes, each day was divided into day and night, dictated by sunrise and sunset, and each of these two periods was further divided into six periods. Because the length of day and night varied throughout the year, so did the length of each of these periods, except at the equinoxes. Wadokei were complicated enough to be able to allow for these daily variations – and later versions even included carillons and alarms. To cope with the different lengths of day and night, each clock had not one, but two verge and foliot escapements, one for the day period, the other for the night – a complication that was unnecessary for clockmakers in any other part of the world.

Among the Japanese clocks produced during the Edo Era were yagura-dokei, clocks on high stands to accommodate the weights that powered them; shaku-dokei, wall mounted clocks with calibrations below, the time read from the position of the weights; and makura-dokei, spring-driven clocks that could be placed on shelves or cabinets. Yagura-dokei, in particular, reached very high levels of sophistica-

tion, with complex multiple functions including chimes, alarms and calendars.

The wadokei clock industry developed throughout the Edo period, but was suddenly rendered obsolete in 1872, when the Meiji Cabinet adopted the solar calendar in place of the lunar system that had been in use during the Edo Era. As a result, December 3, 1872 became January 1, 1873 and the old Japanese time system came to an end. The wadokei clocks made by Japanese clockmakers were no longer of any use as timepieces and nobody in Japan had experience of making clocks that could be used for the new time system. Japan had to enter a new era of timekeeping. At first, clocks were imported from the West, especially America and Europe. Soon, technology introduced from the West helped with the creation of Japan's new horological industry as the country began to come to terms with the solar calendar it had recently adopted. The new industry started in Tokyo in 1875 with the manufacture of bonbon-dokei – wall clocks.

Kintaro Hattori, who started a clock repair service in 1877 at his home in the Ginza area, laid the foundations of modern clock and watch making in Japan. This was the 10th year of the Meiji Era and marked the humble start of the career of the man who was to become known as Japan's "King of Timepieces". In 1881, at the age of only 22, he formally founded K Hattori, which was set up for the repair and sale of second-hand clocks. His company soon developed to become an important clock wholesaler.

The main entrance to the Seikosha factory in 1897.

This hand coloured poster in the Horological Institute in Tokyo shows the Seikosha factory and some of its earliest products.

In 1892 Kintaro Hattori bought a disused factory in Tokyo and Seikosha was formed (In Japanese, "Seiko" means "exquisite", "minute" or "success" and "sha" means house). It was here that Kintaro Hattori produced his first clocks and these marked the beginnings of a company that was to become one of the world's most important manufacturers of timepieces. They started by making wall clocks and later graduated to pocket watches, alarm clocks and wrist watches. During the first part of the Showa Era (1927-1934) the company's pocket watches were given the brand name Seikosha, while the wristwatches were called Seiko.

It was the far-sighted genius of Kintaro Hattori that laid the foundations of the present Seiko Corporation. Since his death in 1934 his descendants have demonstrated skills of imagination, innovation and business acumen that have enabled the company now known as Seiko to become the world's largest watch producer.

Foresight

In the 1960s, Seiko demonstrated that their mechanical watches were a match for some of Switzerland's best at independent trials conducted in Switzerland. It was Chairman Shoji Hattori who had the foresight to recognise the importance of success in these competitions when he gave his technicians the order "Do it". Their

success in the competition gave a great boost to the reputation of Seiko's mechanical watches.

In the 1970s, demand for mechanical watches dwindled as quartz watches began to dominate the market and Seiko eventually reduced dramatically production.

However, by the 1980s Japan's watch enthusiasts rediscovered the collectable qualities of fine mechanical watches; the Seiko chronometer was reborn in 1998. Today there is a healthy demand for Seiko's high grade mechanical watches in Japan, but so far they have not been sold outside the domestic market.

Since 1998 the production of fine mechanical timepieces has been taken very seriously within Seiko and the company believes, with every justification, that once again the best of its products are fit to rival some of the best Swiss timepieces.

It was also Shoji Hattori who issued a decree that led to the most important coup in the company's remarkable history. In the 1960s, Japanese and Swiss technicians were racing against each other to produce the first commercial quartz watches. CEH, the Swiss research centre, and Seiko's research and development department, were working flat out to overcome enormous problems and produce the first commercially viable quartz wristwatches.

One year deadline

Seiko technicians were finding it difficult to overcome the final hurdles when Shoji Hattori, President of Hattori Seiko, ran out of patience and gave the order that there was to be a marketable product within one year. In response to his edict, the company's full resources were applied to the problem and Seiko succeeded, on December 25, 1969, in marketing the world's first quartz wristwatch. This gave them an enormous commercial advantage over the Swiss. The first Seiko quartz watches cost as much as a Toyota car.

The office building of Seikosha in 1909.

Seiko's watch exports in 1965 were only 1.6 million pieces. This rocketed to 4.9 million in 1969 and by 1977 had reached the impressive total of 11.8 million. By 2001, Seiko produced around 21 million watches.

Historically, the watch industries in Japan and Switzerland developed with different structures and this ultimately accounted for Seiko's remarkable success when the world turned to quartz timekeeping.

Switzerland's watch industry had developed as a giant cottage industry, with thousands of companies specialising in the production of particular components.

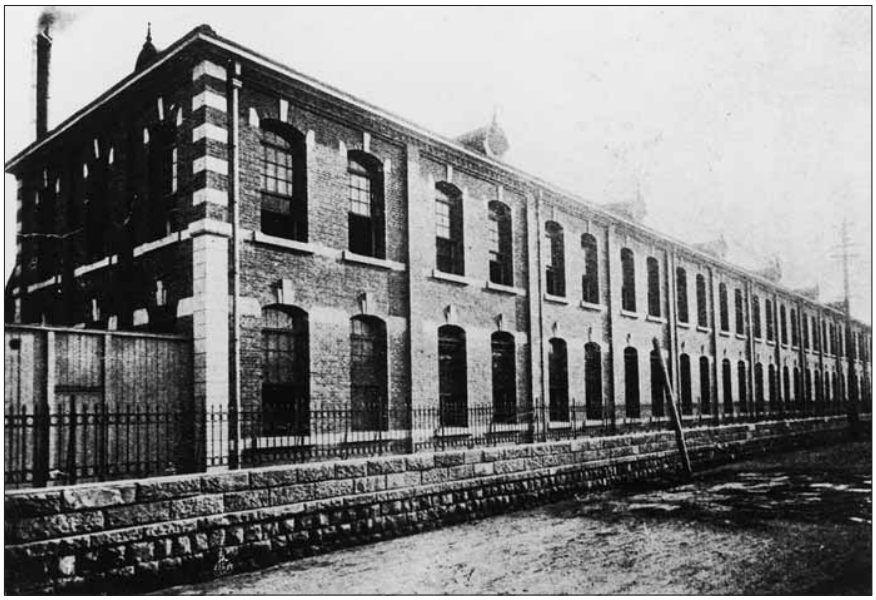
As quartz technology first emerged, Seiko was faced with an important decision. Reijiro Hattori, Honorary Chairman of the Seiko Group, explains "We had been talking about where to buy the steel for our balance springs and then to build a factory ourselves to manufacture them. When we came into the quartz age we were talking about what to do in terms of semiconductor factories, and about the fact that it wasn't enough just to make semiconductors, why not build quartz oscillators and liquid crystal displays, too?"

Seiko produced – and still produces – most of the components for its watches, including movements, cases and dials, in companies within the group. At a time when Swiss production was often held up by a shortage of components from various independent companies, Seiko had far greater con-

trol over production because almost every part was made in-house.

Its integrated approach also facilitated the development of highly automated production and assembly lines which could operate unmanned for 24 hours a day.

As production of quartz watches expanded rapidly to cater for enormous worldwide demand, Japanese makers soon became dominant – and much of their success was the result of the integrated approach to watchmaking that had been instigated by Kintaro Hattori at the beginning of the 20th century.



This view of part of the Seikosha plant in 1909 shows how much the company had expanded in a few short years.

Investing in R & D

Despite its enormous success with quartz watches, Seiko continued to invest in research and development and much of its work was devoted to the development of the next generation of timekeeping, an automatic generating system that required no battery change. By 1973 it applied for its first patent for this new technology, but it was not until 1988 that the world's first automatic generating quartz watch was launched.

Quartz movements represented a revolution in accuracy; digital quartz watches marked a revolution in display technology, and the automatic generating system, which Seiko eventually named Kinetic, was a revolution in energy sources for timekeeping. This enormous step forward marked the beginning of Seiko's new era of social responsibility, creating products that are friendly to the world we live in. This new attitude is not restricted to the manufacture of environmentally friendly products: it also extends to the company's factories and offices and the company won awards for its continuing efforts to reduce energy consumption and environmental pollution in its factories.

Quartz technology led directly to another development of enormous significance for Seiko. In 1964, Seiko served as the official timekeeper for the Tokyo Olympic Games and it revolutionised sports timekeeping by becoming the first company ever to use a quartz clock to time a major sports event. Ever since that time Seiko has played a major role in sports timing the world over and its expertise and proficiency have helped to enhance the company's reputation for reliability and accuracy.

After 1972, Seiko has been one of only two companies that have timed multi-discipline major international sports events. Despite the enormous investment in technology and manpower that is necessary to undertake the timing of these events, Seiko receives no payment for this activity in most cases. This is another example of the company making a conscious effort to put something back into society and make the world a better place to live in.

As part of the package of new technology developed by Seiko to time the Tokyo Olympic Games, the group developed printers to print out the results from its timekeeping equipment. This eventually led to the development of the company that is now well known all over the world for the excellence of its printers and other imaging products, Epson. The name Epson was derived from "Son of EP" – Electric Printer.

Seiko's success in the last 30 years has not only relied on technical innovation and business acumen: the company has also devoted considerable attention to the importance of design. Its designers have won two Diamonds

International Awards, the coveted international awards that mark the pinnacle of jewellery design. Seiko has large teams of designers in several parts of the world and also collaborates with some of the world's most successful industrial designers.

When Kintaro Hattori opened his first wall clock factory in 1892, his 15 staff manufactured 70 clocks in the first six months. By 1897 his company, Seikosha, had become the largest wall clock manufacturer in Japan. In the second half of the 20th century Seiko reached and stayed at the forefront of watch manufacturing by pioneering new technology and developing new production techniques.

Seiko's ground-breaking sales of the world's first quartz watches and its introduction of Kinetic technology played a key role in Seiko's acceptance as a major player on the world stage. At the beginning of the 21st century, the shape of the world market began to change very quickly. Massive production of cheap watches in China and South East Asia had a strong impact on traditional watch companies. The Seiko Corporation responded by restructuring the watch division and creating a new vision of the future as a first step towards meeting this enormous challenge.

In 1881, Kintaro Hattori's vision made possible future success. Today, the company's vision is summed up by its burning quest for innovation and refinement. With substantial ongoing investment in research and development, as well as design, marketing and advertising, it looks set to maintain its dominant position in the global watch market far into the 21st century.

Innovation and Refinement

As the 21st century dawned, the world's watch markets were being transformed by powerful new forces that asked questions of every major company in the industry. In response, the Seiko Corporation made an important change to its structure designed to enable the watch division to achieve its full potential and to take advantage of these changes – it established Seiko Watch Corporation.

The history of Seiko is the history of a family-owned business involving three generations of the Hattori family, under whose guidance the company has prospered for more than 120 years. Under the present Honorary Chairman, Reijiro Hattori, the grandson of the founder, Kintaro Hattori, the company has recently studied how best it can respond to the challenge of the 21st century with a new vision, philosophy and structure. The first era of Seiko embraced the pioneering days, the creation of new factories and the manufacture of various types of timepieces for the first time in Japan. The second era started in the second half of the 20th century when the company began to open important export markets. The third era began with an explosion in sales and production after the company's historic launch of the world's first quartz watches in 1969. The fourth era saw the company expand its brand portfolio, create a global network of support companies and assume global leadership in watchmaking technologies. Today, another new era beckons.

By the 1950s and 1960s the Swiss had seemed to be in a position that was unassailable, but that proved to be no obstacle to Seiko's enthusiastic watchmakers, technicians, designers and sales staff. In the 1960s they had already started to export mechanical watches with some success and then they astonished the watch world by achieving great success in independent watch trials held in Switzerland.

Tsutomu Mitome, first President of Seiko Watch Corporation, which was established in 2001

When Seiko led the world in the introduction of quartz watches in 1969 and pioneered true mass production and automation in the 1970s, they had an enormous advantage over their Swiss rivals. Ever since the early days of clock production – and after visits to the USA at the end of the 19th and the beginning of the 20th century – Kintaro Hattori and his successors had believed in and invested in vertical integration. By the end of the 1960s, Seiko's highly automated production lines could sort and assemble all the parts of a watch, test and adjust them, and then case them up without the need for human intervention. It was comparatively easy to adapt this automation to the assembly of quartz watches

The Swiss watch industry, conversely, had developed along different lines, with a horizontal structure that did not lend itself to the new technology of quartz watches. Thousands of companies specialised in producing individual parts or in assembling particular parts of each watch, such as the escapement of a mechanical watch. This industry structure did not lend itself to mass production or to the building of

The foresight of Kintaro Hattori in the early days of Seiko led to the creation of an integrated production structure that gave the company an enormous advantage when quartz watches took over the market. This watch production line at Morioka Seiko is probably the largest in the world.

automated production lines and this put the Swiss at a great disadvantage. It was difficult to organise parts to be in the right place at the right time to facilitate mass production. The Swiss watchmaking industry needed fundamental reorganisation to cope with quartz watch production, but in Japan, Seiko's vertical integration enabled production lines to be adapted quickly to the new technology and soon they were world leaders.

As the world entered the 21st century, another major change was beginning to transform the world's watchmaking industry. South East Asia had become the major producer of inexpensive watches and at retail level this was fuelled by a new phenomenon. Many new brands appeared in the marketplace and with the profusion of new suppliers, almost anyone was able to source watches and to launch a new brand name.

Unlike earlier companies whose names had become known the world over as watch brands, these new companies were in the business of niche marketing, carefully identifying and targeting a narrow group of consumers and selling to them very successfully. They did not need extensive knowledge of the watch market; instead, they required suppliers who could deliver on time and a flair for marketing.

More than ever before these new marketing companies were selling an image; the quality and technical features of many of these niche products took second place to the brand name. Many of the brand names being used on watches for the first time were already well established as household names in other fields, such as fragrances or sports wear. The expertise of the very successful marketing and advertising departments of these new companies was applied to the selling of watches.

In the face of this assault, and as the Swiss industry recovered its momentum, Seiko's phenomenal growth rate slowed and in this new world of niche watch brands, the structure of the company was such that it was unable to respond quickly to changes in the marketplace and

to demand for new designs. It had become too large and unwieldy. It was time to change. As so often before in Seiko history, the inspiration for change came from the vision, since the earliest days, of the future as a challenge.

A milestone for Seiko

The year 2001 marked an important milestone in the history of the company when Seiko Watch Corporation (SWC) was formed. At last, the watch division became an independent operating unit with responsibility for its own destiny. Until SWC was formed, the watch division had operated as a part of Seiko Corporation. Now the new SWC has joined more than 10 other companies under the umbrella of the parent company.

Like so many fundamental changes in the history of Seiko Corporation, this important decision was taken by a member of the Hattori family – Reijiro Hattori, Chairman of the Corporation, from the third generation to run the business. His decision to make this important change has given the watch division complete autonomy, a new sense of purpose and direction and, above all, responsibility for its own destiny.

Tsutomu Mitome was appointed as the first president of Seiko Watch Corporation. Until he took up his new appointment, he was President of the Seiko Corporation of America and had worked in the American market for 12 years. From his important position in the USA he was able to see Seiko from a different, international perspective, rather than the more narrow view of his colleagues who were based in Japan. For some time he had acted as an opinion provider to Seiko Corporation, helping its directors to understand how Seiko companies and the Seiko watch brand were perceived in other parts of the world.

SWC manages a portfolio of brands with Seiko as its core, each focused on its distinct mission. Seiko's success is partly attributable to the decision, in the 1980s, to protect the value of the Seiko brand name by the addition of the Pulsar, Lorus and Alba brands to operate at other levels in the marketplace. More recently, niche watch brands such as Agnes B and Mandarina Duck, have been produced and sold by SWC under licence.

Before SWC was set up, the watch division's presidents had responsibilities within the holding company and so they were not able to devote their full attention to the watch business. One of the fundamental changes resulting from the creation of SWC is that they can now focus their full attention on Seiko and its associated brands.

A clear vision

Some of the first actions of the new board were influenced, perhaps, by the many years that Mr Mitome had spent in America; they are reminiscent of American management techniques. The first task was to assess why business had slowed over a period of 10 or 15 years and to identify a new direction for the company by devising a clear vision of the future and a clear mission statement.

There are two mission statements, one for the domestic market and the

Styling has an important role to play, alongside technical innovation. These ladies' models in Seiko's Vivace collection are fine examples of the high standards being set by Seiko's designers today.

SEIKO

VISION

SEIKO, in its longstanding tradition of trustworthiness, will bring to people who are in the mainstream of society, products and services representing innovation and perfection. These products and services will encourage, impress, and instill expectations of innovation and advancement.

IDENTITY

SEIKO's identity shall be that of "innovation" and "refinement".

CORE VALUES

SEIKO's core values are "reliability based on quality" and "worldwide brand recognition". SEIKO's additional strength is as a manufacturer, with its power to combine, seamlessly and at a high level,

(a) technological development capabilities that continue to achieve world firsts and

(b) design development capabilities that can create original designs.

other for the rest of the world. This was necessary because of the very different characteristics of the markets. Since Kintaro Hattori started his company in 1881, perceptions of Seiko have developed in different ways in the domestic and export markets. In the Japanese market, Seiko sells mid-range products – at prices between $150 and $600 – but it also has the additional ability to sell expensive products. The Grand Seiko and Credor collections cater for the top end of the domestic market, Grand Seiko being high-grade timepieces for watch connoisseurs and Credor catering for the luxury market with gold and platinum watches, some set with diamonds and other gemstones. These have prices of more than $10,000.

In international markets, by contrast, retailers consider Seiko's greatest assets to lie in the high value of the product name and its reputation for providing excellent value for money. The many millions of satisfied customers worldwide also represent goodwill of inestimable value.

International customers often consider Seiko products to be inexpensive when compared with Swiss products of a similar quality. This perception is a double-edged sword. The fact that Seiko is perceived as great value-for-money is an important brand equity, but the lower average price that customers outside Japan expect to pay for Seiko products is a great disadvantage. It has proved to be a difficult hurdle for a company that for many years has been producing high-grade watches, as well as its mid-priced timepieces.

Thus, Mr Mitome identified a need for a sharper focus for the Seiko brand; it could be perceived in different ways inside and outside Japan to some extent, but it needed to be more clearly defined in both. For many years the company's greatest asset had been brand awareness. In 2001, when Mr Mitome considered plans for the future of the newly formed Seiko Watch Corporation, he realised it was not sufficient for Seiko to be well known; it needed to stand for something.

Mr Mitome believes there were too many different perceptions of Seiko; some saw it as a cheap watch, others as a high quality watch. Some considered that Seiko offered good quality and good technology, while others were more aware of Seiko's unique and very powerful designs. Some even associated Seiko with Japanese industrial design.

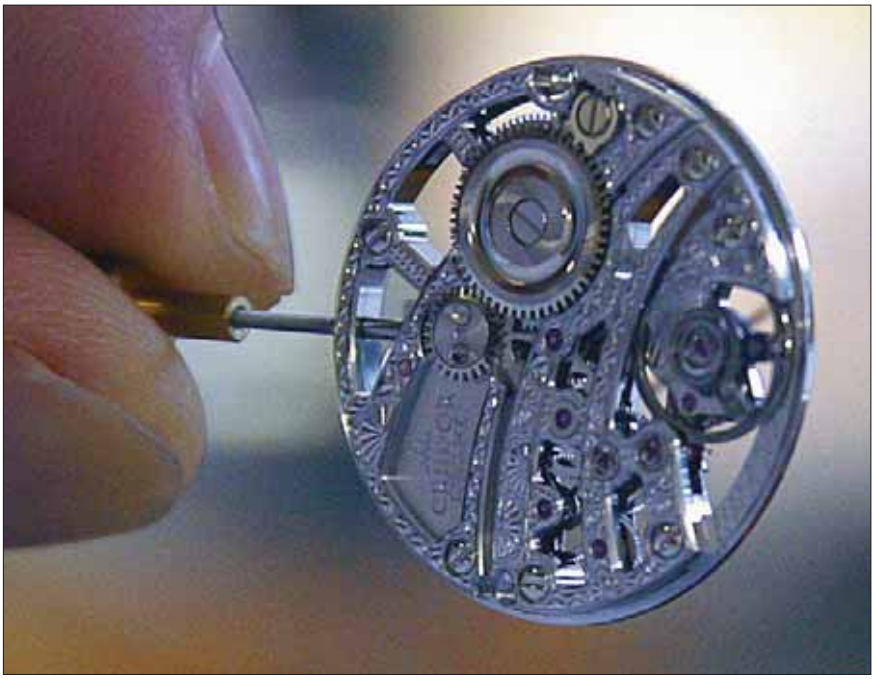
Brand identity

For the future Mr Mitome believes that it is important that Seiko establishes a clear brand identity. This is why one of the first actions of Seiko Watch Corporation was to study brand identity issues. Top priority was given to creating a brand identity that is closely matched by product development, sales and advertising promotions, as well as distribution and pricing policies. A similar programme is also being implemented with each of the auxiliary brands in the group such as Pulsar, Lorus and Alba.

"In the past we may have seized every opportunity to achieve mass sales whenever the opportunity arose at particular price points," according to Mr Mitome in an interview in 2002. "But those days are over. In future, Seiko will create a much cleaner distribution to enable us to concentrate on innovation and refinement." This continues a process that had already started towards the end of the 1990s.

This outstanding Seiko Credor FIFA World Cup skeleton watch, made in a limited edition of one piece, epitomises the exceptionally high standards of traditional watchmaking that Seiko attain. It has a chronograph movement and a power reserve indicator and cost 20,020,000 yen.

"How can we afford to have Seiko's brand image get lost in distribution when we are talking about the importance of refinement?" he asked. "When we were geared to a growth or market share oriented culture, we wanted only mass sales and growth and we tended to overlook what the Seiko brand meant to consumers. With this new company, SWC, we are now going back to where we started."



This beautifully decorated skeleton movement for a Credor watch is a fine example of the Seiko craftsmanship that is so highly regarded in Japan, but little known in other parts of the world – yet.

By 2002 the quality of retail distribution had been improved. It had also become almost impossible for discount companies to obtain Seiko watches through parallel distribution channels and this helped to give the company important control over its image.

If innovation and refinement are the new core values for the future, will Seiko be prepared to produce watches in lower volume, but at higher prices? Mr Mitome is happy to contemplate this possibility. He explains that in the past, the watch division of the Seiko Group developed some gigantic factories and eventually some were adapted to produce other products such as printers.

"When I look back at the company's history and analyse what went wrong towards the end of the 20th century, I see that there was no strategic planning in relation to the development of factories. Because of their enormous success, the main factories in the group made their own decisions about their future. Seiko Corporation was not necessarily able to influence the decision-making process in a way that would reflect the requirements of the watch industry. The decision-making process tended to involve a three-way discussion led not by the marketing departments, but by the interests of each of the three parties.

"Historically the two main factories became enormous companies and eventually they made considerable profits from products other than watches. As a result, they didn't necessarily make decisions based on their watch business alone. They amassed considerable resources from other business and so they were not greatly concerned with looking after the branded watch business. They were taking manufacturing-oriented management decisions.

"What Seiko clearly needs now is leadership from marketing people who are closest to the markets", Mr Mitome said.

"I have also ensured that the new Seiko Watch Corporation now has much closer ties than ever before with Seiko Epson. We can sit down together and share information about market requirements; we can let our production be dictated by the marketplace and not by convenience or production factors. This is a very important aspect of the changes that have resulted from the establishment of SWC in 2001."

Production moved

Volume quartz watch production that has been handled by Seiko Instruments in the past is being moved to Seiko Epson, but Seiko Instruments will retain the production of mechanical products at both the low and high price points. In their branded timepiece production areas they produce high-end mechanical watches for Seiko's Credor brand and, at the other extreme, they manufacture the inexpensive, starting price, Seiko 5 mechanical calibre."

By the middle of 2002, most quartz watch production had been transferred to Seiko Epson. Seiko Instruments still has a huge watch movement business, producing some 200 million pieces a year – many of which are supplied to other companies.

If Seiko is to be market-led in future, how can this equate with the intention to move further upmarket

Akira Ohira, who is one of Seiko's most senior watchmakers, is famous among Japanese watch enthusiasts. He provides technical training in the Morioka Seiko Luxury Wristwatch Section.

and achieve higher average prices in international markets?

In 2002 Mr Mitome was very conscious of the changes in the marketplace that became evident at the end of the 20th century and the beginning of this century. He explains that the number of manufacturers and the number of brands in the marketplace increased considerably and that was made possible by the wide availability of Japanese quartz movements. By the beginning of the 21st century it was the manufacturers in China and Hong Kong who accounted for enormous numbers of cheap watches.

"Some years back production for many of the leading brands was monopolised by companies in Switzerland, Japan and the United States. Now production has spread all over the world; anybody can get watches and all kinds of names have appeared as watch brands. The whole watch industry is undergoing a great change," Mr Mitome explains. "One characteristic of the new marketplace is that fashion watches have come on to the market in enormous quantities at low price points, many of them using low-cost cases and movements and assembled in China.

Premier, one style, but many different calibres, for men and women.

"The watch industry used to be pyramid-shaped, with the most expensive, low volume brands at the top and the high-volume cheap watches at the bottom. Now, the pyramid structure has been destroyed, as the market has been flooded with cheap imports. Case manufacturers produce some of these under their own unknown brand names, and they produce others, to order, for the owners of fashion brands. Some movement manufacturers are also involved in this growing sector of the market, offering complete OEM products to companies that want to sell watches featuring their own established brand names.

"This change has inflated the number of watches being sold at the low end of the market. Even at these prices they are not necessarily bad watches and some have movements that keep good time. Unless brand identity is clear enough to hit a narrowly targeted consumer group, an established brand will not necessarily enjoy the sales that it used to. This has been the case for Seiko and some other Japanese brands.

"The companies best able to respond to this market change are those with highly regarded brands with clear-cut marketing policies. They concentrate on very clear niche marketing and have established very good business at the high end of the market.

"When these factors are taken into account, it is clear that Seiko must concentrate on innovation and refinement. We must not try to compete at the low end of the market and we must not try to take market share from companies in the very competitive low market sector. It is a game we would not be able to afford. It was a

Advertising has played a vital role in enhancing the image of Seiko. This was the first advertisement for Arctura, in 1997.

natural decision that we must move upwards, even if it is also a very competitive marketplace containing some strong brands.

"We know that Seiko enjoys extremely valuable brand awareness and goodwill. What we must do is enhance that awareness and move the brand image upwards by concentrating on innovation and refinement. The brand value of Seiko needs to be uplifted and talked about at every level."

Does this mean that some of the less expensive Seiko products will be phased out? Mr Mitome admits that it does – and announcements to this effect were made within a year of SWC being formed. Another important feature of Seiko Watch Corporation's response to the changing market structure is the development of a number of sub-brands to enable the company to benefit from the new opportunities for niche marketing.

By 2002, all advertising and promotion in the domestic market was focused on just five series, instead of dozens, and by means of this approach it has been possible to define the target audience more clearly. Advertising and communication are now designed to create greater awareness and appreciation of Seiko's innovation and refinement. Some inexpensive series have been sacrificed to allow the company to place more emphasis on the selected core series. A similar pattern can be expected in the international marketplace.

For 25 years or more, a visit to one of Seiko's major watch-making plants would have revealed widespread automation being used to facilitate mass production of watches on an almost unprecedented scale.

Up-gradingisthepriority

By 2002, the picture had changed somewhat. Within Seiko Instruments, watch movements are still being produced in very large numbers, but in other parts of the plant there are many more traditional watchmakers, as well as diamond setters and goldsmiths – craftsmen and women with traditional skills – making high grade mechanical watches and gold or platinum cases, as well as diamond and gem-set models. The existence of high-grade mechanical Seiko watches, and of Seiko jewellery watches, is well known in Japan, but in other parts of the world, the existence of Seiko products that can rival high quality Swiss timepieces would come as a surprise to most people. Grand Seiko and Credor are high quality Seiko watches prized by Japanese collectors, but will customers in international markets have an opportunity to buy them as Seiko begins to move upmarket?

Mr Mitome explains that in the USA, Europe and parts of the Middle East and Asia, Seiko have sometimes introduced timepieces at higher price-points but brand recognition of Seiko as a producer of watches of this calibre has not been strong enough to enable the company to sell high-end watches successfully in these markets. "I think it will be some time before we are able to introduce Grand Seiko or Credor in international markets," He says. "But by adopting a very focused brand management policy I plan to upgrade the image of Seiko. In the United States market, for example, we are limited to sales between $150 and $600 in 2002, but in the mid-term, three to five years, we expect to be able to sell watches there at $750, $1,000 or $1,500.

"It is not possible to achieve such a change instantly. At the moment, US

Watchmakers are not the only craftsmen working on high grade Seiko watches. Diamond mounters and goldsmiths also play an important role.

Seiko has developed very close links with the sports world through its timing of major international events. Reijiro Hattori has spearheaded this involvement that has helped to raise the international profile of Seiko to new levels.

retailers see the selling of watches at $1,000 or more as the role of the Swiss. As long as Seiko has an image of selling $150 to $600 watches, retailers won't take $1,000 Seiko watches. That's one obstacle we have to clear. We are determined to uplift the image of Seiko among consumers and raise it enough to be able to sell Grand Seiko or Credor watches at $2,000, $3,000 or even $5,000.

"It is my personal belief that mechanical watches have proved to be a core feature of the timepiece industry that will never die. With quartz watches we used to say that some day all watches will be made this way, but that has not been the case. Many people actually love mechanical watches, even if they are not as accurate as quartz timepieces.

"Recently Japanese people have become much more fond of mechanical timepieces. Sales of Grand Seiko, our high end watch line that includes mechanical timepieces, have achieved double digit sales increases for the last five years. We are enjoying great success in the domestic market with our mechanical watches. We have great resources for producing Seiko 5 automatic movements and if necessary these can be upgraded in any way to cater for the growing demand for mechanical products.

'Japanese people have become much more fond of mechanical timepieces'

"Traditionally we have made very good low-end mechanical watches, but we can use the same resources to make mid-priced models, too. We could easily build up a pyramid of mechanical watch series so that we can offer good mechanical timepieces at every price level. If ever consumer demand for mechanical watches returns on a large scale we could easily complete that pyramid structure.

"Japan's great awareness of beauty and the existence of many fine craftsmen in Japan is well known, but

So far, Spring Drive watches have only been sold in Japan, but they are likely to have an important role in the future development of watch technology.

these are not qualities we have been expected to talk about in the past when we have referred to our Credor collection – but we will be doing so in future. In Seiko Instruments and Seiko Epson we have staff with these talents and we are now making full use of their skills and their natural awareness of beauty. Craftsmanship is part of the Japanese heritage."

Kinetic technology

The introduction of Kinetic watch technology in 1988 was one of the most important landmarks in the history of Seiko – along with the launch of the world's first quartz watch in 1969. Kinetic marked a revolution in watch technology and provided the first glimpse of Seiko's move towards an environmentally friendly attitude to its products.

Originally it was expected that Kinetic watches would sell themselves because of their advanced technology and design. At the beginning of the 21st century, however, a new approach has to be introduced in order for Kinetic watches to sell successfully. The diversity of new niche brands in the marketplace, some of which have been very successful, has captured the attention of consumers very effectively and influenced their choice of timepieces. The watch is now seen by many as a personal accessory.

"Being technologically advanced is not necessarily a decisive factor that influences a consumer's choice of timepiece today. The use of advanced technology calibres has to be supported by design and concept development," says Mr Mitome. "It is more important than ever before that the concept development departments and those who develop new calibres should work closely together.

"Technology alone does not influence the ultimate choice of watches or brands. That's my way of thinking. The product brand approach of Seiko Watch Corporation in the international market is to incorporate the Kinetic calibre into our design series. That is one way in which we are able to combine fashion and technology.

"Markets such as the UK and the Netherlands that are keen supporters of Seiko's advanced technology have been insisting that we make the Kinetic name well known to the public. That provides us with another approach. In markets such as these we must also keep on introducing Kinetic as a product category in its own right.

"Kinetic technology is a very important asset of Seiko Watch Corporation: nobody else can make similar watches to the same level as we achieve with our technology and so we consider it to be a unique technology that can help to distinguish Seiko's marketing activities from any others. We will take very good care of this asset."

If Kinetic is so important and so exclusive to Seiko why does Seiko Watch Corporation make some of these movements available to other watch companies? Mr Mitome says that by supplying carefully selected brands, SWC is helping to spread the message about Kinetic technology and helping the public to achieve a greater understanding of its importance and its benefits. Some of the companies that

have bought Kinetic movements have used them in their high value models and been very successful. "Because such brands can help to spread the message about Kinetic technology, Seiko Watch Corporation doesn't hesitate to make this technology available – but only to good, high-end brands," according to Mr Mitome.

Spring Drive innovation

Seiko is always determined to improve and develop the technology used in its watches using environmentally responsible solutions wherever possible. Since Kinetic watches were first introduced in 1988, Seiko's Research and Development teams have developed another innovation. It is called Spring Drive and replaces the weakest component of a traditional mechanical movement, the escapement, with technology that enables a mechanical movement to be regulated by quartz technology. It combines the best of both worlds and eliminates the need for battery changes.

Spring Drive technology is expensive to manufacture and so it has only been sold, so far, in Japan, where high prices are more readily accepted than in the international market. The technology has been shown internationally, with special emphasis on major press conferences at the Basel Fair in Switzerland, the annual show that is the world's most important launch-pad for new watches.

Spring Drive combines advanced electronic technology and traditional features such as a power reserve indicator.

Mr Mitome believes that many Swiss companies are interested in this kind of technology and suggests that it may represent the future of watchmaking. He says that Spring Drive technology can be adapted in such a way that it can be implanted into fine mechanical watches. "We appreciate that some consumers find the balance wheel a very attractive feature in watches that have a see-through caseback or a skeleton movement. They are not buying accuracy, but beauty, craftsmanship and appearance. We are examining ways in which in future we could combine the electronic technology of Spring Drive with a traditional balance wheel, but production is not yet in our road map of developments. If we can adapt Spring Drive technology so that it can be used in a watch with a balance wheel, it could provide many exciting opportunities."

'Raising the international price ceiling is central to the new philosophy'

It would make no commercial sense to introduce Spring Drive watches in international markets until the acceptable price ceiling for Seiko products is lifted. Raising the international price ceiling is central to the new philosophy introduced by Seiko Watch Corporation after it was formed in 2001. Mr Mitome believes this task has a very high priority. He has already convinced some customers by persuading them, against their own judgement, to stock some Seiko watches at double the normal price ceiling attained by Seiko in their shops. Each customer confirmed that they had been wrong about the maximum price at which they could sell Seiko watches and added that the exercise had been a great success.

Mr Mitome suggests that it is often the store buyer's personal analysis or the store's traditional buying patterns that determine the maximum price at which a store is prepared to sell Seiko watches. "Our experience shows that when they can be persuaded to offer some of Seiko's more expensive lines they are surprised by the demand. I don't want our retail customers to restrict their own view of Seiko's limitations when they consider price points in future. That is my challenge to our customers."

Seiko's track record for achieving many important "firsts" in watch technology has been achieved as a result of extensive investment in research and development. Now that innovation and refinement are key words in Seiko's vision of the future, R & D still plays an enormously important role. "As we develop the brand identity of Seiko by concentrating on innovation and refinement, that innovation needs to be fired by technological breakthrough," says Mr Mitome. "We keep working hard at it and we will never reduce our commitment to R & D – if anything we will increase it. We fully appreciate the importance of technological development in international markets."

In line with its plans to rationalise product lines and remove the less

expensive products, Seiko has established just five collections of watches for the Japanese market. Each of these has its own point-of-sale material to explain and support it. Mr Mitome believes that in today's watch market, in which traditional brands now face a challenge from many new and successful niche brands, technology alone is not sufficient to attract the buying public. "Technology has to be supported by cosmetics, by excellent case and dial designs. Most consumers are attracted first by the total appearance of a watch. We believe that a combination of good designs and the use of advanced technology inside the watch is an important strategy."

The Development Years

The rapid growth of the Japanese watch and clock industry – and that of Seiko in particular – has been nothing less than remarkable. Watchmakers in many countries had centuries of tradition to build upon, but Japan's modern watch and clock industry was not born until the latter part of the 19th century.

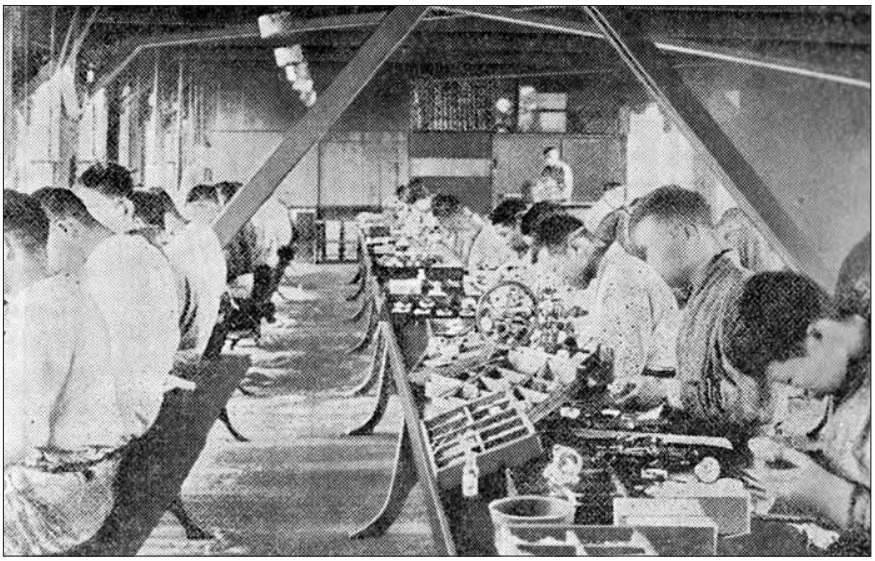
The "opening" of Japan in 1854 and the signing of commercial treaties in 1858 meant that trade between Japan and Western nations was no longer restricted and paved the way for imports of factory-made European and American clocks and watches. The need for accurate timepieces was growing fast and, as happened in other parts of the world, the growth of the railway system was one of a number of factors that brought exact schedules into the daily lives of ordinary people, making clocks and watches a necessity rather than a luxury. However, it was the change of the entire time system that really stimulated demand. In 1872, the Meiji cabinet, as part of its more open policy, passed the Calendar Act which made official, overnight, the adoption of the solar time system as used in all other parts of the world. When this came into effect on January 1, 1873, it replaced the lunar time system and stimulated demand still further.

The founding of an entirely new horological industry in Japan followed the introduction of the Calendar Act. Japan's clockmakers had no experience of making timepieces conforming to the solar time system and they needed to catch up fast, to ensure that Japan was not entirely dependent on imports for its timepieces. The Western solar calendar replaced the uneven horary system that had been used in Japan for centuries. Japanese watchmakers' technology and their old timekeeping mechanisms became useless overnight and they had to make a fresh start.

Kintaro Hattori

Japan imported many European and American clocks; most imported clocks came from the United States, most imported pocket watches from Switzerland and, around 1890, some metal alarm clocks came from Germany. Japanese merchants took on the distribution of these products and, not surprisingly, some eventually decided to try producing similar models themselves. As imports accelerated, so interest in domestic production of clocks increased and clock factories sprang up in Tokyo, Osaka, Kyoto and Nagoya, making largely experimental imitations of imported products. The domestic clock industry was up and running.

One of the first of these pioneers was Kintaro Hattori. He had served an apprenticeship under several clock repairers and, at the age of 18, he started the Hattori Clock Repair service at his home in Kyobashi, Uneme-chou, which is now part of Ginza's 6-chome (district). This new venture started on September 1, 1877. It provided the foundation for the organisation that was to become, by the end of the 20th century, not only Japan's most important watch



The assembly of pocket watches at Seikosha in 1903.

and clock company but also one of the largest and most important in the world. Even in his own lifetime, Kintaro's success in the watch and clock business earned him the sobriquet "King of Timepieces".

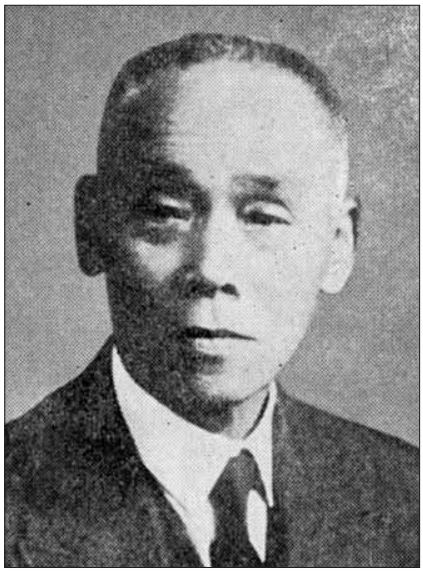
Just four years after opening his first repair shop, he set up a new company, K Hattori, in 1881, as a vehicle for expanding his business beyond simple repairs. This new store began to sell, as well as repair, second-hand clocks and the business grew rapidly. Kintaro soon saw further possibilities for expansion; he began to visit the foreign trade pavilion in Yokohama and there he started to buy clocks that he sold both as a wholesaler and as a retailer.

Right from the start, Kintaro was a pioneer in every way and one of the first manifestations of this adventurous spirit was his decision to abandon the customary bi-annual settlement of accounts. He saw the need to secure the respect (and high credit rating) of the American and European traders who were his source of products in this early period, and decided to reject the traditional payment system to achieve this aim. Instead, he paid his bills promptly within 30 days.

The distribution and selling of timepieces was not enough to satisfy Kintaro; he was anxious to start his own production of clocks. By 1892, K Hattori had made substantial profits from the distribution of imported products and this made it possible for it to afford the expensive diversification that was to follow and to provide the foundations for the company's ultimate success. Around this time, Kintaro Hattori met Tsuruhiko Yoshikawa, an engineer who had been running a clock store, and later recalled, "Immediately on meeting him I expressed my strong determination to set up a clock factory for the country… When I asked him how much money it would take to hire him, he said 30 yen a month would be sufficient and suggested that we start working together…This was the original motivation behind the establishment of Seikosha."

In May 1892, Kintaro purchased a disused glass factory in Ishiwara-cho, Honjo Ward in Tokyo, and here he set up Seikosha to manufacture wall clocks. This factory came directly under the control of K Hattori and Tsuruhiko Yoshikawa, who was only 23, was the first employee; he went on to become the Chief Engineer and to play a leading role in the success of the venture. He was responsible for developing the company's technical skills in its formative years and master-minded the development of its manufacturing capabilities. Mr Yoshikawa's value to the company can be gauged by the fact that his salary increased from 30 yen a month, when he joined the company, to 5,000 yen a year.

Production at the new factory started almost immediately and the



Tsuruhiko Yoshikawa, Kintaro Hattori's first employee, went on to become Chief Engineer. He played a key role in the factory's early days.

first 12 prototype American-style wall clocks were finished just eight weeks after the inauguration of Seikosha. This was a remarkable achievement, given that the factory had no form of power to drive its tools: it had to rely entirely on human power for every process. Two or three labourers turned a large power-supply wheel in rotation. This drove a big flywheel which in turn provided the power for the machinery.

Producing these first clocks was a significant accomplishment because Japan's watchmakers had only been making timepieces working to the solar time system since 1872, whereas their European counterparts had had many centuries to develop their skills. The Chief Engineer used all his ingenuity to find ways to produce each individual component of these wall clocks. When the Seikosha factory opened in Ishiwara-cho in 1892, it had just 15 or 16 employees. Several months later it is believed to have employed 30 or 40 people.

Expanding production

Seikosha desperately needed to introduce power tools to improve its efficiency, but, in the densely populated area where the factory was situated, it was impossible to obtain permission from the police for the use of power-driven tools, so just one year after its establishment, the company left its original site to move to Yanagishima, also in Honjo Ward. In the wooden buildings of the new factory it installed its first 5 horsepower steam engine, which enabled it to expand production. Here, Seikosha produced and assembled not only mechanical parts, but also dials, hands and wooden clock cases. Honjo Ward, on the east side of

The Time Keeper was the first pocket watch ever made by Seikosha, in 1895.

the Sumida River in Tokyo, was at the centre of growth as industrialisation progressed in Tokyo during the Meiji Era and many skilled workers were to be found in the district. The decision by K Hattori to locate its manufacturing branch in Honjo has been described as "a far-sighted move that placed it on the flood tide of industrial development".

It is important not to overlook the fact that Kintaro Hattori was successful not only in manufacturing. While his factory had been developing and expanding he had also been actively developing his retail business in parallel with the manufacturing venture. He had taken the important decision to expand the retail business and with the same instinctive ability that led him to place Seikosha in Honjo, he chose the right location when he moved the Tokyo shop to Ginza 4-chome, 2-banchi. It was 1887. Business continued to boom and seven years later the store had again outgrown its premises, and Kintaro selected a new site –the head-quarters of a newspaper at the Ginza 4-chome corner, which is now the very heart of the Ginza district, where land is more expensive than anywhere else in Japan. In January 1895 the new shop opened for business. This important move, in the year that Seikosha had begun to produce pocket watches, was an inspired decision. It soon became the most prestigious watch and clock shop in Tokyo and to this day the site is referred to as the familiar "face" of Ginza.

In 1932, the head office on the Ginza 4-chome corner was rebuilt; the replacement building still stands today and is one of the most famous landmarks in Tokyo. The large clock on the roof of the building became known as the Hattori Clock Tower and today this prime retail location, at the heart of Tokyo's most fashionable shopping district, is the site of the Wako store, which is still the property of Seiko Corporation.

The K Hattori building in the Ginza district in 1895.

Automatic machines were being used here in the Early Taisho Era (1913 – 1926).

Even as the clock business of Seikosha was thriving, Kintaro was looking to the future and planning his first venture into the making of pocket watches. Production of cases began in the Yanagashima factory in 1893, as soon as Seikosha moved there and, by 1895, it assembled its first complete pocket watch, the 22 ligne Time Keeper. At this time the company's production techniques had not matured to the point where it could make its own movements; these first watches were probably assembled using Swiss movements with a cylinder escapement, but nevertheless, the Time Keeper was the first pocket watch that can be said to have been "made" in Japan.

For reasons no longer known, many products made by the company at the time were given names based on English words – perhaps Kintaro was already thinking of future export possibilities. In addition to Time Keeper, other names used for Seikosha watches in this period included Excellent, Empire, Mercy, Ruler and World.

A new export trade

With clock production rising and watch production in place, Kintaro again raised his sights and decided to develop an export trade, and soon he started to export wall clocks to China. By now, K Hattori and Seikosha had become firmly established as important players in the Japanese watch and clock-making industry, an early sign of Kintaro's business acumen. His long-term vision was based on the market situation, both at home and abroad, and his diversification policy was a feature that was not to be found in any other Japanese clock company at the time.

With the introduction of new machinery, production began to increase. In the first year at Yanagishima, 23,700 wall clocks were made, 70 units a day. Three years later, daily production had reached 300 and, by 1897, Seikosha had become the largest wall clock manufacturer in Japan. In 1899, the company achieved another "first' for a Japanese clockmaker by producing alarm clocks, which, including those exported to China, are reported to have easily outsold German alarm clocks.

Kintaro Hattori was not the only watch and clock merchant of his day, but he was the first to make a great success of both distribution and manufacturing, first of clocks and later of watches. He was also a great entrepreneur and a survivor, able to keep his companies in business when others around him went to the wall. In the 1900s, intense price and quality competition drove other clock manufacturers in Osaka, Kyoto and Tokyo to bankruptcy. At one time, Seikosha was the only surviving watch and clock maker in the country.

While Japan's industrialisation was starting, most watchmaking was concentrated in Switzerland and the United States. In America, the art of mechanical watchmaking and mass production was well advanced and inexpensive models were being produced in large quantities. Many of these products were imported into Japan.

The Excellent was the first luxury pocket watch made by Seikosha, in 1899. Some of the components were probably imported.

In these early days, the products made by Seikosha were not, in their technology or their appearance, very innovative, but Kintaro dominated the industry by means of his business acumen and the speed at which he adapted to each new challenge. However, he had the foresight to recognise that innovation was the key to long-term survival and, from the earliest days, he dreamed of achieving "firsts" in his industry.

First trip abroad

Kintaro made his first trip abroad in 1899. He travelled to the United States and from there visited Europe, where he was able to look at various production facilities in Switzerland and Germany. His analysis of the difference between Swiss and American production methods was to have a profound influence on Seiko's success many years later. He discovered that there was a significant contrast between the centralised techniques used in American factories that mass produced a few varieties and the Swiss factories that produced many different models in far smaller quantities. He decided that Seikosha had to adopt the American system because the parts manufacturing structure that the Swiss enjoyed did not exist in Japan; there were no companies producing watch components locally. Machine tools for mass production became Seikosha's greatest need.

By 1900, Waltham and Elgin in the United States led the world in introducing machinery to automate production; they had succeeded in achieving three important goals – shortening processing time, improving precision and, above all, making

The Laurel was the first wristwatch made by Seikosha in 1913.

machines that could carry out more than one process. The Swiss, relying on supplies from countless small companies and individuals, lagged behind with relatively low productivity, although, from the turn of the century, they made great efforts to innovate and to improve efficiency.

Kintaro noted in the journal of his first trip to the US that it was impossible to import from America the automatic machine tools that were needed for mass production because they were made in-house by two American watch manufacturers, Waltham and Elgin. Despite this setback, around 1900 Seikosha succeeded in purchasing many foreign made, special-purpose machines for the production of pocket watches. Some Swiss-made equipment may have been obtained from Nippon Pocket Watch Mfg., which by then was defunct, but researchers also believe it is possible that Seikosha obtained some manufacturing equipment from other European countries, including free-standing clock equipment from Germany, during or after Kintaro's overseas travels.

It is not clear whether any of this machinery was suitable for mass production of pocket watches, but volume production of alarm clocks began in 1900, after the factory's equipment had been renovated when Kintaro returned from his first factory visits to the US and Europe. Subsequently, Tsuruhiko Yoshikawa, the revered factory manager, and Kamehiko Hayashi, who headed the pocket watch department, developed many of their own machines to complement the 200 imported machines the company had already acquired. Altogether they made about 300 machines in-house.

At the beginning of the 20th century, manufacturers in countries that supplied the Japanese market were making technical improvements in their pocket watches and this provided Seikosha with another challenge

This Laurel movement was fitted in a crude nickel case, but the inside of the case is inscribed, "Gold donated to the nation – 2599th year of the Imperial reign". It seems that the original gold case was donated to the nation and replaced by this substitute.

A Seikosha alarm clock assembly line around 1930.

if it was to maintain its competitive position in the domestic market. The imported pocket watches in the early 1900s were thinner and more compact.

During his visit to the United States in 1899, Kintaro had visited the Waltham watch factory, and had signed a contract to take a large number of their pocket watches annually. But, as ever, Kintaro was keen to develop his own production, and so immediately after his return, Seikosha began making its second pocket watch, the 12 ligne Excellent, which was based on the design of a Waltham watch. This was a smaller version of its earlier 17 ligne model, the Time Keeper.

It is almost certain that Seikosha, still in its infancy as a watch manufacturer, used parts imported from Waltham in place of those it found too difficult to make at that time.

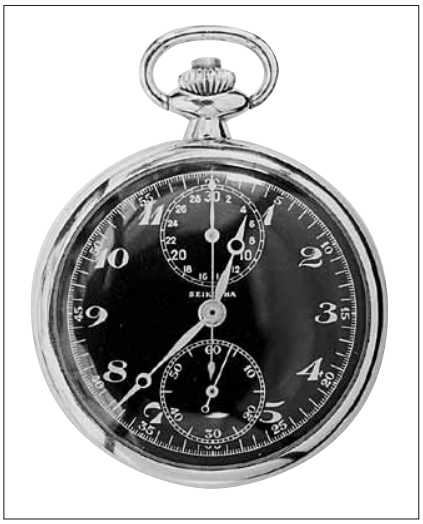
Seikosha decided to use a cylinder escapement for its first pocket watches, although many watches with anchor escapements were on sale in Japan by this time. It probably chose this option for a number of reasons: one factor may have been that fewer parts were required for a cylinder escapement. Another may have been that an anchor escapement is larger than a cylinder escapement and so the components of the gear train of the cylinder version can be larger – and therefore easier to manufacture – in a movement of the same diameter.

The machining of balance wheel cylinder staffs was possibly beyond Japanese technology in the early 1900s and so Seikosha may have chosen to manufacture the gear train itself and to use imported components for the other parts of the cylinder escapement. Gradually the number of parts produced in-house was increased as Genzo Hattori, Kintaro's eldest son, later wrote: "They first made the plates, bridges and gearwheels in-house and bought the other main parts in Switzerland, gradually increasing the ratio of their own parts".

By 1902 the Seikosha clock factory employed more people than any other plant in Honjo's metal and machinery sector. Most of the other factories were small, but the presence of so many small, diverse companies worked in favour of Seikosha – a firm making umbrella frames, for example, eventually turned its skills in metal processing to the manufacture of clock pinions.

Mastering the technology of watch production was not as easy as that of clockmaking and two other companies that had been founded before Seikosha failed to survive the transition. Another hurdle standing in the path of Seikosha was the fact that Japanese customers tended to favour imported timepieces over any domestic counterparts. In order to survive, Japanese timepiece manufacturers had to be able to sell their watches at lower prices than imported watches. The challenge facing Seikosha was not only

This wristwatch, made in 1924, was the first ever to carry the Seiko brand name.



Seikosha made Japan's first chronograph in 1941, a pocket model, which could record time intervals up to 30 minutes.

to make working parts and to train skilled workers to machine, assemble and adjust them, but also to reduce costs sufficiently to be able to sell their watches at the lowest possible prices.

Sudden diversion

In 1904 Seikosha was unexpectedly instructed to divert its manufacturing facilities for the production of munitions for the Russo-Japanese War (1904 – 1905). There were only a handful of engine-powered factories in Tokyo at that time employing more than 100 people and Seikosha was then the fourth largest manufacturing company to use power tools in Tokyo in terms of the number of workers it employed. It was unwilling to give up clock production but was ordered to make artillery shell fuses. The size of the work force was increased to 1,500, working day and night in shifts. Munitions production continued for about a year, alongside clock manufacturing. The considerable profit resulting from this diversion was subsequently used as capital for future investments.

Despite two increases in import duties between 1897 and 1906, Japanese manufacturers' share of the domestic pocket watch market had fallen to as little as 10 per cent. For a long time Seikosha's income from pocket watches did not even cover expenses. By 1906, some of the machines Seikosha had acquired only a few years before must have seemed quite antiquated. Clearly something had to be done to enable Seikosha to compete more effectively with overseas manufacturers and so Kintaro left on his second trip to Europe and the USA in 1906. This time he took with him two colleagues, Hideyuki Yoshimura from the Clock Store, and Tsuruhiko Yoshikawa, Seikosha's Chief Engineer.

In 1929, Kintaro described how this had been an observation trip and added, "The things I learned from this second trip abroad were considerable. The only hope we had of driving out European and American products was to promote factory efficiency through mass production and reduce costs while maintaining high quality.

"I had great plans to expand the factory and to equip it with many of the latest imported automatic precision machine tools. We also planned to rejuvenate the manufacturing process with various production machines designed at Seikosha. By these means we increased production efficiency, lowered prices and standardised product quality, and were finally able to achieve our desired results."

A considerable number of the latest machines were imported and Mr Yoshikawa gained many ideas from American factories for the in-house production of automatic machinery. A subsequent report said that, "Yoshikawa is a great man: if one machine is purchased, he can make new ones using it as a model. When one turning machine was bought, he made many machines and produced equipment for alarm clocks."

The growth of Seikosha's alarm clock production after the 1904-1905 Russo-Japanese War was remarkable. In 1906, the company produced 70,000 alarm clocks. By 1907 this jumped to 120,000 and by the following year 170,000. Meanwhile, Japan's imports of German nickel-plated alarm clocks suffered a steady decline. Seiko was now truly competitive and its clocks were the finest available.

In 1908, Seikosha's production of alarm clocks outstripped its wall clock

This Extra Flat watch was made by the Daini Seikosha factory around 1948. It features a 10 ligne movement with small seconds.

This 1950 Seiko watch has a separate seconds hand. Later in the same year, Seiko made Japan's first three-hand watch with a centre-mounted sweep seconds hand.

production, which remained steady at about 100,000 units a year, but because the unit price of alarm clocks was lower than that of wall clocks, the value of alarm clock production never exceeded that of wall clocks during the Meiji Era (1897 – 1906). The growth of alarm clock sales had been helped by an increase in alarm clock import duties in 1906 from 25 to 50 per cent, as part of broader reforms in Customs duties and this reinforced Seikosha's market dominance.

Standard production lots of alarm clocks were far larger than those of wall clocks and in terms of mass production technology this seems to have played a crucial role in the company's subsequent improvements in pocket watch production techniques. Pinion-cutting proved to be the most difficult process to automate, but by 1909 an automatic pinion-cutting machine had been developed for pocket watches from one of Yoshikawa's designs. A number of modifications were made and eventually it was reported that one employee could handle the pinion-making work that previously needed 25 employees.

Between 1907 and 1912 more engines were installed. Various power systems, such as steam engines, oil motors and gas engines were used in combination from around 1907. Everything was finally converted to use electric power by 1914, and the steam and gas engines were phased out, which must have represented the biggest single improvement in factory facilities.

New Emperor

The accession of the new Emperor in 1912 marked the beginning of the Taisho Era and the arrival of a competitive challenge to Seikosha's position from many new Japanese companies that started to produce clocks and pocket watches. Seikosha responded by deciding to develop Japan's first wristwatch.

The drive to innovate continued to obsess Kintaro as he pondered how to fulfil this dream of creating his own wristwatch. He quickly realised that it was only achievable if he produced all the parts for these products in-house, and that this was the way to stay ahead of the ever-growing competitors. By 1910, Seikosha succeeded in making balance springs and by 1913, it began making its own enamel dials for the first time. Kintaro had set the company's sights on developing Japan's first ever wristwatch and just one year into the Taisho Era his enthusiasm paid dividends when, in 1913, it was put on the market under the name Laurel. This may have been the first Seikosha product that contained components manufactured entirely in-house. If it was, it is impossible to underestimate the significance of this achievement, for it marked the beginning of the policy that was to put Seiko into the top rank of world watch producers half a century later.

The production of wristwatches had presented the company with technical difficulties far greater than those encountered in clock making. The parts were smaller and more difficult to manufacture and the mechanisms were more complicated. All of the parts had to be engineered with much greater precision than had been necessary for the larger parts used in clocks. Many specialised tools were required to make watch parts and these machines were much smaller than the general-purpose machinery used to produce clock components. At that time it was difficult for Japanese manu-

This Super AutoDator, made in 1953, had a 15 jewel movement that was much more accurate than the regular AutoDator. It was based on the Super movement, Seiko's first model with a sweep centre seconds hand, and had a central date pointer hand.

facturers to obtain equipment for such specialised production. For a long time the company was only able to produce between 30 and 50 a day.

World War I created exciting challenges and opportunities for Japanese companies. Imports from Britain and Germany were cut off and basic materials became scarce. The shortages created a great opportunity for Japanese companies to manufacture products to replace those that were no longer available from abroad. The Japanese clock industry had suffered from a period of recession around 1912 and Seikosha's production had declined. When war broke out in 1914 there was a sharp increase in the price of metals and imports of English and Swedish steel for the production of springs ceased. The clock industry in Nagoya suffered from bottlenecks caused by the spring shortage and it was only rescued by the switch to munitions production for the Japanese army fighting on the Allied side, and for the Russian military.

Companies united

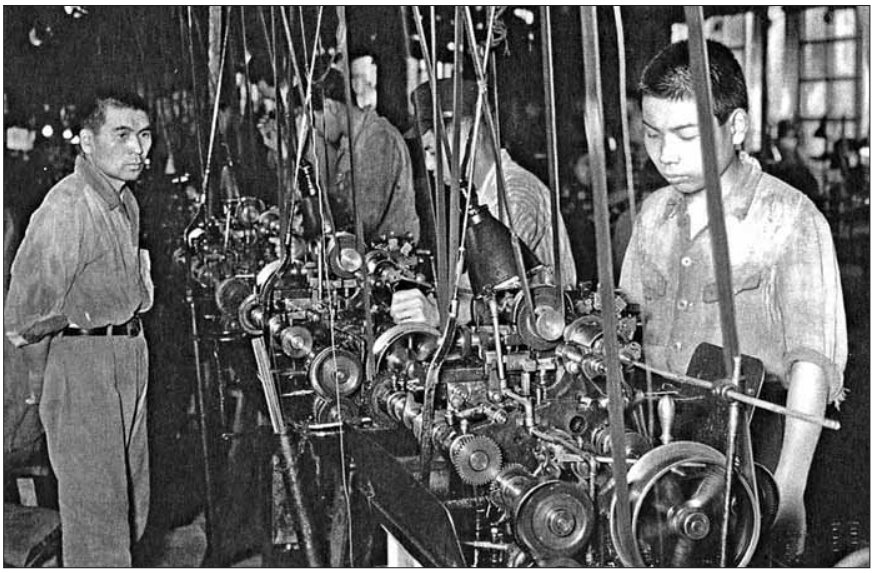
In contrast to the clock industry in Nagoya, Seikosha was united with the K Hattori which had trading function under a single management structure. K Hattori had bought large amounts of Swedish spring steel and American pinion bar steel before the war, so Seikosha was not inconvenienced when steel imports dried up. Other companies, in Nagoya, had not prepared for this eventuality and did not have as strong a relationship with Japanese suppliers as Seiko. German clockmakers could not respond to the demand from England and France, and so Seiko received huge orders from both countries, while still enjoying good business in Japan.

The Daini Seikosha plant in Suwa, pictured in 1949.

By the middle of 1915 the company had received orders from Britain and France for more than 800,000 alarm clocks. Clocks made by Seikosha were exported not only to Europe, but also to South East Asia, India, South Africa, South America and Australia. When the number of units being produced began to approach mass production levels for the first time, the biggest problem on the production lines resulted from the inability to produce components to precise tolerances so that they were truly interchangeable. This was the result of deficient die jigs and insufficient precision in the machine tools. As a result, production from various machines had to be carefully matched in order to bring together components that were as compatible as possible. Time and time again the situation arose in which a combination of parts failed to match during the final assembly process. This became known as "crossed paths" and resulted in a high level of defective parts. Because the parts were not truly interchangeable, the ultimate quality of the movements depended on correction and adjustment by skilled workers, a wasteful and time-consuming process. Some parts were not useable at all and had to be thrown away.

Seiko had to adopt the new mass production techniques that were being pioneered by Ford with the Model-T – in 1909 – and, even earlier, by Eastman for the production of cameras. Mass production was to become the key to the future success of the company eventually known as Seiko; the use of machinery to turn out parts rapidly was an important first step towards this.

Thanks to the rapid growth of clock sales, the company was outgrowing its structure. In November



Inside the Daini Seikosha Suwa plant in 1949.

1917, the privately owned company called K Hattori, managed personally by Kintaro Hattori since 1881, became K Hattori & Co Ltd, with a paid-up capital of 10m yen. Seikosha was a part of this new corporate entity, known as K Hattori & Co – Seikosha Factory, and a single management structure governed the new corporate entity. At the same time the export department of the Hattori Clock Store was separated and established as the Hattori Trading Company.

Kintaro Hattori always involved his family in his business and his mother, Haruko, played an important role during its formative years. She lived inside the factory compound from the company's foundation and has been described as the de facto boss of the Seikosha factory. She was a strong woman who shared the joys and sorrows of the employees and contributed massively to the development of the business.

Apprenticeships

When the factory was first set up, few craftsmen wanted to become clock craftsmen, so Seikosha had no choice but to recruit elementary school graduates and train them. As early as 1897, about 300 pupils were boarded at the factory, but it is not clear when this practice ended. After their apprenticeship had been completed, they were allocated to various workstations. In the later Meiji Era, about half of Seikosha's employees were probably former pupils of this internal training facility, including many work site foremen and important skilled craftsmen.

During this time, Haruko established close relationships with the company's personnel, both pupils and former pupils. Examples abound. In 1896, Kichitaro Kurimoto was hired as a cook to cater for the boarders, working under the direction of Haruko. He came from the same province as Haruko and thought of himself as her follower. He established a close rapport with her and went on to become the personnel manager. Mr Kurimoto's instructions were carried out in the factory with the authority that attached to him as her representative.

The death of Haruko at the age of 84, in April 1915, provided the impetus for change. Until this time, Kintaro had personally presided over the clock store in Ginza and the Seikosha factory in Honjo. Every morning he worked in the store and every afternoon he went to the factory. A management triumvirate had been set up informally a few years before the incorporation of K Hattori in 1917 and this effectively created a systematic senior management structure. After Haruko's death, Seikosha's management was entrusted to these three directors, but the old, close personal relationship that Haruko had established with the

This Super, made in 1940, featured Seiko's first full three-hand movement; earlier versions were modifications of a calibre with a small seconds dial and an extra wheel to drive a centre seconds hand.

Production of the Marvel began in 1956 and ended in 1959. Everything about the movement was gradually refined, including accuracy, ease of production and maintenance. The early models had 17 jewels, but later versions had 19 and then 21.

employees was lost. Out of necessity, a more modern labour-management relationship took its place.

President Kintaro Hattori headed the triumvirate. The other members of this management team were Michio Shinohara and Genzo Kawada, both sons-in-law. Mr Shinohara became a director and was the full-time management representative at Seikosha. Mr Kawada took on responsibility for the orders for munitions and machinery at the factory.

After the difficult years in the first decade of the 20th century, when many competitors had been forced out of business, the market's growth began to attract a growing number of competitors from 1912. Seikosha had long been the only domestic maker of certain types of clock and of pocket watches, but by 1922, 22 clock and watch manufacturers were listed in Tokyo. Not surprisingly, these newly established concerns attempted to poach Seikosha's workers. The company tried hard to prevent this, but it could not offer preferential conditions, and especially salaries, only to those workers who had been offered other jobs, and so it often lost them to rivals. As a result, Seikosha's technology and know-how spread to most of the new factories, and competition intensified.

It was the long-term business approach of Kintaro Hattori that permitted K Hattori to survive, with innovations in one area being funded by the profits of another. Seikosha's alarm clock and pocket watch manufacturing ventures ran at a loss in their early days, subsidised by the profits from wall clock production. Alarm clock production moved into the black after a few years and then increased production and sales subsidised the production of pocket watches, which had been unprofitable for 15 years. The pocket watch department only began contributing to profits for the first time in 1911, 16 years after the first 22 ligne cylinder model went into production. By 1921 the Seikosha factory produced 321,762 units entirely in its own factory: they were worth 3,539,382 yen. During those years, the product that made the best use of improvements in pocket watch production technology was the 16 ligne "Empire", which was first produced in 1909. It was a luxury item with 15 or 17 jewels and each year some 150 were purchased by the Imperial Court, to be used as gifts.

By the early 1920s, the horizontal and vertical expansion of Kintaro's business empire and its use of precision technology helped K Hattori & Co to become leaders in the Japanese horological industry. But in 1923, the Great Kanto Earthquake struck and the company's Ginza headquarters and the Seikosha factory all burned down (although they had survived the earthquake). A fresh start had to be made.

Kintaro, now well over 60, might have been expected to be shattered by this devastation, but his energies were by no means spent. He committed all of his personal resources to the company and started to rebuild the factory. Amazingly, he managed to resume watch and clock production within a few months, in a barracks building, using his surviving skilled workers. The fire after the earthquake had destroyed 1,500 watches that had been left with the company by

The Cronos was developed as a new wristwatch for men. Its movement was slightly thinner than that in the Marvel and other refinements included a bridge anchored at both ends and Diashock shock protection. Production began in 1958.

customers for servicing or repair, but instead of seeing this as a problem, Kintaro turned it into an opportunity to boost the reputation of Seikosha. His concern for his customers was as great as for his factory. Every one of these lost watches was replaced with an equivalent new timepiece and this raised the level of trust in the company to new heights; this gesture was widely appreciated and has entered the folklore of the industry.

First Seiko watch

Just months after the Earthquake, the company had created an entirely new watch and it went on sale in December 1924. It was the first to carry the name Seiko, introducing to the world for the first time the brand name that was later to become synonymous with precision and accuracy, innovation and refinement. From that day forward, with the exception of a brief period during the Second World War, all Kintaro Hattori's watch products were united under the new name, a name that was soon to take its place alongside the industry's most valued brands.

In the mid-1920s, as the world moved towards economic recession, Kintaro again took a definitely positive approach and introduced yet more new technology in his factories and this helped Seikosha, in 1927, to produce the smallest woman's wristwatch made in Japan, just as the Japanese began to take to the wearing of wristwatches.

The re-built factory had faced stiff competition from both home and foreign producers and had survived. The quality of its products had risen significantly, thanks to the continued investment in new equipment, and the trauma of the destruction in 1923 was by then only a memory. Sales had continued to rise, with a peak soon to be reached in 1937, when 2 million timepieces were sold, accounting for about half of the total Japanese production. Kintaro Hattori didn't live to see this, however. He died in 1934 at the age of 75.

After his death, his two sons, Genzo and Shoji, succeeded him in the family business. It was able to survive and prosper because they had always been totally immersed in it and had followed in his footsteps. They, too, believed in innovation and had inherited their father's uncanny ability to recognise what was best for the company and its future.

The rebuilt Seikosha plant managed to improve the quality of its products, which had previously come in for some criticism. After the earthquake, the company had faced stiff competition both from domestic rivals and from the Swiss, but with its improved products Seikosha increased its sales in the Japanese market.

One of the first important moves made by the new management team was the creation of a new company called Daini Seikosha, which was set up in 1937 and took over the watch production activities of Seikosha. The Japanese word "daini" means "second". Today it is known as Seiko Instruments. In the same year the company had a stroke of luck when the Japanese government virtually halted the importation of watches after the outbreak of the war in China. For the first time,

This wristwatch assembly line, around 1950, used conveyor belts to boost production and the staff wore protective clothing to protect the movements from dust.

Seikosha was free from competition with the Swiss, but as the war in China continued into World War II, Seikosha was once more ordered to reduce watch and clock production for civilian use and instead to develop time fuses and marine chronometers.

Despite this, considerable effort was concentrated on the development of pocket and wristwatches and, by 1940, the new company produced Japan's first 3-hand wristwatch, and like all products since 1924, the latest in a long line of watches bearing the Seiko name. This was followed in 1941 by the first Japanese pocket watch chronograph and in 1942 a marine chronometer was produced – at the request of the Japanese Navy. K Hattori & Co Ltd had become the sole integrated timepiece manufacturer in Japan, with Seikosha producing clocks and Daini Seikosha concentrating on watches.

More destruction

On March 9, 1945, just 22 years after the Great Kanto Earthquake had destroyed the Seikosha factory, bombing destroyed the Daini Seikosha Kameido wristwatch factory. The only part of the group that survived the war was the Daini Seikosha Suwa Plant in the Nagano Prefecture, about 100 miles from Tokyo.

At the end of the war, Seiko was released from its obligation to produce military material and watch production continued again. Before the war Daiwa Kogyo had been started in the Suwa area as a factory that cooperated with Daini Seikosha. During the final period of the war large numbers of machine tools and timepiece components were transferred there from Tokyo and this became an evacuation factory for Daini Seikosha. As a result, the company was able to resume the production of wristwatches as early as August 1946.

The Second World War had a disastrous effect on Japanese industry, and Seikosha did not escape the impact. Not only had Seiko's plants had to switch to the production of items for military use, but problems emerged with raw materials. Imported basic materials became scarce and although this shortage stimulated domestic production of some of the materials that had previously been imported, serious supply problems remained. The price of raw materials, especially metals, increased dramatically and imports of English and Swedish steel, used for springs, stopped altogether.

During the war, material from Kyushu Yahata Iron Works was used for the production of springs, but this created many problems and the quality was not consistent. The result was stagnation. The lack of international competition – because of import restrictions – removed the incentive to be innovative or to make improvements. At the end of the war Seiko watches sold very fast, but the quality was not very high and Seiko's products were not even competitive against the many low-cost wristwatches that were available in Japan featuring imported Swiss movements in Japanese cases. The models made by Seiko immediately after the war only displayed hours and minutes

Wristwatch parts are being produced on these assembly lines, around 1950.

This very accurate King Seiko watch was a second generation model with a second-hand stop mechanism for accurate setting. The use of Seiko's Diashock shock protection system was highlighted on the dial.

and the styles had strong pre-war and war-time influences.

The most urgent challenge facing Seiko was the need to get away from the use of pre-war movements at the earliest possible opportunity and to start producing new watches for a new era, but it was only in 1948 that a new Seiko model with seconds was introduced and this was only a modified two-hand calibre; it had not been designed from the outset as a three-handed watch. Seiko's first watch with a centre seconds hand was called the Super. It had been developed at the Suwa factory of Daini Seikosha and with its modern styling it proved a great success. It enabled Seiko to counteract the growth in sales of crude three-hand watches that used foreign two-hand movements that had been modified by some Japanese watch stores using inferior kits in order to meet the demand. Introduction of the Super signified the beginning of a new era for Seiko. Once again, Seiko was in the lead in the Japanese watch industry.

Daini Seikosha's Kameido factory in Tokyo responded by introducing the Unique, a product that was similar to the Super, but 0.3mm thinner. This marked the beginning of a period of healthy competition between Daini Seikosha's Kameido and Suwa factories. The Suwa factory went on to introduce a new and highly accurate watch in 1956 called the Marvel. The two factories responded to the need to design even better watches by competing for the glory – and the company was the winner. This friendly rivalry concentrated on achieving technical improvements and helped to bring Japanese watch technology up to world-class levels.

Designsbasedonresearch

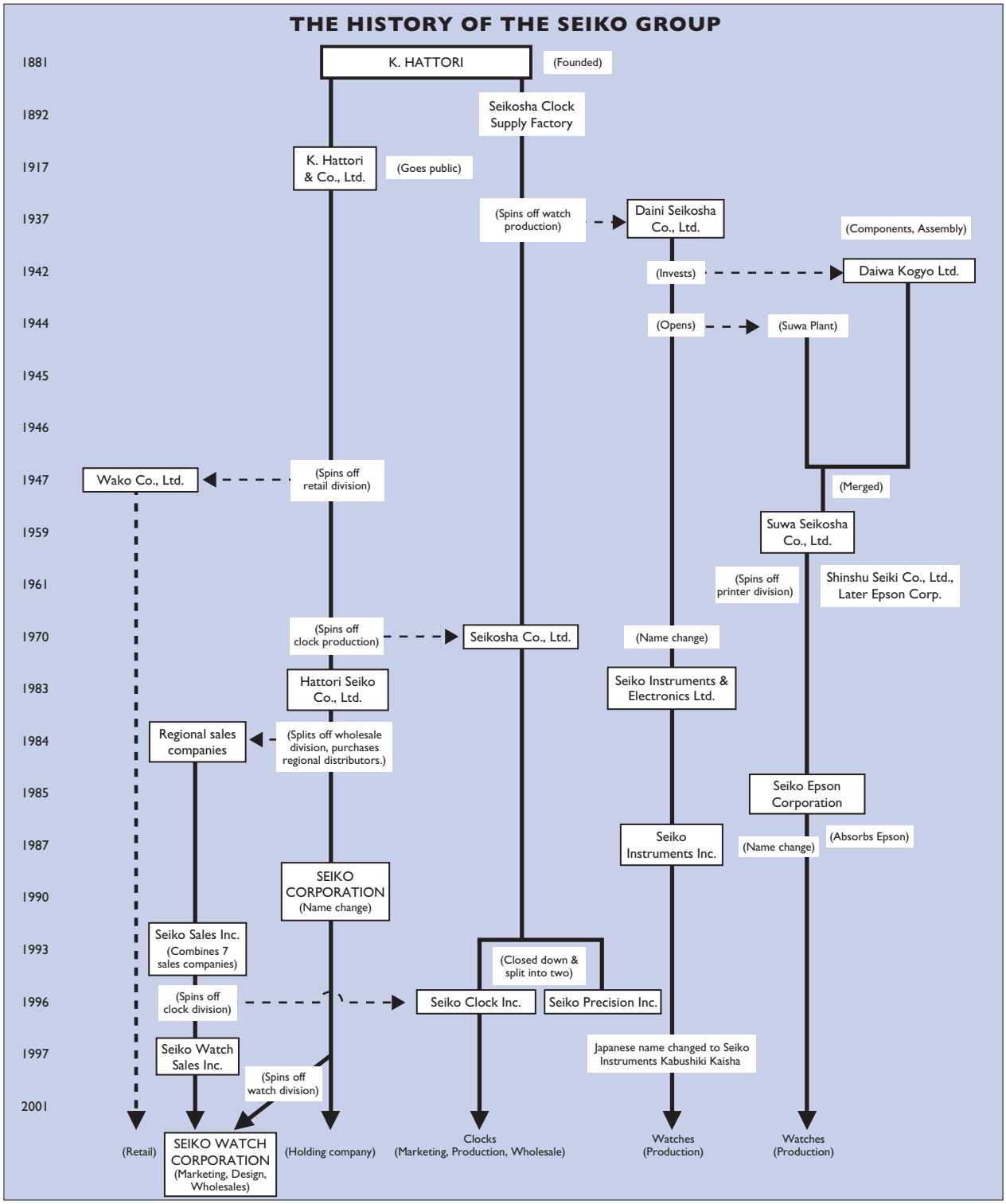
Skilled engineers were employed after the war to design new clocks and watches, and to base their designs on scientific research. They were given the task of improving accuracy and adding features such as automatic winding, waterproofing and calendars. The results were the first designs that were truly original Seiko products and they were catching up fast with those of European manufacturers. By the mid-1950s, Seiko's sales still lagged behind those of the Swiss, whose watches had finally reappeared in post-war Japan. The solution put forward by Seiko's management was to reduce the technical gap between its production facilities and those of foreign watchmakers. Their first target was the production of mass produced components that were uniform enough to be fully interchangeable – and not based on the design of foreign models.

The most advanced automatic machine tools were imported and others were developed internally so that the quality of precision components could be improved sufficiently to enable them to be completely interchangeable. This finally put an end to the "crossed paths" syndrome that had plagued assembly in earlier years. This reduced costs and in the early 1950s, conveyor belts were introduced to the watch and clock assembly lines. By 1965, Seiko was said to have the most automated production units anywhere in the watchmaking world, so its output was no longer dependent on a limited number of skilled craftsmen.

Mass production and quality improvements gave an enormous boost to sales of Seiko clocks and watches around the world. For the first time they sold in very large numbers and soon the number of timepieces exported by Seiko exceeded those of any other country, including Switzerland. At last, success for Seiko products in export markets was achieved because of their accurate timekeeping, more than just low cost or volume production. They were beginning to present a serious challenge to the Swiss watchmakers.

KEY LANDMARKS IN THE HISTORY OF SEIKO

1892 Manufacture of wall clocks begins.
1895 Manufacture of pocket watches begins.
1899 Manufacture of alarm clocks begins.
1902 Manufacture of desk clocks and music box clocks.
1913 Manufacture of first domestic wristwatch begins.
1924 First use of "SEIKO" name for watch products.
1930 Manufacture of shutters for cameras begins.
1956 Introduction of first domestic self-winding watch.
1958 Commercialisation of quartz clocks for broadcasting.
1959 Introduction of transistorised wall clocks.
1963 Completion of portable quartz chronometer.
1964 Quartz Christal Chronometer QC-951 plays a major role at the Tokyo Olympics.
Small quartz clock adopted for driver's cabin of the Tokaido "bullet train."
1968 Introduction of world's first quartz wall clock for home use.
1969 Introduction of Seiko Astron, the world's first quartz watch.
1972 Introduction of world's first ladies' quartz watch.
1973 Introduction of world's first LCD quartz watch with six-digit digital display.
1974 Introduction of world's first quartz dress watch.
1975 Introduction of world's first multi-function digital watch.
1976 Introduction of world's first quartz alarm clock.
1979 Introduction domestically of Credor and Alba brands.
Introduction overseas of Pulsar brand.
Introduction of twin quartz watch.
1982 Introduction of the world's first TV watch.
Introduction of Japan's first watches with voice synthesizers.
Introduction of Lorus brand overseas.
1983 Introduction of Seiko Voice Notes, the world's first watch able to record audio memos.
Introduction of the world's first multi-function analogue quartz watch.
1984 Introduction of the Seiko Wrist Computer Series, the world's first wristwatch computers.
Introduction of the Seiko Pyramid Talk, a "talking" clock.
Introduction of the Seiko LCD color television.
Introduction of the Alba Solar, an analogue watch with solar batteries.
Erection of Japan's first large-scale clock with automata, the "Seiko Mullion Clock"
1985 Lassale brand is introduced.
1986 Introduction of winding/charging quartz watch.
1988 Introduction of quartz watch with auto generating system.(KINETIC)
1990 Introduction of world's first diver's watch with diver's tables and depth gauge.
World's first watch with paging functions in practical use in the US.
1993 Introduction of world's first quartz watch using twin impulse control motors.
Introduction of "S-Yard" golf clubs.
1994 Introduction of diver's watch with small KINETIC mechanism included.
1995 Introduction of Alba "Spoon" series.
1997 Introduction of SEIKO KINETIC ARCTURA.
1998 Introduction of Perpetual Calendar, a watch driven by world's first ultrasonic micromotor.
Introduction of the SEIKO THERMIC, the world's first watch driven by body heat.
1999 Introduction of the SEIKO KINETIC AUTO RELAY watch, which automatically resumes correct indication of current time.
Introduction of SPRING DRIVE, a hand-wound watch with quartz accuracy, combining the best features of mechanical and electronic engineering .
Introduction of KINETIC CHRONOGRAPH, in a limited edition, offering new levels of technical sophistication.


THE HISTORY OF THE SEIKO GROUP
1881
1892
1917
1937
1942
1944
1945
1946
1947
1959
1961
1970
1983
1984
1985
1987
1990
1993
1996
1997
2001
K. HATTORI
(Founded)
Seikosha Clock Supply Factory
K. Hattori & Co., Ltd.
(Goes public)
(Spins off watch production)
Daini Seikosha Co., Ltd.
(Components, Assembly)
(Invests)
Daiwa Kogyo Ltd.
(Opens)
(Suwa Plant)
Wako Co., Ltd.
(Spins off retail division)
(Merged)
Suwa Seikosha Co., Ltd.
(Spins off printer division)
Shinshu Seiki Co., Ltd., Later Epson Corp.
(Spins off clock production)
Seikosha Co., Ltd.
(Name change)
Hattori Seiko Co., Ltd.
Seiko Instruments & Electronics Ltd.
Regional sales companies
(Splits off wholesale division, purchases regional distributors.)
Seiko Epson Corporation
Seiko Instruments Inc.
(Name change)
(Absorbs Epson)
SEIKO CORPORATION
(Name change)
Seiko Sales Inc.
(Combines 7 sales companies)
(Closed down & split into two)
(Spins off clock division)
Seiko Clock Inc.
Seiko Precision Inc.
Seiko Watch Sales Inc.
Japanese name changed to Seiko Instruments Kabushiki Kaisha
(Spins off watch division)
(Retail)
SEIKO WATCH CORPORATION
(Marketing, Design, Wholesales)
(Holding company)
Clocks
(Marketing, Production, Wholesale)
Watches
(Production)
Watches
(Production)

Competitions Spurred Seiko to New Heights

Seiko finally achieved international recognition after it entered the Swiss Observatory Chronometer competitions, competing successfully against some of Switzerland's finest manufacturers on their home ground. It marked an important turning point in the company's international fortunes and resulted in worldwide recognition and acceptance.

From its inception, Suwa Seikosha – now Seiko Epson – pursued a quest to develop the "perfect timepiece". From the mid 1950s it began to achieve total dominance in domestic timepiece competitions, which had been started in 1948 with the objective of improving the quality of Japanese watches. The Central Inspection Institute of Weights and Measures of Japan carried out accuracy tests on samples from the competing companies. At first, the results were depressing: of 180 watches submitted for testing, 62 of them stopped during the testing. This provoked the companies into a drive to raise their standards, with the result that levels and quality improved year by year.

When Seiko submitted the Marvel to the Institute in 1956, it was so successful commercially that it had no serious competition in the domestic market.

By 1958, the Marvel swept the board when it took every place from first to ninth in the domestic competition. Participation in these competitions provided the incentive to raise standards and Seiko successfully rose to the challenge.

The Marvel, on the market from 1956, won 1st to 9th places in domestic competitions and led to Seiko's interest in participating in international competitions.

When these domestic competitions came to an end in 1960 many people working at the company's Suwa plant were still determined to build the best possible watch and they "wondered how their products would fare in competition with the Swiss", according to Tsuneya Nakamura. He later became President of Seiko Epson and was closely involved with the development of Marvel and Grand Seiko, as well as quartz watches. The Observatory competition held each year in Neuchâtel included the word "International" in its title but it rarely attracted entries from any country outside Switzerland. When he investigated the rules of the Swiss chronometer competition, he discovered that foreign manufacturers were allowed to participate and was told the organisers "would welcome competition from Japan".

The company decided the Swiss chronometer competition would provide the perfect platform, both for

the pursuit of accuracy and for letting the world know the Seiko name. So in 1963, Seiko's Suwa Seikosha plant became the first Japanese watchmaker to enter the Neuchâtel competition. The product selected as Seiko's entry was a tabletop quartz clock known as the Crystal Chronometer, which was entered in the marine chronometer category. It was awarded 10th place, which was a remarkable achievement: never before had a manufacturer from outside Switzerland got into the top 10 places.

In the following year Seiko also participated in the wristwatch category, but the results were very disappointing. The highest position gained by entries from its Suwa Seikosha plant was 144th and the submissions from its Daini Seikosha plant achieved a dismal "best" of 153rd place. The only redeeming feature was that 14 Seiko quartz chronometers passed the chronometer tests. Far from being disillusioned, these disappointing results served only to fire up a spirit of competition among Seiko's designers and watchmakers. The pursuit of improved accuracy became a priority for the engineers in both plants and they, too, competed against one another in the race to make progress. Year-by-year, Seiko's competition results improved.

The event became an obsession and the plants went to extraordinary lengths to solve the problems. For example, Daini Seikosha's first entries in the chronometer trials suffered from an unexpected phenomenon: the balance springs had become magnetised and this was found to explain the unsatisfactory competition results. Despite this enormous setback, none of the reports at the time referred to the competition team being disappointed. In following years, Daini Seikosha ensured their timepieces were anti-magnetic, but nevertheless they were determined to minimise any risks and so their entries for the competition were sent to Switzerland using one of the southern routes, in order to avoid the influence of the earth's strongest magnetic fields.

Cailbre 965, was nicknamed The Potato, because of the shape of the movement inside the case. It was one of the earliest movements submitted to the Swiss competitions by the Daini Seikosha factory – it ran at 6 beats a second.

They also decided to make as many components as possible out of Permalloy – a nickel-iron alloy – to minimise the effects of powerful electronic currents that could affect them inside an aircraft. Magnetic fields pass through Permalloy without affecting the material. The same material was also used inside the containers used to ship the watches to Switzerland.

The early competition timepieces were unique and bore little resemblance to any products in regular production. As the competition timepieces became more accurate, some of the advances that had made this possible were introduced to Seiko's regular production watches. There is a parallel with today's car manufacturers: sometimes new design features first tried and tested in motor racing are subsequently adopted in production models. When Seiko was competing in the chronometer competitions, the use of movements with an extremely fast beat produced dramatic improvements in accuracy. Subsequently, fast beat movements were introduced to some models that went on sale to the public and helped to raise public awareness of the accuracy of Seiko watches.

Successive generations of movements made by Suwa Seikosha for the Neuchâtel Observatory Competition. Although the movements are housed in cases that look like pocket watches, they complied with the rules for entry in the wristwatch category.

At a time when the Swiss were finding their way in terms of using higher oscillating frequencies, the Seiko teams were breaking new ground, testing at two to six times the regular frequencies. Some of their competition watches used 15 and 20-beat movements, but during the testing phase, experiments were even carried out at speeds up to 50 beats a second. These were the second generation calibre 052 movements and they incorporated a number of improvements designed to provide stable support for balances operating at high speeds. Seiko's engineers decided that for anything other than competition use, the use of movements faster than 10 beats a second would be meaningless and 8 beats a second seemed an even better solution. By coincidence, the Swiss reached the same conclusion.

Another experiment involved filling watch cases with hydrogen so that there was no oxygen inside that could cause oxidisation – and rusting. This system was subsequently used in the production of some VFA (Very Finely Adjusted) and Grand Seiko watches.

Friendly rivalry

Seiko's Suwa and Kameido plants each developed their own watches for the Swiss Observatory trials and there was a spirit of friendly rivalry between them. The designers at the Suwa plant opted for an oval movement, but Daini Seikosha's Osamu Sugawara designed a special competition calibre featuring a movement in the shape of a distended parallelogram and this earned it the unlikely nickname of "The Potato" among the staff who worked with it. They started with a standard 6-beat timepiece known as Calibre 965, which had a large balance and barrel. At first, senior management were sceptical about Osamu Sugawara's "potato" design. Mr Sugawara subsequently wrote an analysis that became known as his "Firestorm Report". In it, he said that the "higher-ups" had reacted angrily when the prototype was built, but he convinced them that it was the only way to achieve their objectives. It was virtually unprecedented, even for the Swiss, for an entirely new design to be entered in the Observatory Competition.

Special cases were used when movements were submitted to the competition. The cracks in this case mark the wear and tear of 40 years.

Movements with a fast beat contributed in a major way to the higher accuracy of the competition timepieces and the concept was later adapted for use in some regular production models.

Apart from the shape, one other feature that was innovative for a Seiko movement was the use of a Guillaume, or bimetallic, balance wheel. At first, nobody in the company knew anything about bimetallic balances or how to make them, although they were aware of the benefits they offered in terms of eliminating rate changes attributable to variations in temperature. A Guillaume balance was used in the R-67 competition model. When they started work on competition movements, Seiko technicians knew relatively little about a number of technical features of some Swiss watches, and later they considered that starting with a blank sheet of paper had made them stronger.

In 1967, Daini Seikosha sent to Neuchâtel calibre 45 movements that were being used in the Grand Seiko and King Seiko lines, and these were subsequently marketed as special pieces that had passed the tests for "specially calibrated timepieces". They were known as the Observatory Chronometers and these VFA Seiko watches took second and third places

Kiyoko Nakayama, one of the team of competition regulators, "a watch lover down to her bones".

in the chronometer competition. A watch from the Daini Seikosha plant was second only to the winning entry from Omega and an entry from Suwa Seikosha was third. This was the last year of the Neuchâtel competition held under the old rules. Early in 1968, Suwa Seikosha submitted a timepiece that achieved substantially better results than the Swiss winning entry the previous year. Immediately after it was tested, an announcement was made in Switzerland that the highly respected competition had been cancelled.

Seiko then entered the Geneva Observatory competitions and at the very first attempt achieved a fantastic result. Swiss companies took the first three places, but Seiko's entries were awarded every place from fourth to tenth, which was the best result achieved by any manufacturer of mechanical wristwatches. Seiko achieved first place overall. By any standards, Seiko's achievement of moving from 144th place to first place overall in just five years was an outstanding result.

The right spirit

When Seiko first entered the Swiss competitions, the company's advertising used the ambitious copy line, "Worldwide, it's Seiko", but sales around the world were still very slow. However, the competitions – and Seiko's growing achievements in them – proved to be the perfect way to inform the world about the company's successful quest for accuracy. Seiko probably has the Swiss Chronometer Competitions to thank for instilling the right spirit in its development teams and in its factories and for making the name of Seiko more widely respected in the industry.

Success in the Swiss competitions could be attributed to many factors, including improved design, greater control of the quality of raw materials, higher standards of finishing and, above all, the work of the team of regulators who adjusted each competition movement to achieve the highest possible accuracy.

These regulators played a vital role in achieving such good results and Suwa Seikosha had a much-revered trio of calibrators. The most senior of them was Kiyoko Nakayama. Her career had started as a technician at Daiwa Kogyo, which later merged with Daini Seikosya Suwa Plant to form Suwa Seikosha. She was present when Suwa Seikosha was first established. At that time the factory paid staff on a piece rate system: the more watches an employee assembled the more he or she earned. Ms Nakayama often took parts home and worked until 4am. She later said that she never felt this was a burden because she really liked watches.

In the early domestic competitions Ms Nakayama was largely responsible for assembling the gear trains. She attributed her success to the fact that the palms of her hands hardly perspired at all. In those days there was no air conditioning, so it was a great disadvantage for a watchmaker to perspire. "My mechanisms wouldn't corrode, defect rates were low and I assembled massive numbers of watches," she said. She was successful as a watchmaker not only because her movements didn't rust, but also because her aesthetic sense and skills enabled her to produce superb watches. The watches made by Ms Nakayama had an excellent reputation and customers started to request watches that had been made by her. She was a born watchmaker.

This is a second generation movement of the kind used in the chronometer trials from 1966-68. The frequency was increased to 10 beats a second and a larger winding crown was fitted.

Eventually she worked full time in the research department and was included in the Observatory Competition team when the company decided to enter the Swiss competitions.

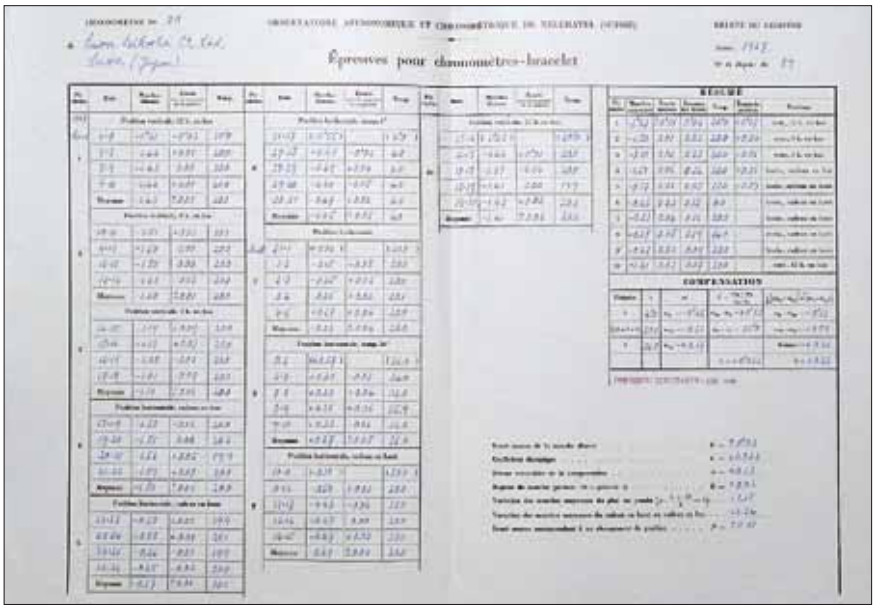
A living thing

The work of the highly valued team of regulators at Suwa Seikosha who were responsible for the competition timepieces seemed to them to be "looming larger than the children they had carefully reared". They often took no time off at weekends or holidays. Another member of the team, Kenichi Koike, recalled that this was a tough but enjoyable time. "A timepiece that we kept company with up to Saturday would be getting lonely when the Sunday holiday came around, so I couldn't settle down if I didn't look in on it. We really did think like this – if we don't take care of that timepiece today it might just fall off the straight and narrow tomorrow… it was a living thing."

Mr Koike was convinced that although the regulators carried out their work pretty well in the competition, success was the result of teamwork. "It was the designers pursuing theory to the extremes, the people in the prototype department making parts that had never been made before, and the top executives who watched over us that allowed us to produce results this far-reaching."

Thanks to their superior technical skills, Suwa Seikosha's famous trio of regulators were eventually selected as "Modern Master Artisans" by Japan's Ministry of Labour because they had helped to take Japanese watches to the top levels in the world.

The engineers who had been involved in the chronometer trials were invited to reminisce some 30 years later. These special people had achieved such an improvement in the accuracy of Seiko's competition timepieces that in a remarkably short space of time the company was able to match the best watches from Swiss manufacturers. One engineer recalled, "This [development work] wasn't in an atmosphere of 'if it feels do-able, let's do it; if we can't we won't'. No, it was



Rating details and certificates from the 1967 competitions in Neuchâtel.

The competition team celebrating success in the Geneva Observatory Competition. Seated in the centre is the famous trio of regulators.

By 1968, Seiko was experimenting with even faster movements. The barrel housing the mainspring was increased in size to accommodate the stronger mainspring and the movement shape was changed to a "deformed pentagon". This was Seiko's ultimate competition movement.

all because Chairman Shoji Hattori had issued the order 'Do it'!" It was one of a number of edicts made by various generations of the Hattori family that were to lead to substantial changes in the fortunes of Seiko.

Anenhancedreputation

Another member of the competition team later said that he thought it was good that Seiko had been able to go so far with mechanical timepieces and then switch to the development of quartz watches. It was time to bring down the curtain on research into mechanical watches – there was nothing more to be done at that time. The timepiece research section was closed and some of its staff transferred to quartz watch development. The journey from obscurity to global recognition had taken just eight years – eight years of effort that changed the reputation of Seiko forever.

Mr Nakamura later said of Seiko's participation in the chronometer trials, "I think we had a strong sense of purpose. It wasn't about logic, it was about our doggedness and zeal to 'build a watch that betters the Swiss'. Our corporate principles include the phrase 'the power of the individual and the demonstration of comprehensive strength', but this might never have emerged had we not had this competition experience. In this sense, I wonder if it wasn't the Observatory Competitions that created the principles that became the life and soul of the company."

The Pinnacle of Mechanical Excellence

Seiko's 120 year history of watchmaking has enabled it to master all aspects of the art, from micro-engineering to precision polishing. These skills are most evident in the remarkable range of high-grade mechanical watches that are so much in demand in the Japanese market to where, for the present, they are restricted, as demand in Japan is already much greater than the supply.

Around the globe, Seiko is best known today for its quartz products, but in the Japanese market it has long enjoyed a well-deserved reputation for the excellence of its mechanical timepieces. These products are made without compromise and by hand to ensure the highest possible standards of craftsmanship.

Grand Seiko (GS) is the name of the mechanical products that represent the pinnacle of Seiko's excellence in mechanical watchmaking. They first saw the light of day in 1960, when Seiko was making vast numbers of mechanical watches and had achieved outstanding success in the Swiss Chronometer Trials. The company had already produced the Super and the Marvel collections, the sleek and superior Cronos, Crown and Lord Marvel.

First models

The first Grand Seiko models were developed to cater for the top end of Seiko's wristwatch market. Development work started, when the Daiwa Kogyo and Daini Seikosha Suwa plants were merged to form Suwa Seikosha which later became Seiko Epson in recognition of the huge success of the Epson brand. Technicians working in Nagano Prefecture, far from Tokyo and near the Japanese Alps, developed the very top range of Seiko watches. The first GS watches were launched in 1960. In the next 15 years, the Grand Seiko range went on to become the finest collection Seiko had ever produced.

The self-winding Grand Seiko SBGR002 has an 18ct gold case and represents the pinnacle of Japanese mechanical watchmaking excellence. It boasts accuracy of +5 to -3 seconds a day. Both surfaces of the sapphire glass are curved and have an anti-reflective coating.

Development of the original GS range was directed by Tsuneya Nakamura, who joined the company in 1944 and designed the Marvel, which was first marketed in 1956. It was far more accurate than existing watches and proved to be a great hit. Even then, he was aiming to create the "ideal watch". Grand Seiko was created as the model with the ultimate specification and the company was determined that it should be the best in the world, so, not surprisingly, it became Seiko's signature piece. By this time, they had developed the technical skills needed for such an ambitious project and their experience and success in domestic competitions had enabled their calibration skills to be honed. All the technicians involved with the development of Grand Seiko knew that their goal was to exceed Swiss chronometer standards and so the skills they had acquired during the chronometer competitions were developed and adapted for use in production on a larger scale.

The company set out to make Grand Seiko watches to a standard higher than any timepieces ever made before in Japan; chronometer standards were the key to this ambition.

Tsuneya Nakamura directed the development of Grand Seiko and designed and developed some models of the Marvel, as well as the Diashock shock protection system

Originally "chronometer" was used to refer to an extremely accurate clock. It takes its name from the Greek words Chronos and Metron, meaning to measure time. The Swiss Official Chronometer Control (Contrôle Officiel Suisse des Chronomètres, also known as COSC), is the organisation that sets the standards for chronometer testing. It is an independent association governed by the Swiss Civil Code and it was set up in its present form in 1973. Previously, chronometer tests had been carried out by other organisations.

In 1968, an organisation called the Japan Chronometer Certification Institute was established to provide a chronometer certification service. The first watch certified by this new body was the 56 King Seiko, first marketed in 1969, but Grand Seiko watches were not submitted for certification because they were produced to the company's own "GS standard". This is more demanding than the Swiss chronometer tests and involves testing the rate of the watch in six positions, instead of the usual five. Mr Nakamura believed that the success of the first generation of Grand Seiko could be attributed to three important factors, accuracy, ease of production and beauty.

During the first years of the quartz revolution, production of Grand Seiko declined, and eventually ceased in 1975 when the accuracy and reliability of Seiko quartz watches pushed public demand for mechanical timepieces to one side.

Mechanical watch production came close to extinction in the first 10 or 15 years that quartz watches were available and in Switzerland, traditional watch factories either closed down or started to fit quartz movements in their cases. Many manufacturers could find no use for their traditional production equipment and much of it was scrapped. Most of the craftsmen whose knowledge had been handed down from one generation to the next turned their skills to other work. Swiss companies now openly admit how much they feared competition

Seiko sold watches containing movements that had been certified as chronometers in Switzerland, but this example with Neuchâtel Astronomical Observatory Chronometer Certification in 1969 is a rare collector's item.

In the first generation of Grand Seiko watches, a disk bearing a lion emblem was attached to the back of the watch case. The emblem became synonymous with Grand Seiko, but in later models it was engraved on the case back, as can be seen on the left.

This first generation Grand Seiko Chronometer was supplied with a rating certificate showing 15 days of inspection results.

in the quartz watch markets from Japanese watch companies, and Seiko in particular, during the 1970s and early 1980s. In Japan, as in Switzerland, watch factories devoted all their effort to the production of quartz watches.

In the mid-1980s, there was a gradual change and mechanical timepieces very slowly came back into the limelight. The Swiss responded by focusing their attention on high quality

The new mechanical GS movement 9S55 is decorated with traditional lines of polishing that identify it as a high class movement. The rotor of the self-winding mechanism bears the same decoration and is engraved with the name Grand Seiko.

spring-powered watches and many companies concentrated on recreating the past, producing reproductions of some of their best old models.

In the meantime, the reputation of the GS collection continued to grow to the point where there was a strong market demand for production to begin again. As a result, the second generation of Grand Seiko was born in 1988. These new GS watches, launched in Japan, featured a quartz movement, but they failed to set the world alight. By 1993, a new model using the Calibre 9F quartz movement was launched and this had a bold, sharp style that owed much to the first generation of Grand Seiko. It attracted a great deal of praise and at last people were saying, "Finally there is a new GS that lives up to the name". Many people believed that once Seiko had come this far, it was inevitable that there would be demand for a mechanical GS next, but although the company introduced new mechanical watches, they were not in the GS collection.

In 1992, it added a watch with a mechanical movement to its luxury dress watch line and, in 1995, launched an affordable collection of mechanical watches in its Laurel sub-brand. As interest in spring-wound watches gradually returned in the Japanese market, Seiko added more mechanical models to its range; they launched the Credor Chronometer, which came with Swiss chronometer certification, and a Credor Chronograph, with a newly designed movement.

By now, it was surely only a matter of time before a mechanical model was added to the second generation of Grand Seiko. Those who had eagerly anticipated the return of a mechanical

Although the 9S55 is finished to the highest traditional standards, it was designed using the latest 3D Computer Aided Design (CAD) software. It can be viewed on-screen from any angle and the software can simulate the movement in operation.

Grand Seiko since the second generation of GS was launched had to wait 10 years before their wishes were rewarded at the end of 1998, 24 years after the last one had been sold. There was still enormous brand awareness and goodwill for the GS name.

Mechanical GS revival

The first new mechanical GS watches featured movements that were refinements of existing calibres – in the same way that first generation GS

To achieve the high quality inherent in the Grand Seiko range, many processes have to be carried out by hand, but in the early days, production line experience gained with the Marvel was applied to some aspects of production.

watches had used refined versions of earlier models. The only exception was the chronograph. Eventually Seiko's designers persuaded the company's decision makers to let them create an entirely new calibre, the 9S55. They had the rare and exciting opportunity to design a completely new escapement, the part of the watch that provides its accuracy and can be considered as the heart of the watch. When problems were encountered, the new designers could not depend on asking their predecessors for advice, because most had retired or left the company when mechanical watchmaking stopped. Nevertheless, they studied the components and materials used in the past and were even able to track down some of the designers who had once worked for the company, in order to seek their advice.

The designers were determined to produce not only a very accurate movement, but also one that was so attractive and well finished that a watch repairer seeing it when it required servicing would say, "That's a beautifully finished watch". After achieving the necessary accuracy, the designers turned their attention to the finish of the movement. This new 9S calibre was designed from the outset to reach the highest standards of accuracy and appearance.

In designing this new calibre in the second half of the 1990s, Seiko's designers had two big advantages over their predecessors in the 1960s.

This Grand Seiko automatic VFA Week Dator was the first mechanical watch to claim a time difference per month of ±60 seconds – two seconds a day. It came with a two year guarantee.

They had the benefit of computer technology to speed up the design process, especially the production of very precise technical drawings, and improvements in modern machine tools made it possible to manufacture components with much greater precision. It would not have been possible to create an entirely new calibre in just two years without the benefit of computer-aided design.

This computer technology made it possible to determine the ideal shape

Grand Seiko movements are largely assembled by hand, so inevitably they are expensive. Here, hands are added to a watch.

Only a handful of craftsmen still have the requisite skills to use the Zaratsu method of polishing, which enables them to produce results that cannot be achieved in any other way. It is used on the finest Grand Seiko watches.

of the teeth on each wheel in the gear train and, as a result, the designers achieved a level of efficiency in the transmission train that equalled that of the 45 Observatory Chronometer and other ultra-special models from the past.

The decision that the new generation of Grand Seiko watches must

Many processes in the production of high-grade watches cannot be automated. Here, hands are examined one-by-one to eliminate any with tiny imperfections.

A case is examined after it has been polished using the artistic Japanese Zaratsu technique.

exceed Swiss chronometer standards confronted the designers with a considerable challenge. The standard tests for a chronometer involve checking the accuracy – or rate – of a watch in five different positions, but Seiko's designers gave themselves an additional task by adding a sixth testing position. Watches run at slightly different speeds when they are at different angles and so it is important to check that they perform to high standards in each of the required positions if they are to be certified as chronometers. The additional position that Seiko introduced in their own tests rarely occurs when a watch is being worn, but it does occur when a watch is taken off and placed on a flat surface.

In order to produce high grade gold and jewellery models, Seiko employ craftsmen with many different skills. Goldsmiths assemble gold bracelets by hand.

Seiko employ diamond mounters for work on their gem-set watches, as well as jewellery. Here, diamonds are set into the case of a gold watch.

The additional test that the 9S calibre had to pass meant that Seiko's internal testing of chronometer watches was much more demanding than would normally be expected, but this was in the spirit of the challenge that the design team had set for themselves. Only if it passed tests that were more demanding than any others could the designers be sure that Grand Seiko was the world's best.

Seiko's finest watchmakers use traditional methods to assemble the high-grade 9S55 mechanical movements used in today's Grand Seiko mechanical watches. It comes as something of a surprise, therefore, that they are produced at Morioka Seiko, in Iwate Prefecture. This factory is one of the most important in the watch industry and one production room in the plant is almost the size of a football pitch – but this is for the mass production of less expensive movements. High grade watch assembly is carried out in smaller, more traditional workshops within this plant, where the watchmakers work in surroundings in which any traditional European watchmaker would feel at home. At each workstation a skilled craftsman assembles and adjusts escapements with the aid of a microscope, assembles the movement, adds the dial and hands and cases up each watch in the finest traditions of the watch industry. Assembly of the 9S55 calibre benefits from the best of Seiko's high accuracy mechanical wristwatch manufacturing techniques,

Yasunori Nishimura was active as a designer during the transition from mechanical to the early quartz watches. He designed mechanical Grand Seiko, Seiko Sports, Bellmatic, Quartz Superior and Twin Quartz models.

The SBG001 was the quartz model that heralded the return of Grand Seiko models in 1988. It had a curved case back, to provide a more comfortable fit on the wrist, and accuracy was ±10 seconds a year.

combined, where appropriate, with Morioka Seiko's own automated technology for some processes.

When the designers began designing cases for the current generation of Grand Seiko watches, they sought to create a watch that would attract people and have a real presence, an enduring design that wouldn't soon become passé. "Above all, it had to be recognisable as a Seiko, with a certain universality," according to Nobuhiro Kosugi, manager at the Seiko Watch Design Centre.

Original design updated

When Grand Seiko was brought back to life, the designers started their work by creating replicas of the original GS design. This enabled them to appreciate the most attractive features of the design, as well as some inherent weaknesses. Seiko's engineers realised that water resistance would be improved considerably by altering the construction of the case without losing its best features. Success of the revival of Grand Seiko depended on retaining the feel of the original series, while adding enhanced features wherever possible. For example, the original model had "bamboo leaf" hands, diamond shaped and pressed to give them a certain contour. Only the top surface was polished. For the new GS, the top surface was diamond cut to give a mirror finish and in addition, the sides were polished, too. For the 18ct gold model, the hands were curved very slightly – by hand – so that they nestled close to the curved dial.

Case polishing of the highest possible quality is key to the appearance of Grand Seiko watches and so a special Japanese process called "Zaratsu" polishing is used to attain a superb finish. Extensive use of manual skills is required to achieve the perfect curves and the spectacular finish on the case of a GS watch. This special artistic technique cannot be automated: it can only be achieved with the human touch. Zaratsu polishing was first used on the second Grand Seiko model and it is still being used on current GS cases today.

Although quartz timepieces are sure to dominate the market for the foreseeable future, Seiko have responded to the revival of interest in mechanical watches with its new generation of Grand Seiko models. Experience in the domestic market has already shown that these new high grade watches appeal to collectors, but the production of each one involves so much manual work that production is not yet great enough to be able to supply international markets.

This diamond cutting tool applies a superb finish to watch hands, but relatively few can be polished at once.

In the 1960s, GS was Seiko's signature range; since its reintroduction, it has again been recognised for its excellence and is considered to be the signature range once more. The rebirth of Grand Seiko mechanical watches in 1998 may be just the beginning!

The Day that Changed the History of Time

December 25, 1969, was probably the most significant date in the history of modern watchmaking and without doubt it was the most momentous day in the history of Seiko. On that day, the company sold the world's first ever quartz watch and revolutionised our expectations of time. Overnight, the accuracy of wristwatches changed from seconds a day to seconds a year.

The phenomenon of quartz time-keeping was not new, but the ability to miniaturise the components to fit within the confines of a watch case had taxed the finest brains in the watch industry for many years. When Seiko started its quartz watch development project, the technology to achieve their goal did not exist and so they could not get outside help with this pioneering work. In the true Seiko spirit, almost everything that was needed had to be developed in-house.

Towards the end of the 1960s, it was widely known that the Japanese and the Swiss were neck and neck in the race to be first to market a quartz wristwatch. Seiko crossed the finishing line ahead of the Swiss and marketed their first quartz watch, the Astron, on December 25, 1969. Although the Swiss had already unveiled prototypes, they did not market their first quartz watches until 1970.

The first step towards the use of quartz as a regulator in timepieces was the result of work by Pierre Curie, who was better known for his pioneering work on radioactivity with his wife, Marie Curie. He first observed the phenomenon of piezo-electricity in 1880 while he was working with his brother, Jacques. Their discovery, which subsequently led to a revolution in timekeeping and a number of other industries, was that some crystals generate electricity when pressure is applied to them. They also discovered that the reverse is true; when an electric current is passed across a quartz crystal, it deforms and vibrates.

Seiko changed the history of time when it sold the world's first quartz wristwatch, the Astron, on December 25, 1969.

As telephony and the use of the radio developed in the early part of the 20th century, there was a need to find ways to maintain stable electrical frequencies. Warren Marrison, a Canadian telecommunications engineer working for Bell Telephone Laboratories, was searching for solutions to this problem. In the course of his work he investigated the properties of quartz crystals that had been discovered by Pierre Curie. Mr Marrison succeeded in developing a large, but highly accurate, clock that utilised the stable frequencies generated by a quartz crystal when used in an electrical circuit. He was able to demonstrate that clocks regulated by a quartz oscillator were more accurate than the most accurate mechanical clocks then being used as time standards in astronomical observatories. By the 1940s, quartz clocks were being used by time standard laboratories all over the world.

The major problem with these early quartz clocks was that they were bulky; Mr Marrison's quartz clock

The Astron movement began the quartz revolution. The screws suggest that it could be dismantled simply, but when it was first introduced no watch repairer outside Seiko would have known what to do with it.

filled an entire room. Apart from the difficulty of miniaturising components sufficiently in the 1940s and early 1950s, there was another enormous obstacle to the production of quartz wristwatches: there were no batteries small enough to fit inside a watch case. The first miniature batteries were developed by Samuel Ruben during World War II and manufactured by P R Mallory, but they were not leak-proof and could not store enough electricity to power a watch for a year or more. Only when Hamilton Watch Company in the USA pooled its development resources with National Carbide (later Union Carbide) was a battery small enough for use in a wristwatch produced for the first time – Hamilton Watch Co's first electric watch, the Hamilton 500, was launched in the USA in January 1957.

Seiko first developed its quartz Crystal Chronometer for the Observatory Competitions in Switzerland and then put it into production as the QC-951. Launched in February 1964, it was used to time some events at the Tokyo Olympic Games in the same year.

Hamilton's introduction of battery powered watches represented an intermediate step towards the successful development of quartz wristwatches. In the 500, the mainspring was replaced by a battery, but the use of a balance wheel and balance spring was still retained. This novel approach failed to produce much of an improvement in timekeeping because the frequency of oscillation remained the same as in mechanical watches.

Tuning fork accuracy

The next step in the development of battery-powered watches was the use of a metal tuning fork, which produced a more stable rate of oscillation at a higher frequency, harnessing the principle that a tuning fork vibrates at a constant frequency. This technique was employed in the Bulova Accutron, the invention of Max Hetzel, a Swiss engineer. Working for Bulova in Bienne, he produced the first prototype of the Accutron in 1955, but it was not launched until 1960. It contained a tuning fork that was made to oscillate 360 times a second by a germanium

The quartz crystal oscillator in the QC-951 was housed in a large vacuum tube 10cms long. It had a frequency of 6,269.388Hz and its circuitry included eleven germanium transistors and three silicon diodes.

transistor powered by a button-sized battery. Instead of ticking, like every mechanical watch that had ever been made, the Accutron hummed at a fixed pitch, just above middle C on the musical scale. It marked a step forward in timekeeping accuracy, as it was claimed to be accurate to within one minute a month, which was five to six times better than the best mechanical watches at the time. Bulova claimed it had an accuracy of 99.9977 per cent. However, it was susceptible to shock and to external sounds and so it failed to provide the perfect solution the watch industry had been seeking.

Meanwhile, in Japan, Seikosha had been busy developing its quartz technology. By 1958, the company had created a practical quartz timepiece for use by a radio station, but it was still the size of a filing cabinet. In the following year Suwa Seikosha embarked on a quartz timepiece development mission called the "59A Project". This led to the creation of the marine chronometer, a clock, that became Seiko's first entry in the Neuchâtel Observatory Chronometer Competition. In February 1964 a commercial version of the clock was produced, called the Crystal Chronometer QC-951, and it was used when Seiko timed the Tokyo Olympics in 1964. Subsequently the 59A Project developed other small quartz clocks for the Observatory Chronometer Competitions, as well as versions that were used in Japanese Bullet Trains.

Although the principle of quartz timekeeping had been known since Mr Marrison made his first quartz clock, the challenge for technicians trying to adapt the technology for use in a watch could be summarised by one word, "miniaturisation". Enormous progress was needed to adapt technology that once filled a room until it was small enough to fit inside a watch case, but Seiko set its engineers to work.

Before Seiko succeeded in perfecting a quartz wristwatch, it developed battery-powered mechanical watches, such as this 37EL. When quartz watches went into mass production, these lost their raison d'être and disappeared from the scene.

Quartz precision

In a mechanical timepiece the escapement, with a balance wheel at its heart, regulates the speed at which energy is released from a coiled mainspring. This energy drives a gear train that turns the hands. In a quartz timepiece, a quartz crystal oscillator does the work of the escapement and oscillates at an extremely precise rate. An electronic circuit counts these high frequency vibrations and uses its circuitry to reduce this to one pulse each second. This pulse can be processed by another electronic circuit that enables the time to be displayed on a digital display. In an analogue quartz timepiece, a stepping motor converts the pulse into rotary movement to drive a gear train that turns the hands to display hours, minutes and seconds.

Although the race to sell the first quartz watch was very closely contested, Suwa Seikosha had begun its development work 10 years earlier, when Seiko's mechanical watch production was in its heyday. The challenge of quartz technology brought about a fundamental change in the skills needed by those developing these revolutionary new watches. Mechanical engineers had been successful in introducing improvements in mechanical watches, but quartz watches also necessitated input from experts with other specialities,

When he joined the company in 1955, Hideaki Yasukawa produced designs for Marvel mechanical watches and subsequently became involved in the development of quartz timepieces. He later became CEO of Seiko Epson.

Kouji Kubota, who was involved with the development of Seiko's quartz watches, is seen here at the Seiko Institute of Horology with an experimental clock that used a section of balance spring stuff as an oscillator, when experiments were being carried out to discover if any other materials would function satisfactorily instead of quartz.

including electrical, chemical and other kinds of engineering. These specialists became key players in the development of the emerging technology.

Tsuneya Nakamura, who joined the Daini Seikosha Kameido Plant in 1944 and transferred to the Suwa plant in 1945, had investigated and written a report about the possibility of participating in the Swiss Observatory Competition. In 1963 he was appointed Suwa Seikosha Managing Director. As Managing Director he had the perception to appreciate that quartz technology could become the future standard of timekeeping although, during the 1960s, mechanical watches were still at their zenith. Some people even doubted the wisdom of allocating resources to quartz development at a time when Seiko mechanical watches were selling so well, but Mr Nakamura completely rejected this line of thought. He believed that sales of mechanical watches were so successful that they had created sufficient leeway for the company to look to the future and to invest in the development of quartz timepieces. His courage paid off for the company and for him – much later, in 1987, he became President of Seiko Epson.

A huge investment

The investment needed for this development work was huge, but Seiko accepted the challenge. It was considered necessary because of the company's on-going quest for "the perfect timepiece". Once again, Seiko's pioneering spirit came to the fore; everything had to be developed in-house and this brought out the creative spirit in the company's development team.

Before concentrating on the use of quartz as the oscillator for the new age of battery powered watches, Seiko's technicians experimented with a variety of other materials. Kouji Kubota started his career as an engineer at Daini Seikosha in 1947 and later joined the pioneering quartz watch development team. In an exclusive interview during research for this book, he explained that a variety of materials were tested as possible oscillators; he even tried using the metal from a balance spring, but the 1kHz frequency it produced was too low to be useful. A clock containing a movement equipped with one of these balance spring metal oscillators can be found in the Seiko Institute of Horology in Tokyo, where Mr Kubota became curator of world timepieces in 1999, and serves as honorary director. (Although the Institute was set up by Seiko, it contains exhibits by other manufacturers and from many periods of horological history. See Chapter 13.)

Asked if the Japanese knew the Swiss were in the race to launch the first quartz watch, Mr Kubota said that Seiko was aware of the intentions of the Swiss, whose Centre Electronique

Kinichi Ushikoshi had responsibility for developing systems for mass-producing quartz wristwatches.

Horlogère (CEH) research centre had already entered a prototype quartz watch in the Swiss chronometer trials.

Knowing that Mr Kubota had been closely involved with quartz watches since their inception, we asked if he could foresee the day when any other technology might take the place of quartz timekeeping. He replied, "It is

Seiko launched the world's first digital quartz watch with a Field Effect Mode (FEM) liquid crystal display in 1973. The six-digit LCD panel was manufactured in-house.

pointless to even try to replace quartz technology unless some other system reaches the same level of accuracy as atomic clocks." (Atomic clocks are the most accurate of all; the best now have an accuracy of one second in six million years, but scientists expect to be able to improve this to one second in six billion years. Such levels of accuracy are important in some scientific and astronomical work and in the communications industry.)

The early days of Suwa Seikosha's quartz wristwatch development programme, in the 1960s, were beset by difficulties. First they had to produce a reliable, durable timepiece. They had already produced quartz clocks and entered some of them in the Swiss chronometer competitions, but regular production timepieces presented an entirely different technical challenge. There was no problem if a competition timepiece stopped working once the 45 day test period was over, but a quartz watch in commercial production had to be reliable, robust and durable. These differences were the cause of many difficulties in the early days.

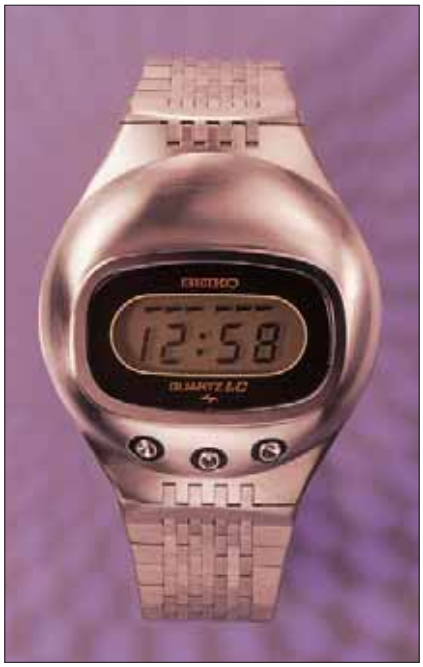
Eventually Suwa Seikosha decided to start afresh with a project to develop quartz watches for regular production, instead of trying to adapt technology that had originally been developed for competition timepieces. The short life of batteries was one of the first hurdles they had to overcome, together with the difficulty of reducing the size of quartz movements. They also experienced problems in maintaining accuracy when the earliest prototypes were moved about.

A Presidential decree

The project team became bogged down by their difficulties, and it took the intervention of the Hattori family to kick-start the effort again. In 1968, Shoji Hattori, the President of Hattori Seiko, ran out of patience and gave the order that there was to be a marketable product within one year, according to Hideaki Yasukawa. Leaving in place only one member of the original design team, he put together a new team comprising four or five of the brightest staff he could find and decided they should work on design and preparing for mass production in parallel. Mr Yasukawa has since said, "I think this is where the seeds for today's Seiko Epson culture of 'creativity and challenge' took root."

This new team started work towards the end of 1968. The three key technologies in quartz analogue wristwatches are the quartz crystal oscillator, the CMOS IC and the stepping motor. Engineering staff at Suwa Seikosha developed all three of these technologies and provided an enormous boost to Seiko's future.

The new development team assembled by Shoji Hattori decided to use an open-type stepping motor which was smaller, thinner and more robust than anything used before, and similar to those still used today. It conserved energy by moving the seconds hand only once a second, rather than trying to emulate the traditional sweep seconds action, thereby overcoming some of the problems experienced with the earlier quartz watch prototypes. There was considerable resistance from the marketing department to the fundamental change involved in using



Seiko's Daini Seikosha plant developed this 05LC liquid crystal quartz watch in 1973. It had a futuristic appearance, but was extremely difficult to produce.

Just 25 years after Astron, some quartz watches had almost unlimited functions. This diver's watch included an alarm and depth sensor.

a seconds hand that stepped forward only once a second, but eventually the objectors were convinced by the argument that this was a positive feature of a quartz watch.

At one of their marketing meetings, Mr Masahiro Kurita – a leading member of the quartz watch development team – happened to say, "I've never seen a second". This led to the company's new catchphrase for quartz watches, "Have you ever seen one second?"

High performance Integrated Circuits (ICs) and Large Scale Integrated circuits (LSIs) with low power consumption were not yet available and so the new development team made use of electronic circuits developed by its predecessors. They inherited a hybrid circuit comprising 76 transistors, 29 capacitors and 83 printed resistors that were soldered together manually. This had been developed in keeping with the company's philosophy, "what doesn't exist we'll make ourselves" and it facilitated Seiko's ability to market the world's first quartz wristwatch.

The next significant step forward was to be the development of an integrated electronic circuit to process the pulses generated by the quartz crystal oscillator and reduce them to one pulse per second. The Smithsonian Institute has defined an integrated circuit (IC or chip) as, "An assembly of interconnected components on a small semiconductor chip, usually made from silicon." It added, "One chip can contain millions of microscopic components and perform many functions."

The integrated circuit was invented in different forms in the United States by Jack Kilby, of Texas Instruments, and Robert Noyce, at Fairchild Semiconductor. They could have had little idea of the importance of their invention and the far-reaching effects it would have in the field of electronics. In watchmaking, one of the most significant benefits of the integrated circuit was that it had no moving parts, and therefore no friction that could cause wear, unlike the escapement of a traditional mechanical timepiece. This reduced the need for maintenance and gave quartz timepieces a further advantage over mechanical timekeepers.

In 1967, CEH entered quartz wristwatch prototypes in the Neuchâtel Observatory competition for the first time. The CEH laboratory had been set up in 1962 as a joint venture between a number of manufacturers. The first prototype quartz timepieces they entered in the chronometer trials took first, second and third places and signalled the serious interest of the Swiss in quartz timekeeping.

The race was on.

The Swiss had made it clear they wanted to market quartz watches as soon as possible, but Seiko, too, had commercial objectives in mind. Development work continued at top speed in Switzerland and Japan as companies in both countries pulled out all the stops to be first into the marketplace.

The first quartz sale

Seiko won the race and the first Astron quartz watch was sold on Christmas Day 1969; it made history and changed the world of watchmaking forever. The Astron's quartz oscillator had a frequency of 8,192 cycles a second (Hz) and the watch was claimed to be accurate to within five seconds a day. It was produced in a limited edition of only 100 pieces and sold for 450,000 yen – which was then about the same price as a Toyota Corolla car.

By the time of the Basel Fair in Switzerland, four months after the first Astron was sold, a number of Swiss companies announced the introduction of quartz watches for the first time. They used the same Beta 21 calibre that had been developed by CEH. After Seiko's hugely important launch, the quartz watch race moved at an astonishing pace and soon, Seiko was to take control of time. They launched new models in quick succession and by the end of 1970, continued to lead the way by launching the world's first quartz watch using a CMOS IC as its electronic brain.

In the first Swiss prototype quartz watches, a single IC comprising around 110 components was used to manage all the electronic functions of the watch. Seiko's Astron used a hybrid circuit – a combination of circuits on

Masatoshi Tohyama was instrumental in helping Seiko to launch the world's first digital quartz watch with a Field Effect Mode (FEM) display. Today, this system is used in all LCD watches.

a single substrate. These developments in integrated circuit technology were fundamental to Seiko's rapid progress and soon they were forging ahead with important new development work. At first, Daini Seikosha wanted to develop quartz watches that would not use integrated circuits, because they "were really a handful to deal with". Masatoshi Tohyama, who later became a director of Daini Seikosha, was searching for a way to make a quartz watch without an IC, but a chance meeting with one person changed his opinion and had a profound influence on the future of Seiko and led to the use of an IC in Seiko's second quartz watch.

Dr Tohyama explains, "A Swiss physicist called Dr Hoerni left the American company Fairchild to start his own small firm, Intersil Corporation, with a colleague. Dr Hoerni had been a disciple of Dr Shockley, the Nobel prizewinner who was one of the inventors of the transistor. Dr Hoerni was a pioneer of the semiconductor industry and the inventor of the planar process that forms the basis of today's microchip technology. These two founders of Intersil developed MOS and later CMOS technology.

In April 1967, after a meeting in Japan with Fujitsu, Dr Hoerni was taken to meet the development team at Daini Seikosha. He proposed the use of frequency dividers for watches using CMOS ICs. As Mr Tohyama heard this he thought, "This would work perfectly". At first, Dr Hoerni suggested a chip that required 6-volts and so the problem was whether or not the 6-volt power supply it required could be reduced to 1.3 volts. Integrated circuits can be broadly divided into bi-polar and CMOS types. The bi-polar type works at high speed, but consumes a large amount of electrical current. Conversely the MOS, and its more developed form, the CMOS, is slower, but requires less electric power. It also has greater potential for miniaturisation. Dr Tohyama chose the CMOS route.

Daini Seikosha accepted Dr Hoerni's proposals and in January 1969 development began. It was completed in May 1970. The contract between Daini Seikosha and Intersil had specified that the CMOS IC should have an input frequency of 16kHz, a voltage supply of 1.3V or less, power consumption of 7.5 microwatt or less, the chip size should be 4x4x1.3mm, and the development lead time was set at 15 months. The agreed development cost was $190,000.

While Seikosha and Intersil were developing the first CMOS IC suitable for use in a watch, the Swiss had been using bi-polar ICs in the Beta 21 movement used in their first quartz watches, but these had very high power consumption.

Dr Tohyama recalls the development of the first CMOS IC used by Seiko. "As expected, the most difficult challenge was that of reducing the required input voltage. Dr Hoerni expended 75 per cent of his effort on this." This CMOS IC was first used in

A view inside Seiko's experimental IC plant in Narashino. It was developing CMOS ICs, which have become the industry standard, at a time when the Swiss and others were still using energy-hungry bi-polar ICs.

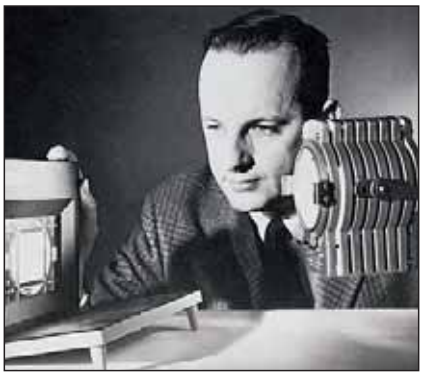
the Seiko 36SQC which was launched at the end of 1970. However, there were problems with yields – the percentage of acceptable chips in each batch – from Intersil's production and so Seiko took the momentous decision to produce all ICs in-house. This dramatic policy change proved to be of enormous significance and made the company even more self-sufficient. It also meant that they would not be at the mercy of an outside supplier for the supply of CMOS ICs.

Twenty years later Seiko Epson had become one of the world's largest manufacturers of CMOS chips and Japan had become the world leader in electronic timepieces.

In-housemanufacturing

Daini Seikosha developed versions that consumed even less power after it took CMOS IC manufacturing in-house. The performance of these ICs was fine-tuned to improve accuracy to just seconds a year and support was built-in for additional functions, such as chronograph and alarm features. Eventually the company expanded into the development of general-use micro-controllers that are now found in a wide variety of home and industrial equipment. This diversification provided the foundation for Seiko Instruments, which is today a major company in its own right, with consolidated turnover of US $1.8 billion in 2001.

Seiko's 36SQ was the first watch in the world to utilise a CMOS chip; now all quartz watches use CMOS technology. In 1972, Seiko replaced the short-lived 36SQ series with the 39 series. And the development continues – today, typical IC chips in watches contain 100,000 components or more and they can be likened to dedicated computers.



In 1968, RCA in America released these two pictures. The upper picture shows an RCA scientist holding an outdated mechanical watch alongside an LCD clock. The lower picture shows Dr Heilmeier, who had a meeting with Dr Tohyama to discuss digital display technology.

It was not just in chip technology that the approaches of Seiko and the Swiss were at variance. In the earliest quartz watches, there were important differences between the quartz crystal technology used by Seiko and by the CEH in the Swiss Beta 21 movement. Seiko used its own proprietary quartz crystal in the shape of a tuning fork, while the CEH calibre was fitted with a bar-type quartz oscillator, which was fixed at its centre. Seiko experimented very briefly with the bar type, but soon appreciated the superior benefits of the tuning fork version and today, the tuning fork shape has become the industry standard.

A quartz crystal oscillates at a precise frequency that is determined by the volume of the crystal; the larger the crystal the lower its frequency. Seiko's first quartz movement used quartz crystals with a frequency of 8kHz. Although the first quartz crystal chronometer clock made by Suwa Seikosha, the QC-951, used a bar-type quartz crystal purchased from another company, the Astron, Seiko's first quartz watch, used tuning fork quartz oscillators that were manufactured in-house and the company has made its own quartz crystals ever since.

In the early 1970s, the focus of the quartz revolution turned from invention to production. The evolution of quartz crystal production at Suwa Seikosha demonstrates the challenges that had to be overcome in order to succeed in producing quartz watches in quantity. The early quartz crystals used in the 35SQ watch, launched in 1969, were produced by hand. First, a tuning-fork-shaped tool was pressed against a quartz wafer about 1.5mm thick and an ultrasonic beam was applied in order to extract a quartz crystal in the shape of a tuning fork. Any imperfections were polished out and two holes were drilled, each to a different depth. Gold was then deposited on the crystal to form the electrodes, but before this was done a person drew a line on the crystal, using a brush, to prevent gold from adhering to this part.

The next stage of production was the most difficult. An operator

would hold the oscillator with a pair of tweezers and grind the tips of the tuning fork using a grindstone coated with diamond dust, while observing progress under a microscope. This process reduced the crystal to the precise volume necessary to ensure that it would oscillate at the correct frequency. This was truly the work of craftsmen, because even a speck of ground quartz dust on the oscillator could change its frequency. The quartz crystal was then cleaned in an ultrasonic tank. The frequency of each crystal was checked while it was being ground and after it had been cleaned. It was then soldered, by hand, to a platinum supporting wire and connected to the leads that powered it. Finally it was sealed in a protective case.

This work was extremely labour-intensive and anyone making 100 oscillators a day received a bonus. In the earliest days of producing the 35SQ, production was so slow it could be difficult to produce 10 units a month. By 1974, photolithographic etching was introduced and this enabled production volumes of oscillators to be increased dramatically. Today, tens of thousands can be produced in an hour.

By the latter part of the 20th century and at the beginning of the 21st century, most watches use a quartz crystal that oscillates at a frequency of 32,768 Hz. In Seiko's product range one exception is the crystal used in the Perpetual Calendar; it has a frequency of 196kHz, which enables it to attain even greater accuracy.

Mr Nakamura observed, "One big difference between the Swiss Industry and us that we learned of through the competition is that, in contrast to the distributed style of the Swiss, here we are an integrated manufacturer. If we believe anything to be a requirement, it's within our management's scope to take all the measures needed to act." His comments related to the Chronometer Competition, but his observation was very perceptive. This integration was ultimately one of the principal reasons that Seiko was able to expand production of quartz watches faster than any Swiss manufacturers.

In 1975 Seiko launched the world's first digital quartz watch with a chronograph, the 0634. It could record time to $^{1}/_{10}$ of a second and had a lap time function. It also incorporated an internal light, so that it could be seen clearly in the dark.

According to research by the Smithsonian Institute, the Beta 21 had been developed by CEH, which was financed by a consortium of Swiss watch companies, and each was responsible for a different area of the production of the early quartz movements. CEH designed the watch and produced the integrated circuit, Ebauches SA made the mechanical parts and the quartz crystal oscillator and Omega produced the micromotor. The finished products were assembled in three different factories that produced final products to the designs of the Swiss companies that placed orders. By 1970, 16 Swiss companies began selling quartz watches under their own brand names.

By contrast, the integrated production lines that had been a feature of Seiko's factories for some years imposed few production restrictions

The edition of Life Magazine in which Dr Tohyama discovered an article about a "chameleon chemical". The author could have had little idea of the progress that would be made in the development of liquid crystal displays in the following 30 years.

and the only significant component that was dependant on outside cooperation was the CMOS IC – and even this was only manufactured as a joint venture for a short time.

Chameleon chemical

In the late 1960s and early 1970s there was a growing desire to display information electronically and to show as much information as possible in digital form and Seiko was determined not to be left behind. The inspiration for Daini Seikosha's development of liquid crystal displays (LCDs) came when Dr Tohyama was looking through the March 3, 1968, edition of 'Life' magazine. He was intrigued by an article about "The Chameleon Chemical", which described how liquid crystal changes colour as its temperature increases. What riveted his attention was a sentence that said that liquid crystals "had the ability to create electronic images". The developer of this new technology was Professor Ferguson, at the Kent State University in the USA – which is now home to the Liquid Crystal Institute.

Dr Tohyama was keen to meet Professor Ferguson so that he could ask him about "creating electronic images". He soon discovered that liquid crystal displays were already being used in quartz clocks and as soon as he reported this to Shoji Hattori, he was asked to investigate LCD technology immediately. Just six days later, he took a flight to America and first visited RCA and met Dr Heilmeier, who was in charge of liquid crystal research. One American company had already asked RCA about the possibility of using LCDs in watches.

One major disappointment was that RCA admitted that the first LCD displays only had a life expectancy of 3,000 hours, but they believed that further research would extend this figure. Next, Dr Tohyama met Professor Ferguson, whose article in Life had sparked his interest in the opportunities of LCDs.

By this time, Professor Ferguson was developing a new system to utilise the properties of liquid crystals; he was developing Field Effect Mode (FEM) LCD's, whereas RCA were using the dynamic scattering mode (DSM) method. He was unable to show a sample, but promised to send one by the end of the year. After returning to Japan, Dr Tohyama became unhappy about the prospect of entrusting this work to foreign companies; he reasoned that it would not leave Seiko free to "scratch where it itched". Once again the company decided to undertake production in-house, maintaining its independence.

Research work started on

The world timer, A239, was equipped with a two-layer coloured LCD panel and displayed a world map and the time. It was aimed at international travellers.

The wrist computer, launched in 1984, was in two parts, the wrist mounted portion and the controller. It represents a very complex marriage of quartz, LCD and IC technologies, the fields in which Seiko has played a leading role.

December 12, 1968 with guidance from Professors Toyoshima and Mitsui from Tohoku University, using the DSM approach developed by RCA. On the last day of the year a package arrived from Professor Ferguson. Dr Tohyama said, "When I opened the package, there was a liquid crystal panel inside, and it said to apply a current of some tenths of a volt. When we tried it, the image was a clear as if it were ink on paper." Although he had only just started his research, Dr Tohyama decided that development into DSM technology should be discontinued and all effort switched to working on the FEM type of display.

Microma was the first company to launch digital watches, but its LCD display used DSM technology. By this time, the joint research between Daini Seikosha and Tohoku University was producing results and in 1973, Seiko was able to launch LCD wristwatches featuring their own FEM-type LCDs. The first of these products were the 05LC (Daini Seikosha) and 06LC (Suwa Seikosha). As Dr Tohyama had predicted, the FEM-type LCD became the main type of liquid crystal display.

Hamilton, the American watch company, introduced a further twist in the evolution of quartz watch technology in May 1970, when it launched a quartz watch with a digital display that featured Light-Emitting Diodes (LEDs) in a model called Pulsar. Seiko later acquired the name for a new brand they were to launch, and it has been in use ever since.

At the time that Hamilton launched their new first digital LED watch, Seiko, in Japan, and Ebauches SA, in Switzerland, were in the process of developing liquid crystal displays – LCDs. LEDs consumed so much power that they could only be used to display time at the press of a button for a few seconds at a time. The LCD display, conversely, provided a continuous display of the time and was much more energy efficient. The watch world was in a state of turmoil and it was difficult for trade buyers to know which of these approaches would dominate the market. There was also much debate about the future of digital and analogue displays. Some were convinced that digital displays represented the future for wristwatches, while others argued that they were a passing fad and when the novelty had worn off, analogue quartz watches would outsell digital models.

As the contest between LED and LCD displays heated up, it was almost impossible to predict which would prove most popular. Some watch industry observers thought that sales of digital quartz watches would become more important than those of their quartz analogue counterparts, but this did not happen. Seiko never produced an LED watch, although it considered the possibility briefly. Instead, it took the decision to use LCD technology for its digital watches and today it is clear that this was the right choice. With the benefit of hindsight we know that digital displays failed to dominate the watch world. By the early years of the 21st

century, analogue quartz watches are still outselling their digital counterparts, although digital models have continued to take a significant, but minor, share of the market.

Mass production

Meanwhile, the quartz analogue market was demanding ever thinner models, providing another challenge. Mr Kenichi Ushikoshi took charge of the mass production of Seiko quartz watches and his leadership resulted in the development and production of a thinner and less expensive quartz movement. Eventually, the size of the quartz module was reduced sufficiently for use in a dress watch. In 1974, it was marketed in a watch called the 41QD, the world's first quartz dress watch. This reduction in size was achieved by omitting the seconds hand and displaying only hours and minutes.

One development that Seiko – and European manufacturers – had not anticipated sufficiently was the interest of companies in Hong Kong and Taiwan in the watch industry. When they entered the market, a price war broke out in the digital wristwatch market. This had repercussions in the Swiss watch industry and also created difficult conditions for Seiko, which still wanted to pursue its watchmaking ambitions.

Seiko's remarkable success since the introduction of quartz in 1969 is partly attributable to the fundamental decisions it made in the early days of quartz. It opted for tuning-fork shaped quartz oscillators, developed the first open-type stepping motors, CMOS ICs and LCD displays for digital watches; all four have become the global standards in quartz watchmaking that have endured through to the 21st century. The quartz revolution, and especially the new technologies developed by Suwa Seikosha, laid the foundations for the future of Seiko.

Work on CMOS ICs by Daini Seikosha's development team had profound and far-reaching implications. This technology not only provided the basis for the development of all future watches, but also made possible the enormous Seiko Epson business that has its roots in electronic technology. The company's development of ICs, stepping motors and LCDs continued far beyond products for watches; now they are used in a broad variety of equipment for industrial and home use. This provided the foundation for the present Seiko Instruments, which is also an integrated electronic device manufacturer. Today, the Seiko Group is one of Japan's largest – and its success all started with a quartz crystal…

Kinetic Watches – All That is Best in Seiko Technology

Less than 20 years after selling the world's first quartz watch, Seiko took another giant step forward in the development of watch technology when it announced a new generation of quartz watches that eliminated the need for battery changes.

Creating a watch that was not dependent on batteries was of considerable significance not only because the new watch was more user friendly, but because it was environmentally friendly, too. Discarded batteries are harmful to our environment; anything that reduces the number of batteries that are being disposed of should be warmly welcomed.

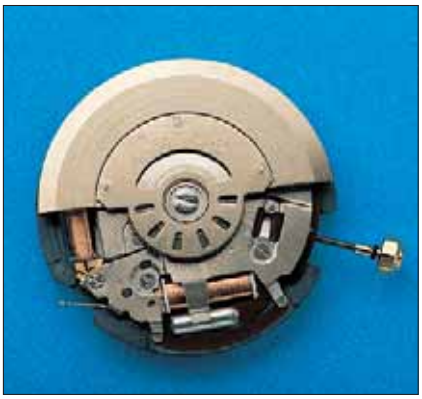
By the early 1980s, Seiko's technicians had developed a new way of generating and storing electricity, instead of relying on disposable batteries. At the Basel Fair in Switzerland in the spring of 1986 they unveiled the prototype of a watch that was called AGM, an abbreviation of Automatic Generating Mechanism, but this was soon changed to AGS, short for Automatic Generating System. Eventually it was given the more memorable and relevant name of Kinetic. (Collins English Dictionary defines "kinetic" as "relating to, characterised by, or caused by motion".)

At the heart of the new technology was the desire to create the first battery-free quartz watch, but Seiko's ambitions were even more profound. They had set their sights on producing a mechanism that would outperform all existing technologies. Most manually wound mechanical watches will stop after about 36 hours if they are not wound and even very expensive models with extended "power reserve" will only run between five and eight or 10 days at the most, but they are few and far between. Even self-winding mechanical watches stop a day or two after they are last worn.

This prototype of the Kinetic was first launched at a press conference at the Basel Fair in Switzerland, in 1986. The case was made from bright titanium, the most advanced type of titanium available at the time.

The running time of most quartz watches is governed by their batteries; most will run for at least one year before a battery change is required, and a few models can run for five or 10 years. One of the great attractions of quartz watches has always been that they work without any attention for long periods of time and with much greater accuracy than their mechanical counterparts. The one disadvantage that they had when compared with mechanical timepieces was that the battery needed to be replaced and this can become necessary at an inconvenient moment. For most people, if a quartz watch stops it is inconvenient, but to some people, such as divers or pilots, the failure of a battery could have serious safety consequences.

The lack of a self-winding mechanism was one of the very few disadvantages inherent in quartz watch technology. Seiko's development engineers were also conscious of the fact that discarded batteries are harmful



The world's first Kinetic movement was the 7M, which appeared in 1988. Off the wrist it ran for about 75 hours when fully charged. It was well received in Europe before its importance was fully appreciated in Japan.

to our environment. They worked long and hard to overcome all of these problems and to combine the accuracy of a quartz watch with the self-sufficiency of a self-winding mechanical timepiece. They started serious work on the problem in 1983. The first prototypes contained a rotating weight, similar to that used in a self-winding mechanical watch. The rotation of this rotor, caused by movement of the wearer's wrist, was used to generate energy (kinetic energy), which could be stored, and this was used to power the circuitry of a quartz watch.

The concept of using movement to generate electricity was not new – it had been floating around the company since 1969. The first Kinetic-related patent was applied for in 1971 – but it had been written off as an idea that was quite impractical for use in a quartz watch because the supply of energy, movement of the wrist, was erratic. The efficient generation of electricity usually requires a continuous source of kinetic energy consistently above a certain minimum level. At first, Seiko's technicians could only generate very small amounts of electricity using the irregular movements of a tiny rotating weight in a watch. The idea of harnessing such a tiny current to power a quartz watch movement seemed little more than a dream.

When development of the Kinetic concept started, it was referred to as 'internal generation' in order to distinguish it from solar-powered 'external generation' watches, which had been successfully developed for sale by Seiko by 1977. Serious work on the concept that led to the introduction of Kinetic watches really started at Seiko Epson in 1983. The leader of the project was Masahito Yoshino. He said, "I think of myself as the parent who brought Kinetic to birth, although I am not the one who later reared it to maturity". He became leader of the development team at the age of 34.

A variety of projects

At the time, his team had the task of conceiving "something new in watches" and was allowed free rein to develop new technologies of any kind. Their work covered multi-spindle watches such as multi-function chronographs and the provision of watch functions controlled by using the basic CPU and software. Their other research themes included quartz watches with sweep seconds hands (in which the seconds hand sweeps smoothly instead of jumping once a second) and wrist-type stopwatches with built-in ultra-miniature printers. The Kinetic watch was just one of these projects; they were not working exclusively on Kinetic. Mr Yoshino was subsequently appointed as general manager of Seiko Epson's R & D division and then became general manager of Corporate Planning Office, where he coordinated development work for various products being developed with Seiko Corporation.

This project team, faced with the challenge of developing Kinetic technology, decided to challenge conventional wisdom; they refused to believe that a self-powered quartz watch was impractical and eventually their innovative solutions proved

Masahito Yoshino was in charge of the Kinetic project and later became general manager of Seiko Epson's Corporate Planning Office.

remarkably successful. At first, energy issues provided them with apparently intractable problems. It took much hard work and the commitment of a dedicated team to overcome them. They were able to succeed because they had a wealth of development and production expertise at their disposal. They had the know-how to produce conventional mechanical watches, as well as the expertise in

electronics that had been acquired during the development and production of quartz watches. Above all, they had that vital Seiko attitude that welcomes the opportunity to tackle a new challenge, starting with a blank sheet of paper.

When work on 'internal generation' got underway in 1983, it could not be embodied in a viable product, but every few years a new start was made. The stumbling block was always the same: the gap between the amount of electrical power that could be generated and the power that was required to operate a quartz watch movement. This led to the failure of many of these projects. Mr Yoshino was not deterred by these past failures. He discussed the problems with Naoaki Yasukawa, who joined the development team to develop practical solutions of Kinetic problems and then became a section manager in the Watch Development Group.

More power needed

The two men concentrated on the need to produce more electricity and developed a system whereby electricity could be generated by turning the crown of a modified man's watch. "We managed to generate a current of 100 microamperes," Mr Yoshino recalls. "At that time, thinking of how much current was required to run a quartz watch, Yasukawa and I had agreed 'If we can generate 10 milliamperes, we'll be able to produce a viable product'."

Because the development team was working simultaneously on several other projects, getting the Kinetic concept to work was not a make or break deal for them. Having succeeded in generating one hundredth of the required power, Mr Yoshino said, "That is enough: let's give it a try". Some people in the company thought this result was discouraging, but Mr Yoshino was convinced they could make it work and he decided to go ahead with full-scale development. "Engineering, if you give it sufficient thought, can soon give you a ten-fold improvement, and if you go about it properly, can even give you a hundred-fold improvement. That's how I see it. There's also the fact that I felt strongly attracted by the idea of the original mechanical self-winding watch and had joined a company that made them."

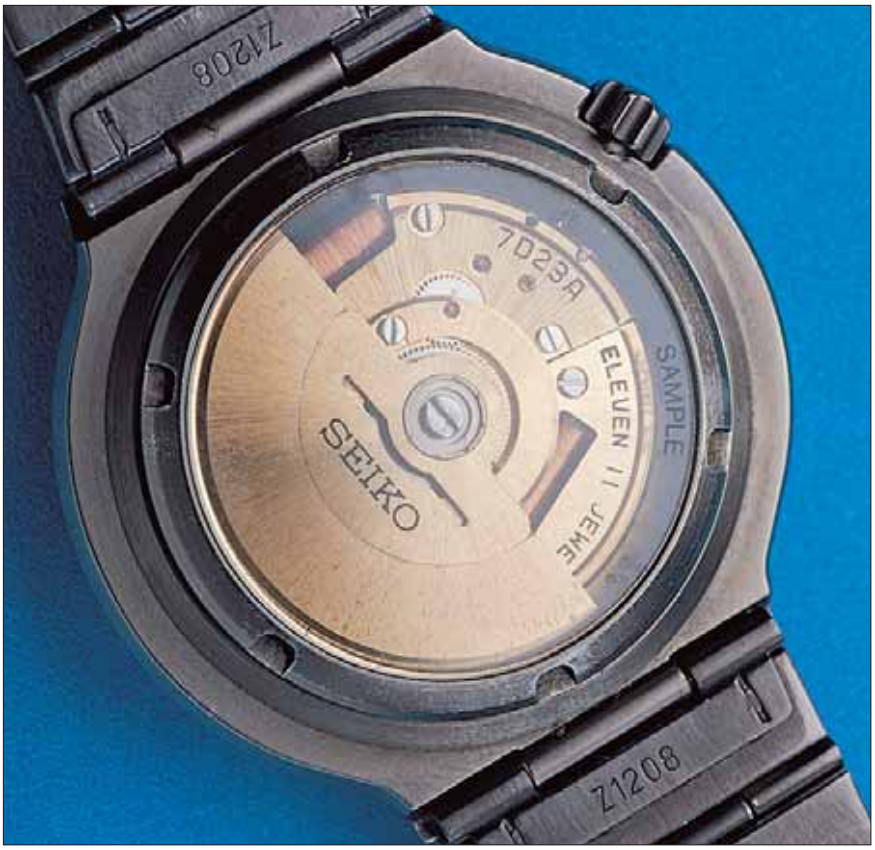
Shoichi Nagao was closely involved with the development of Kinetic technology, starting with prototypes, and then working with five generations, from the 7M to the 1M.

Mr Yoshino explains, "The wrist is a very hostile environment, always subjecting the watch worn on it to a series of vibrations and shocks. I thought the concept of the self-winding mechanical watch that takes advantage of this and uses it to power a watch was wonderful! I wanted to use the power that is generated just by the watch being worn on the wrist. It's already on the wrist, so we could use that fact to power it. There's nothing to say that a solar watch has to be on the wrist, but if a watch is driven by electricity generated by movement of the wrist, there's every reason for it to be on the wrist. You have a marriage of convenience and necessity."

Development work started with detailed investigations into the relationship between rotation of the oscillating weight and the generation of electricity. At first, the development engineers dismantled the dynamo that powers the lights on a bicycle. This revealed that only minuscule amounts of electricity could be generated when a generator was turned erratically. "At first, we didn't even understand how the rotation would affect the amount of electricity that could be generated. It was no use looking at run-of-the-mill electrical generators, because they were all designed to run continuously; movement of the rotor of a watch on your wrist is quite erratic."

After the team succeeded in improving power output to one tenth of their target, they ran into a brick wall. If product development was to continue, assuming that future power requirements would be the same as those of quartz movements being made at that time, it was clear that the rotor would have to be made larger and heavier. The drawback was that this would result in quartz watches that were thicker and heavier than those using conventional batteries that had to be replaced.

Another factor that had to be considered was that quartz movements were already available that only required battery replacement every



This prototype included the generator, voltage multiplier and low consumption quartz circuitry that formed the basis of the 7M calibre launched in 1988.

10 years. There was intense discussion within the company about the wisdom of producing thicker and heavier watches. It was wrong to assume that future generations of quartz movements would have similar power requirements to earlier generations. The only way to resolve the power problem was to develop a quartz movement specifically for Kinetic, with very low energy requirements. At the time, the industry was then moving its focus from ever-increasing accuracy to thinner and thinner watches. One quartz dress watch made then was only one millimetre thick. There was no demand for watches with lower power consumption than the models that were currently in production.

The development team persevered and began to conduct a thorough review of the fundamental attributes of quartz watch design, including low power consumption. Their research included important work that led to major advances in the generation and storage of electricity. They succeeded in developing an innovative voltage multiplier circuit that enabled the quartz watch circuitry to be powered successfully by an electrical generator that produced much lower voltages than the minimum that would otherwise be needed to operate the watch. It proved to be the breakthrough that enabled the concept of a Kinetic watch to be transformed into a viable product.

One of the engineers who later raised Kinetic technology to maturity was Shoichi Nagao. When he first joined the development team he had been working on general quartz watch design, starting with the design of gear trains. He had also worked on the Model 63 mechanical watch. He was invited to join the Kinetic project when it first looked as if it might be successful. He worked at the front line of Kinetic development from the first generation 7M to the introduction of the miniature 1M calibre.

He explains, "When I joined the development group, all we had was the first sample generator. This was the first project I had been involved with in which a decision had not yet been taken to produce a commercial product. The project involved a strong element of development that I really enjoyed."

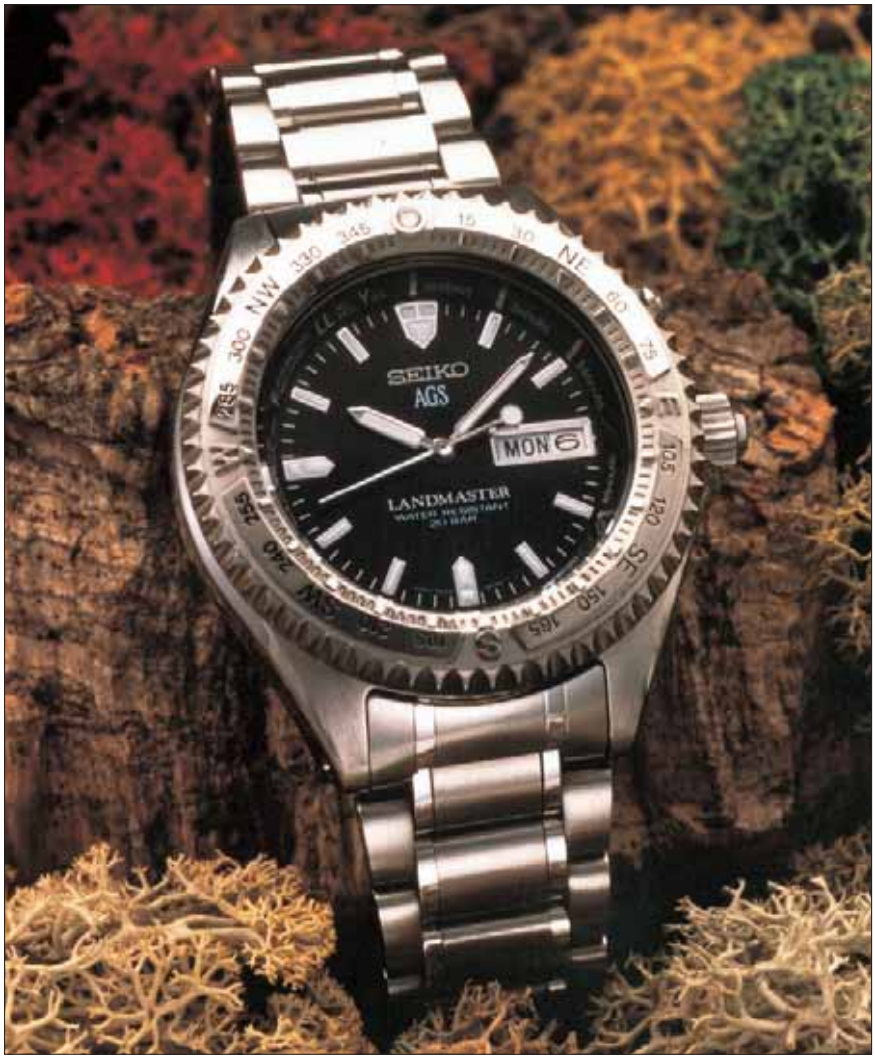
The team developed a perfectly balanced combination of a quartz movement with very low electrical power requirements, and an astonishingly efficient electrical generator and a storage system. Together these formed an electrical self-winding system to provide power for the quartz movement.

This great achievement marked the beginning of an extremely efficient ecological system that can be operated by minute electric currents. In this respect, Kinetic technology symbolises everything that is best about Seiko.

To succeed with Kinetic technology, Seiko's engineers developed many remarkable new devices. In the

generating unit, for example, the speed of rotation of the oscillating weight is multiplied 100 times by means of a gear train that turns a samarium cobalt (AG2) microrotor at speeds between 10,000 and 100,000 rpm. The rotor is suspended in a magnetic field and does not touch its housing – it is suspended by "magnetic levitation". The resulting magnetic field induces a current in the coils of the generator. This tiny, fluctuating current was rectified and stored in a capacitor. This stored energy was then used to supply the quartz oscillator and the stepping motor so that they could provide the timekeeping and display functions. To achieve this using only a tiny current required the development of CMOS IC devices and stepping motors that used only fractions of the power that had been required by previous generations of quartz watches. It also necessitated the development of new activated carbon capacitors with an enormous capacity. (Recently the capacitor in Kinetic watches has been replaced by the use of a rechargeable cell with a much greater capacity, ensuring the watch will operate for six months without any additional charge.)

Of all the new technologies developed for the Kinetic movement, the voltage multiplier is the star performer. It takes miniscule amounts of electrical energy from the power cell and uses it to power the circuitry of a quartz movement – without any wastage. A current of at least one volt is required to power a quartz movement. If the energy stored in the capacitor of a quartz watch is used to power the movement directly, the watch will stop working as soon as the voltage supplied to its circuit drops below one volt. Using Seiko's energy multiplier, the movement will continue to work even if the voltage within the power cell falls below one volt. The voltage multiplier has been compared with the automatic transmission on a car. It detects when the voltage in the power cell falls below one volt and steps up the output to ensure that it is maintained above one volt.



This Landmaster diver's model, housed in a one-piece case, was a good example of the use of AGS (Kinetic) movement which never necessitated opening of the case for battery change. It boasted a 20 bar water resistance thanks to this water-tight structure.

The concept of the voltage multiplier was as brilliant as it was effective. It made possible the completely stable operation of the quartz circuitry. This makes it possible to ensure stable operation of the quartz circuitry.

Eventually Mr Nagao's team produced a prototype, having surmounted all the technical problems. This was the prototype that was shown in public

In 1988, Seiko launched AGS, its first quartz watch powered by the wearer's movement. It was the forerunner to Kinetic.

for the first time at the Basel Fair in Switzerland in the spring of 1986. Ironically, few people realised that although the prototype was on display, work on the Kinetic project had already been cancelled. The decision had been taken for three reasons; the huge development cost, the high price of the watch and the thickness and weight of the watch. It was decided that further development of Kinetic technology was unwise at a time when there was a fashion for thin watches in both the Japanese and world watch markets.

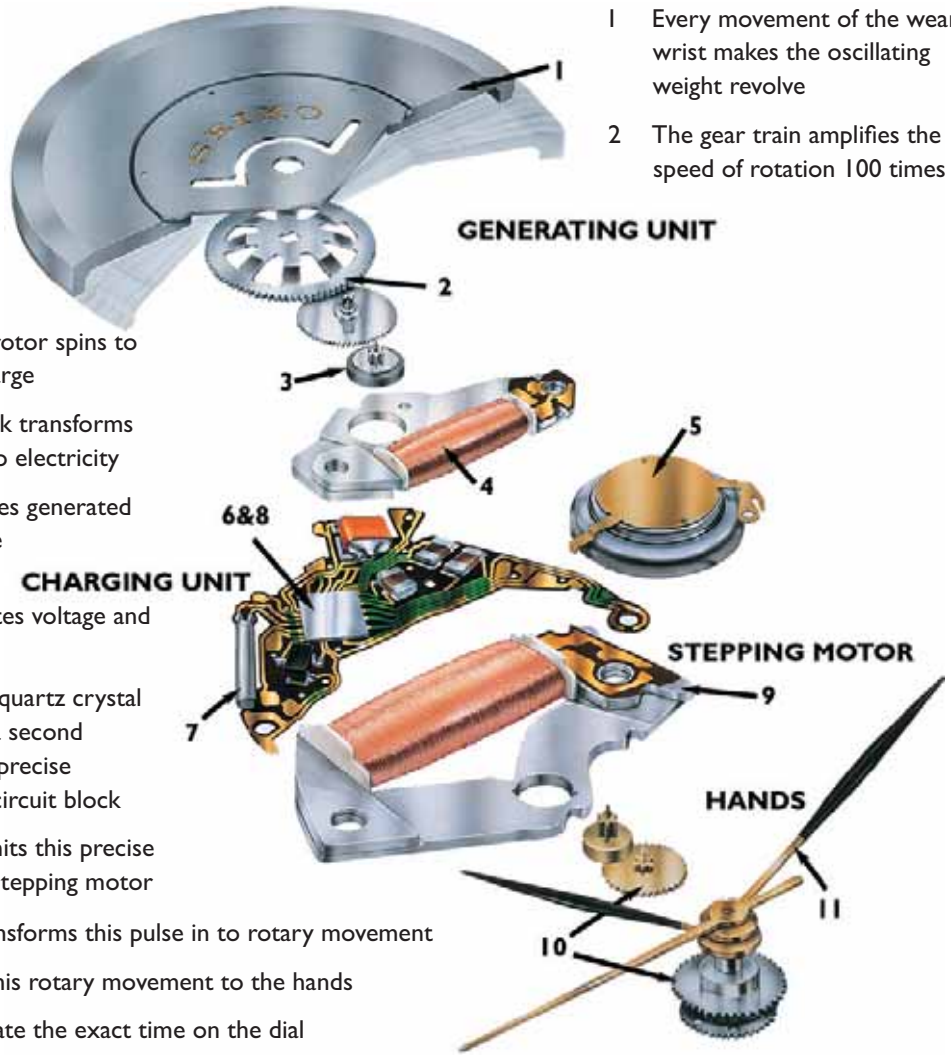
In October 1986, Mr Nagao attended a horological engineering conference in Switzerland where he presented a paper explaining Kinetic technology. He says, "I had very mixed feelings. I suppose I should have counted myself lucky to be able to announce Kinetic, because there were so many other developments that never saw the light of day." (A quartz watch that was also powered by the movement of a rotor was announced by one of the smaller Swiss watch companies. It was developed in co-operation with scientists at a Swiss university, but it ran into so many technical problems that it was soon withdrawn.)

The announcement of Kinetic technology caused a much stronger reaction in Switzerland than anybody at Seiko had anticipated. There was also a very favourable reaction in other parts of northern Europe, and especially Germany. In this part of the world, where days are quite short in winter, Kinetic technology was recognised as superior to that of the solar-powered watch. Seiko's top management quickly reversed their earlier decision and decided to commercialise this innovative new product. The development team began to work with very little rest. "In the early Kinetic days, I spent most of my Saturdays and Sundays working at the company. I remember that well," Mr Nagao recalls.

The first drawings for a production version of the Kinetic were completed in 1987 and just a year later the first Kinetic watch in the world, the 7M, was marketed. It was produced in small numbers and suffered from a number of limitations, not least that it utilised many components used in other Seiko movements. Nevertheless, it was another significant world "first" for Seiko. These ground-breaking new watches were sold first in Germany in 1988 and by April they were also launched in Japan. Mr Nagao later explained that these new watches were successful in Europe, but in the Japanese market they attracted customer complaints. Behind them lay changes in lifestyle. In 1988, Japanese lifestyles were more leisurely than when the first self-winding mechanical watches were made, and people were not as active as they had been in earlier years.

When the original 7M movement encountered these problems, the development team realised that if they could not improve their Kinetic technology, the tremendous future potential of the Kinetic watch would never be realised. They began to develop a new calibre, called 5M, at the end of 1989 to address the problems associated

Anatomy of a Kinetic Watch



1 Every movement of the wearer's wrist makes the oscillating weight revolve

2 The gear train amplifies the speed of rotation 100 times

3 The fast-turning micro-rotor spins to generate a magnetic charge

4 The generating coil block transforms the magnetic charge into electricity

5 A rechargeable cell stores generated electricity for future use

6 The circuit block regulates voltage and amperage

7 The tuning-fork-shaped quartz crystal oscillates 32,768 times a second precisely and delivers a precise electronic pulse to the circuit block

8 The circuit block transmits this precise electronic pulse to the stepping motor

9 The stepping motor transforms this pulse in to rotary movement

10 A gear train transmits this rotary movement to the hands

11 The hands turn to indicate the exact time on the dial

with the 7M. Mr Nagao explained, "It didn't seem right to accept the existing poor opinion. We felt we should make a calibre that satisfied us and see what people thought of that."

The hard work of the R & D team on Kinetic technology produced technical advances that were to prove useful not only for the Kinetic watch project, but in all later generations of Seiko quartz watches. "We tend to adopt an approach that is different from that used by most people around the world. In our own chosen field we gather everything that is best and then go for broke. If we don't do that, it's very difficult to make any real progress," Mr Yoshino explained.

In the late 1980s Mr Yoshino left the watch department and moved to the development of hard disks, printers and PCs, but watches still hold a strong fascination for him. "The wristwatch is the only piece of equipment that you wear next to your skin from the moment you get up in the morning to when you go to bed at night, without ever being aware of it. When you think of that, there's really nothing else like it. You become fond of it, because it

always moves around with you. Given that, I think you can say that the watch is something that communicates with its user and, for that matter, with its creator. And it's all concentrated there on your wrist."

In the 20 years after the first quartz watches were launched, their power requirements reduced by a factor of 30:1. Even today, power consumption is still being reduced. Without this improvement, Kinetic technology would never have been viable, nor would the development of many Seiko timepieces such as slim dress watches or models that are enhanced with additional features, ranging from chronographs to models with special sensors.

Soon, awareness of the advantages of Kinetic began to increase, not least among divers who were among the first to appreciate the value of this battery-free technology, and they were among the most enthusiastic customers for the new models. For them, a watch that could continue working without ever stopping was an attractive proposition.

The work of Seiko's development teams never ceases and development of the Kinetic range continued. Mr Nagao and his team went on to create the 3M line for use in women's watches, the 4M, a slim version that was ideal for dress watches, and the 1M, a miniature Kinetic movement.

An imaginative design

The next major step forwards was the unveiling, in spring 1998, of the Kinetic Chronograph calibre, which had been awaited with great anticipation. This was an imaginative product with a dramatic, eye-catching case design. The separate sub-dials made bold statements that enhanced the design still further. This exciting new model also had a see-through case back, so that the full beauty of the finely finished movement could be seen. The prototype was first shown at a press conference at the Basel Fair that year.

The Kinetic Chronograph was launched in February 1999 as a limited edition of 1,000 pieces for worldwide consumption. The regular production line was not introduced until 2000. This highly specified watch used the 9T82A Kinetic movement. This generated three times more electricity than any previous Kinetic watch. This was essential in order to provide sufficient power to drive the additional motors that were needed to turn the various hands. When fully charged it will run for over a month without any further charge, assuming that the chronograph functions are used for three hours every day. Given the extra power requirement of the motors for the additional hands of the four sub-dials, this is a remarkable achievement. Other appealing features include an instant zero reset function for the chronograph hands and an auto-braking wheel that reduces backlash on the hands, a feature taken from the Grand Seiko series. Improvements such as these appeal to watch connoisseurs and they clearly show how much attention is being paid to even the smallest detail in these watches.

Mr Nagao explained, "Watch designers have only a limited space within which to fit all the components and balance is critical. This is particularly true of Kinetic watches. All components had to be reviewed from the very start, because this was the most effective way of reviewing quartz technology itself.

"I see no reason why a Kinetic watch should not do anything a quartz watch can do. The future of the Kinetic is only just beginning!"

The 'Grammar of Design'

The word 'design' was largely synonymous with movement design for the first 60 years of Seiko's existence. It was only in the second half of the 1950s that the company began to pay serious attention to the design of the dials, hands and cases of its watches. Today, design is at the heart of Seiko product development.

The growing importance of design in the Seiko story is not one that is sprinkled with "firsts" or revolution. Instead, design emerged from being a mysterious art into a craft that is now influenced by input from market research and by a strong awareness of regional tastes and needs. Since the 1960s, and especially since the 1970s, the phenomenal growth in sales of Seiko watches suggests that the company has read the market correctly most of the time in terms of design and technology, but few of its own designs have stood out as stars; instead, this is a story of steady improvement.

Immediately after the Second World War, when Seiko was restarting its wristwatch production, the only designers at Seiko were those who developed new movements. Then, almost all Seiko watches had round cases and any change of design was restricted to minor details such as altering the shape of the lugs. Even in the early 1950s, the staff who produced printing materials for dial production were considered to be the "designers".

Since then, the meaning and importance of design for Seiko has changed beyond all recognition. The change of attitude started in 1956 when a Design Section was established for the first time at Suwa Seikosha, but, at first, its responsibilities were restricted to dial design. In 1958, there was a big step forward when Daini Seikosha for the first time decided to employ design graduates from college and, in 1959, Taro Tanaka became the first graduate ever to be employed by K Hattori & Co., Ltd. This was the first move in the company's history towards considered design not just of the dial, but of the whole watch.

Taro Tanaka was the first graduate hired for design work by K Hattori. He created Seiko's "Grammar of Design" that set out the ground rules that improved the design and finish of Seiko watches.

Mr Tanaka joined at a time when nobody in the company used the Japanese equivalent of the English word "design" and he often had difficulty explaining his role. Later he said that when he joined the company his first job had been to "make something like this" – and often, Seiko cases and movements were similar to those of European products. His pioneering new role in the company led to the establishment of new guidelines for designing Seiko watches.

When Mr Tanaka joined the company, there was a strong feeling that although Seiko products were mechanically sound, they were lagging behind when it came to case and dial design. So, first, he set out to gain experience in the factories involved with design, such as the case and

The 45 GS Hi-Beat, made in 1968, is a classic example of Seiko styling based on the Grammar of Design created by Mr Tanaka.

dial manufacturing plants. Mr Tanaka learned at first hand about raw materials and the production processes that were being used. At the same time, he was presented with an opportunity to consider carefully what watch design was all about.

He explained, "One day in 1962 I had gone to the Wako sales counters, just as I always did, and as I looked in one of the showcases I saw many watches sparkling brilliantly. Then I looked on the other side and saw watches that had a rather uneven gleam; the difference was all too apparent. The brilliantly sparkling watches were Swiss, and those with the duller finish were by Seiko."

This contrast alarmed Mr Tanaka. He studied them closely and discovered that while the cases of Swiss products consist of flat and conical surfaces perfectly smooth and free from distortion, the dials and bezels of the Seiko products had distortions that he attributed to Seiko's manufacturing techniques. The majority of Seiko watches at the time had brass cases that were polished using buffs and then chrome- or gold-plated. It seemed there was little that could be done about it.

He was convinced that Seiko had to produce high quality products that could match or surpass those from Switzerland and, with the sort of vision that has so often helped to set Seiko apart from other companies, he set out to resolve the problem. He created a "design formula" and eventually this became known within the company as "Seiko's Grammar of Design". He started by creating cases and dials that had a perfectly flat surface, with two-dimensional curves on the bezel as a secondary feature. Three-dimensional curves were not used, as a general rule. He also decided that all distortion should be eliminated from the dial, too, so that it could be finished with a mirror surface. This formed the basis for the new Seiko style.

The first model that received the new treatment was the Daini Seikosha factory's 44GS, which was produced in 1967. Later, the new Grammar of Design was passed on to Suwa Seikosha and used for the 61GAW, in 1968, and in the same year it was applied to the new 45GSC from Daini Seikosha. Mr Tanaka's design and production principles set new standards for Seiko's high quality and high precision timepieces, but the technique was only applied to high quality watches because it was labour intensive and therefore was not viable for low-price products.

The Grammar of Design was very much in evidence as the Seiko Style began to emerge. It was most evident

in the Grand Seiko and King Seiko watches created for the domestic market in the 1960s and the early 1970s. The rules of the "Grammar of Design" were used for 20 years, but the concept was eventually sidelined as increasing demand for a wider variety of styles obliged Seiko's designers to expand their horizons beyond the strict principles of the Grammar. Although few people within Seiko today have heard of the Grammar of Design, its importance at the time has been compared to that of Seiko's success in the Swiss Observatory Chronometer Trials and even the development of the quartz watch. Mr Tanaka can also take pride in having been involved with a number of other important design initiatives. He helped with the design of stopwatches for the Tokyo Olympics and the Seiko 5 series, as well as Seiko's Professional Diver's Watch 600.

Emphasis on design

This growing emphasis on design began to bring its own rewards not only in the form of increased sales, but also external recognition. In 1964, two Seiko products, the Crystal Chronometer 951, which had brought a new age of precision to competitive sport, and the Sportsmatic 5, which had been designed to appeal to young people, were among products chosen for the G-mark good design award. The public acclaim that resulted from these awards helped Seiko to appreciate, perhaps for the first time, that consumers valued the external design of its products, and not just movement design. In 1967, it responded to these design awards by starting a joint Design Conference between K Hattori, and the Daini and Suwa factories. This helped to create a bond between designers from the three companies. This led to design improvements in the outward appearance of all Seiko watches, whether designed by K Hattori's, Daini Seikosha's or Suwa Seikosha's teams. Further, this Conference decided to introduce international ideas to Seiko and, in 1968, the company began to send staff overseas to study design; and some were even enrolled at an Italian jewellery school.

The start of the quartz revolution, from the end of 1969, led to an important new role for the design teams as they began to think in terms of designs that were "appropriate". In 1971, K Hattori & Co., Ltd. established a specialised design team in its watch division. For the first time the company began to use computers to analyse the outward appearance of watches. It was considered extremely important that a design distinguished a watch as a quartz product, because the first quartz models cost as much as a car and it was vital that the public could identify these exciting new products at a glance.

In 1973, Seiko's first ever entry in a design contest in Switzerland won praise from the judges, but ironically, just as design was becoming more important than ever before, the Design Team was disbanded in 1974 and the designers were absorbed into the Product Planning division. The design work previously carried out by the team was transferred to the design divisions of Daini Seikosha and Suwa Seikosha. However, the need for more coordinated design soon re-emerged and it was not long before the two Seikosha divisions and K Hattori established a central design office in Ginza once again, with the goal of a more international approach to design.

Mr Tanaka helped to develop the product that was eventually called Lumibrite, a completely safe alternative to tritium. In this example, the white dots on the hour indexes and the white panels on the hands are Lumibrite.

By the early 1980s, Seiko's overseas business was growing rapidly and it was decided to add more models suited to local tastes. The decision to open design studios in various parts of the world was taken because Seiko recognised the importance of keeping in touch with design trends and market requirements all over the world. By 1980, Seiko design activities began in Dusseldorf and New York. Since then, further design centres have been opened – Paris, Milan and Hong Kong in 80's. In addition Seiko Instruments and Seiko Epson jointly established a design office in Kameido. This network of design offices liaised closely with their headquarters and the early adop-

For the Sapporo Winter Olympic Games, Mr Tanaka designed these three types of mechanical stopwatches. Only three designs were needed because the core sports timing functions were carried out using quartz timing by this time.

tion of 3D Computer Aided Design (CAD), in 1989, facilitated the creation of these new designs. The group introduced Apple Macintosh computers for design work in 1991, and was probably one of the first international companies to do so.

In the late 1970s and the 1980s, quartz timepieces dominated the watch market and, as manufacturers developed ever more sophisticated technology, more and more functions and features were built into this new generation of timepieces. When function-laden watches were at the peak of their appeal, Seiko design, too, was function-driven.

Designs were created around the many new technical features of quartz watches. This was a time when technology was the star. Even today, many people consider that Seiko's products were so successful in the 1970s purely because they were truly functional and had no added frills.

Mr Tanaka, the company's first design graduate in 1959, continued to develop new solutions to design problems and went on to combine form and function when he developed a new type of illumination for watches in the 1990s. He worked with Nemoto & Co, a chemicals company, to produce a luminescent product suitable for use on Seiko's luxury products to illuminate dials in the dark. Together they created a luminescent paint, originally known just as "NW", but subsequently known as Lumibrite; it was introduced in 1993. After being exposed to light for 10 minutes, it is able to provide an afterglow that illuminates the dial for 3 to 5 hours – without any use of electricity.

This technology has seen further improvements at various times and has been featured on many Seiko watches. It is still in use today and is a wonderful example of the enduring influence of the company's first ever design graduate. Lumibrite was invented in an effort to eliminate from watches the use of radioactive products that have an impact on production, as well as the wearer.

However, by the early 1990s, the rate of introduction of new features in quartz technology had slowed and manufacturers once again needed to look for other features to attract customers to their new products. There was a growing awareness of the contribution that good design could make

The Speedmaster SBBT001 chronograph was designed to showcase Seiko's technology. It is the world's only chronograph with $^{1}/_{100}$ second accuracy.

to the watch industry and some watch manufacturers realised that the public would pay a premium for watches that featured outstanding design.

As part of their quest for good design with consumer appeal, Seiko's designers started to introduce market research techniques into their design activities. At each stage of the design process they went out of their way to get feedback from friends and members of the public before fine-tuning their creations. They developed a dialogue with their target audience and listened carefully to what they had to say.

Dreams realised

One of Seiko's designers, Mr Nakanishi, achieved remarkable success with a design he produced in only his second year with the company. "When you've aimed for the field of design and got a job in this field, you want at some point to create something that will be recognised. I designed a Seiko Speedmaster during my second year with the company. In some ways I felt that my dreams had been realised much more quickly than I expected and I wasn't sure what was going on. I had joined Seiko Epson and thought 'I guess I'll be doing computer design', but instead I ended up in watch design and I was put in charge of Speedmaster. My attitude was that I wanted buyers to hold on to my product for 10 or even 20 years with the feeling 'I'm glad I bought this'. This was my attitude when creating this design, which was my first piece of work; I poured into it every ounce of energy that I had."

In the early 1990s, Seiko's designers investigated the possibility of entering their designs in overseas design competitions. Mr Okaya, one of the designers, said, "We had the impression that the 'Grand Prix de la Ville de Genève' was a contest to encourage designers within Switzerland, but when we asked, 'Can we submit an entry as well?' they allowed us to participate. I was awarded a Grand Prix in 1991. It was very similar to the situation that had led to our participation in the Observatory Competitions." He was awarded the prize for a bangle watch in the Rivoli series.

He explained, "I had entered Seiko at a time when the entire company was looking towards a new era and Seiko design offices had been set up in Paris and Ginza. A new age seemed to be dawning then with the end of mechanical watches and the beginning of the quartz era. We thought, 'Now we'll be on a different path from the Swiss, now it's going to be all about design.'

"In the midst of this, the role of the designer was changing. Our role was no longer just about designing the dial and sketching out the case. There wasn't much dialogue with outside parties and there was no way to get independent feedback about the skills of in-house designers. This was when I started to get the feeling that I would really like to enter an outside design competition and this led to our entry in the Geneva Grand Prix."

Since winning that prize in 1991, Seiko has recognised the importance of design not only in its watches, but also in other activities. According to Tomohiro Asayama, who had majored in metal engraving and joined Seiko as Design Director of the Credor division, "Here, we think about the overall image of the brand and then, as a result, what should happen with design. There's not much point creating product designs in isolation; it is necessary to make a total design effort, taking into account the watch, the presentation box, the advertising and sales promotion. With our own designers and a manufacturing division of our own, we are like an in-house company," he observed. Mr Asayama seemed to represent the voice of

Tomohiro Asayama, Design Director of Seiko's Credor division, believes in the importance of an all-embracing total design effort.

CREDOR

Credor is the name given to the most sophisticated and luxurious Seiko products.

today's Seiko designers when he added, "With luxury models, if you create too wide an assortment their rarity value declines and that's another problem.

"In the past, Seiko had a reputation for being a company where the 'hardware' ruled the roost. The key words that come back from surveys are terms such as 'accurate', 'doesn't break' and 'reassuring'. There were not many comments along the lines of 'cool' or 'good design sense'. In the future, it is an issue our designers must consider if they are to have an impact on users."

Importance of design

When Mr Tanaka became the first graduate employed as a designer by K Hattori & Co., Ltd., in 1959, he might have been surprised to know that he was the first of many, and he would have been delighted to see how his passion for design is today shared by the 60 designers who work, worldwide, on the creation of Seiko watches.

Today, in Seiko, design has become the discipline that dominates the company's activities in all areas, from product design to the creation of advertising. The design team form the heart of the company and they are involved in all aspects of product and conceptual design, seeking to build a complete "Seiko Experience" into every way that consumers encounter the brand. During the 20 years following the establishment of the "Grammar of Design", in the mid 1960s, the company succeeded in attaining standards in case and dial design that matched the chronological excellence of the movements. Now, the role of design has expanded to pervade all aspects of the marketing process, including graphic design for communication materials. The evolution of design is perhaps best exemplified by the Kinetic Chronograph, launched in 2000. The design of its movement was dictated by the desire to create a unique case – proof that interior and exterior design were finally in complete harmony – the ultimate synthesis of technical innovation and design refinement.

In order to appeal to design and image conscious customers, Seiko next turned to some of the world's top independent designers. The story of design innovation continues…

Seiko's Credor line includes luxurious jewellery watches, such as this diamond-set model. Production of Credor watches is limited, and so they have only been sold in Japan…so far.

The Influence of Global Design

Seiko's success as an internationally famous brand has long depended on the interaction between its internal design experts and the design trends of the European and global markets. This is why, in the early 1980s, Seiko decided to join forces with leading external designers to create some truly unique products.

Since the early 1980s the work of Seiko's in-house designers has been supplemented by means of collaboration with independent designers. The first example was the Speedmaster series launched in 1983. It was based on a design produced especially for Seiko by the renowned Italian designer, Giugiaro. Although best known as one of the world's leading car stylists, he has occasionally turned his talents to the design of products in other fields, such as the Nikon F5 camera, fashion, train station benches – and even pasta. His client list is impressive and includes such stylish names as Alfa Romeo, Audi, BMW, Bugatti, and Lancia. He has been involved with the design of more than 300 cars, including the Volkswagen Golf and the Toyota Aristo.

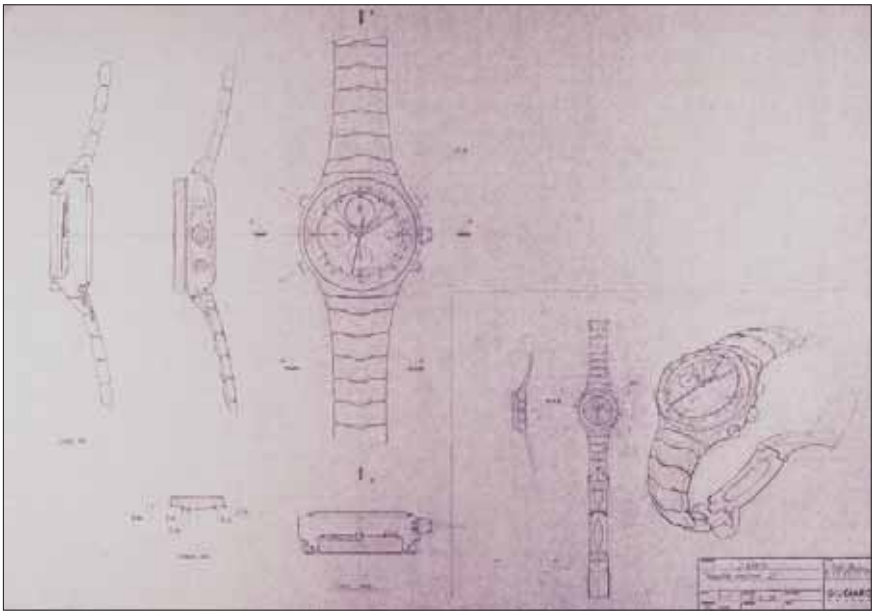
In Las Vegas in 1999, a jury of more than 100 journalists elected Giorgetto Giugiaro as Designer of the Century. It is appropriate, perhaps, that his personal motto is in keeping with the spirit of Seiko. It is "Go for it".

Until Seiko started to work with Giugiaro, the company had no previous experience of working with independent industrial designers, although it had undertaken some joint design work with fashion designers. As the urge grew to expand its design horizons, Seiko decided there was little point in working with any designers who were not among the best in their field. When they first contacted Giugiaro they got a pleasant surprise; they discovered that he already wanted to get involved in watch design, and so they came to terms quite quickly.

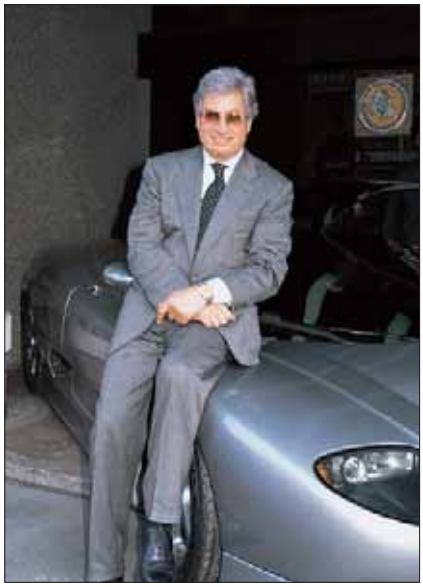
Yoshio Hirabayashi believes Seiko has reaped some extremely rich rewards from its cooperation with world-renowned designers.

When Giugiaro's first sketch was received, there was a startled reaction. Mr Hirabayashi, who was a senior manager in Seiko's Products Division, said, "We have to say that the first venture with Giugiaro was a shock. I really don't think that we would ever get something like that from an in-house designer." His proposals included digital chronographs with a tilted dial and

The digital chronograph Speedmaster was the most popular of the Giugiaro designs launched in 1983. The digital display was twisted 20° clockwise.



Initial sketches for the Macchina Sportiva, which came from Seiko's second involvement with Giorgetto Giugiaro.



Giorgetto Giugiaro is the Chief Designer for Italdesign, and made his name creating leading-edge car designs.

chronographs with sliding buttons that could be pushed up or down. With the technology available at the time, this was quite hard to implement.

Despite the difficulty of translating Giugiaro's designs into practice, Seiko's technical team overcame all the hurdles. "This really provided a stimulus to our designers and developers. It set them thinking, 'Now we're really going to have to develop a very special mechanism for this.' In that sense we reaped some extremely rich benefits," Mr Hirabayashi said.

In order to implement the unique button-operated system, Suwa Seikosha developed a new mechanism and obtained a patent for it. The feature that made Giugiaro's design for the 1983 Speedmaster truly original was the specification that the dome-style LCD digital display should be tilted 20 degrees to the right. This exciting new model was rich with innovative features. By turning the bezel, which had a built-in rotary switch, it was possible to select stopwatch, alarm, countdown timer and other functions.

Unique design

All that Seiko's managers had initially expected to achieve from collaboration with external designers was a new design for the Speedmaster. The result was a watch with unique styling, the manufacture of which challenged Seiko's expertise and resulted in a design that nobody else could mimic or match. It was recently reproduced as a collector's item, because of strong demand.

The next famous designer to work with Seiko was Austrian born Ettore Sottsass, who began his career studying architecture at the Turin Polytechnic. He became a leading figure in architectural and industrial design and acquired a reputation for working in a wide range of materials, including ceramics and glass fibre. He has been described as a "forward-looking designer who is also mischievous". His work was known for being colourful and humorous in the 1980s at a time when many designers were producing modern designs finished in black. It was said that his work could never be

A new mechanism had to be developed for the unique button-operated system specified by Giugiaro for this 1983 Speedmaster chronograph.

This Macchina Sportiva alarm chronograph, with a distinctive sienna orange dial, became the flagship model in the series.

described as bland and dull. His most thought-provoking comment on design was, "I don't understand why enduring design is better than disappearing design".

Three or four years before Seiko entered into the joint venture with Ettore Sottsass, he had marketed a "Sottsass" watch in the United States. Despite his reputation for bright, adventurous design, this was quite staid and conventional and was not a great success. Mr Hirabayashi was convinced that Sottsass really wanted to create a watch design that reflected his design philosophy and his eventual cooperation with Seiko provided that opportunity.

His design approach proved to be completely different from that of Giugiaro and from the moment his first presentation was received, the staff at Seiko were dumbfounded. They received not plans or sketches, but presentation boxes containing full-size samples made from a resin accompanied by comprehensive marketing packaging. Actually, the way he presented his ideas surprised Seiko personnel to no small extent.

The images that he presented to Seiko involved creating a three-dimensional feel by laminating together transparent plates. The Seiko technicians who had the task of translating his ideas into practical products that they could manufacture buried their heads in their hands. They asked, "How can we make something out of this? If he had given us the design in the form of plans, like Giugiaro, we could have developed a way of interpreting them, but this…!"

According to Mr Hirabayashi, Seiko's solution to the problem was to laminate together three layers of glass to achieve a sense of transparency, while preserving the most attractive features of the design. As full-scale production was beginning there were real problems in positioning the various layers of glass. Some people were saying, "Can this really be offered as a product?"

Although the production problems associated with the Sottsass watch drove Seiko's production team to their wit's end, the product was quite well received. The initial production model

The first design concept submitted by Ettore Sottsass included not only the watch design, but also packaging materials and even sales methods.

The three-dimensional effect in this first-generation Sottsass design for Seiko was achieved by using three layers of glass.

sold out and another version was produced with a modified design. Only because of the difficulty of production was it manufactured in a very limited series.

New Kinetic design

Inspired by the response of core enthusiasts who had been attracted by the Sottsass design, Seiko's managers appreciated the value of collaborating with top international designers. At this time, they needed a very special design that was as unique as the Kinetic movement, and a very special designer to create it. They chose Jorg Hysek. He was already famous for designing watches for many of the world's best-known watch companies, including Ebel, Breguet, TAG-Heuer, Tiffany and Dunhill and has been described as "one of the most sought-after horological designers". He is also highly respected as an innovative designer of pens.

When Seiko first announced that they were launching a Kinetic range, Jorg Hysek approached the company and said, "I've got a good idea for this." He believed the arrival of Kinetic watches marked the beginning of an important new era, just as the switch from mechanical to quartz movements had done almost 20 years earlier, and he wanted to design a product that was worthy of this new technology. Until he created the revolutionary Arctura design specifically to make good use of the Kinetic movement, practically all Kinetic watches, including the early AGS models, had simply been fitted in cases that were originally created for regular quartz movements.

Jorg Hysek was convinced of the great importance of Kinetic technology and he was determined that his new designs should be worthy of housing such an important new calibre. He had worked with Seiko previously when he created the design for the core model of the Jean Lassale watch collection and for some of Seiko's high-grade Credor watches, which are sold only in the domestic market. (Jean Lassale was a Swiss watch company owned by Seiko. It was dedicated to the production of jewellery watches for international markets.)

Mr Hysek created a design to house the Kinetic movement that comprised three-dimensional curves. The external appearance of his design was sophisticated but its construction presented another difficult challenge for the product development team. Mr Hirabayashi explains, "For the Arctura, the seams between the upper and lower parts of the case also had three-dimensional curves. Looked at in terms of our conventional wisdom this was simply impossible. To get these parts to fit together exactly and to maintain their water resistance and strength was an extremely difficult task."

Ingenious solution

Once again Seiko's technicians applied themselves to the problem with great diligence and devised an ingenious solution. The made use of Metal Injection Molding (MIM), a technique that is also used in some Landmaster and other models. This complex process is a form of Near Net precision Powder

This design, from Seiko's Sottsass collection in 1993-94, introduced exceptionally bold colouring.

Jorg Hysek submitted the mock-up on the left; Seiko had to devise a way to produce its complex curves and joins in regular production. The solution was the use of Metal Injection Molding.

Shaping (NNPPS), in which a mold is made that is double the size of the metal part that is being created and this is filled with a stainless steel powder, mixed with a wax-like binding material. This is baked in a furnace at a very high temperature. The powder consolidates into a single piece of metal, but in the process it shrinks to half the size of the mold. It is extremely difficult to control the dimension and shape of the finished watch case, but thanks to its success in mastering MIM, Seiko can now manufacture a case regardless of its dimensions or complexity. This provides a major advantage over conventional pressing or milling techniques, because it enables new shapes to be produced. Although Mr Hirabayashi had every confidence in the ability of Seiko's development team to devise creative solutions to difficult problems, he was amazed by what they did with the Arctura.

These 1997 Arctura Kinetic designs by Jorg Hysek feature brightly coloured silicon straps and stainless steel cases.

Collaboration with overseas designers has helped to give a cutting edge to Seiko designs and to ensure they appeal to a worldwide audience. The revolutionary creations resulting from these partnerships have brought out the best in Seiko's own design and production teams and resulted in the development of interesting technical solutions to some of the production challenges these designs have created. The end result of Seiko's collaboration with world-class designers has been stimulating and has helped to focus the attention of the media and the public on some of the company's most exciting products. Seiko has always made a virtue out of its desire to take on fresh challenges and this cooperation with top designers is an excellent example. It builds on the company's strengths and instils fresh enthusiasm in its design and development teams.

Jorg Hysek was born in East Berlin and set up his own company, Hysek Styling, after working in the design division of a Swiss watch company. He is one of the world's most respected independent watch designers.

Since the company was restructured and Seiko Watch Corporation was set up in 2001, it has confirmed that design is of fundamental importance to the future of Seiko watches. In order to remain at the cutting edge of design, and in keeping with its vision of succeeding through innovation and refinement, the company will continue to work in partnership with leading international designers. The combination of international designs and Seiko's innovative manufacturing expertise will no doubt create many more intriguing new watches in the coming years.

The top model in the Hysek Arctura line was the SBVW013. The curved aperture on the right of the dial shows the level of charge in the power cell.

Sports Watches That Go To Extremes

During the development of timing systems for the 1964 Olympic Games, and ever since, the challenge of sport has inspired Seiko to create new technologies, new materials, new functions and new display systems. These serve the needs of true sportsmen and women worldwide.

By working closely with specialist users, Seiko has helped to ensure that its sports watches are able to survive the most demanding environments and provide all the relevant information. Many of the resulting features and manufacturing methods have subsequently been incorporated in regular production watches for serious use by explorers, as well as sports enthusiasts and professionals the world over. This proved, beyond any doubt, the company's technical capabilities and expertise.

Seiko launched Japan's first diver's watch, the Seiko 150M Diver, in 1965. At that time, relatively few people were involved with diving and so this was a very specialised product. Then, even in Switzerland, very few timepieces were described as diver's watches. Now, with so many people taking up diving as a hobby, and many professionals making their living underwater, diver's watches have an important place in the Seiko collection.

Even today, some manufacturers respond to the allure of the market for diver's watches by labelling almost any water-resistant watch as a diver's watch, but Seiko takes its responsibilities much more seriously. It knows that in some circumstances lives can depend on the information provided by such a watch. Entry into this specialised marketplace marked significant progression in Seiko's product development and later brought benefits to many of its product lines.

When Seiko first decided to create truly professional diver's watches, Mr Tanaka visited an oil drilling platform to study the problems at close quarters. The research carried out here influenced the Diver's Watch Professional 600.

The success of Seiko's first generation of diver's watches encouraged its engineers to develop new techniques to improve water resistance, legibility and shock resistance. By mastering these challenges, Seiko was able, in 1967, to launch the 300M diver's watch. This was another important step forward because it doubled the depth to which a Seiko watch was operational. The following year, a fast-beat preci-

The 150M marked the beginning of Seiko's production of diver's watches.

sion movement was used in this model – the same calibre that was to be found in some Grand Seiko watches.

Soon after the launch of this timepiece, which was thought to have set a new standard in diver's watches, the arrival at Seiko of a letter from a professional diver in Kure City, in Hiroshima Prefecture, dismayed the company's technical team. It described the harsh technical conditions in which divers have to work and explained how this caused problems with watches.

The diver explained that he worked at sea in depths as great as 350 metres, using a diving capsule and saturation diving techniques, and he complained that some watches had been damaged when ascending from such great depths. He added that when working on the ocean floor his watch was sometimes knocked quite hard against rocks; the existing Seiko diver's watch had not been designed to cope with such arduous conditions. Seiko's technicians realised that much more work was still needed to make their watches even tougher and to overcome the problems that watches could suffer when ascending from great depths after prolonged submersion, as happens with saturation diving. This one letter revolutionised the company's attitude to sports watches.

Seiko responded immediately by establishing a new project team that began work on a watch that was for use by professional divers. In order to produce such a product, they first had to develop watches that could endure much more rugged use than the first generation and that were able to provide much more information, tailored specifically to the requirements of serious divers.

The work of this team had profound implications for all Seiko's future sports watches and established a philosophy that remains valid today: if Seiko is to make a sports watch, it will be made to the highest possible standards, with the professional user in mind. A stream of high quality sports watches flowed from this philosophy throughout the 1970s and 1980s, all of which enhanced the company's reputation for precision, reliability, functionality and good design.

As a result of this success, Seiko became a leader in this fast-growing market segment.

Any major development project is the work of a team of people, but usually one person provides the leadership and inspiration for that team. In the development of sports watches that person was Ikuo Tokunaga, who is in charge of the development of high functionality wristwatches. He joined Seiko in 1970 and was first put in charge of the development of a chronograph that incorporated a built-in slide rule. This was the start of his involvement with product development, and especially with sports wristwatches.

After progressing from the chronograph to the development of diver's watches, his horizons expanded to

The 8th Antarctic Wintering Team made use of the 150M diver's watch in 1966.

encompass other heavy-duty models that were supreme examples of the ultimate performance that can be achieved by a watch on land, at sea and in the air.

Seven years of research

The research period for this serious new product, the first professional diver's watch, was seven years. When the development team started their work, the expression "the outdoor life" was only just coming into popular use and many companies offered their ordinary diver's watches for almost any outdoor activity. Instead of taking this easy route, Seiko launched no new models; instead it concentrated single-mindedly on perfecting a watch with advanced features for serious use by professional divers under the rigorous conditions they often encounter.

When the Seiko Professional Diver's 600M watch was finally unveiled in 1975, it was the first diver's watch in the world to have a titanium case. The development team had achieved all their objectives: they had created a diver's watch that was shock-resistant, corrosion-proof, and antimagnetic. It was rugged enough to remain unscathed even after long hours of use by professional divers and could operate at depths of 600 metres. It had superb legibility – it was possible to see the time display even at depths where daylight could not penetrate.

Above all, this model stood out from all others because it was designed from the outset for saturation diving. This is a diving technique used by divers who work at great depths for prolonged periods and involves breathing an inert gas such as helium mixed with oxygen. The helium

This 300M diver's watch, from 1967, used the high-beat movement (10 beats a second) used in some Grand Seiko and other models, affording excellent accuracy. It was the last new diver's watch for seven years.

in the mixture eventually penetrates most watch cases. As the diver ascends, the difference between internal and external pressure increases to the point where the watch glass can break or, in extreme cases, the watch can even explode.

Seiko's technicians overcame this problem by developing a case that is practically impermeable to helium gas. Even the strap came under close scrutiny. The new watch they created had a pressure-vented strap designed so that if the diver's wetsuit shrank under pressure, at depth, the venting process would enable the strap to shrink and ensure the watch was still a snug, safe fit on the diver's wrist. Other companies later used the concept, but Seiko produced the original version.

The first Professional Diver's 600M featured a high-grade mechanical movement, but eventually it was fitted with a quartz movement. An even more advanced model was introduced later, offering water resistance to a depth of 1,000 metres. It still used the basic design concept, but high-tech ceramics were used for the case in place of titanium.

Seiko's resolve to remain at the cutting edge of diver's watch technology continues to this day. Its determination to develop watches for serious users soon extended from the manufacture of professional diver's watches to models tailored to the precise requirements of other specialist users. Today, the company is renowned for its policy of producing watches of the highest quality for

The Professional 600M had a titanium case and was water resistant to 600m. It overcame the problems associated with helium gas during prolonged saturation dives and met the needs of professional divers. It was an enormous improvement over earlier models. At first, it was fitted with an automatic hi-beat movement, but later a quartz movement was used.

Mitsurou Ohba who specialised in solo crossing on foot of the Arctic and Antarctic. By creating special products for explorers who encounter extreme conditions, Seiko's designers have had the opportunity to subject their products to some of the most demanding conditions on earth.

any application or environment that needs a special timepiece. The original interest in developing a professional diver's watch was inspired by just one letter, but eventually it led to the creation of an entire new genre of watches.

Products such as the Scubamaster, the Landmaster and the Flightmaster, for use in the sea, on land and at altitude, have all been created as part of the "Master" series. To earn the name "Master", a Seiko watch has to prove it can cope with the toughest conditions imaginable.

All these "Master" timepieces and all Seiko's other heavy-duty watches, have been developed under Mr Tokunaga's supervision. He has aimed to create watches that demonstrate the ultimate performance in all possible land, sea and air environments. His name is particularly closely associated with the Landmaster series developed for some pioneering adventurers. He calls them "watches worth entrusting your life to".

Many Seiko advances have started with customised watches that were created to satisfy the needs of just one, very demanding, individual user with specific and challenging needs. One of the most interesting and unusual examples of a Landmaster watch developed to meet specific requirements was a special timepiece created specifically for Mitsurou Ohba, the explorer who successfully crossed both the North and South Poles on foot. For his first

The Landmaster South Pole, developed for Mr Ohba's Antarctic expedition, had a 24-hour hand that rotated anticlockwise as a navigational aid. The case and bracelet are made from Cermet and the bezel is of zirconium ceramic.

attempt to cross the Arctic in 1994, Mr Ohba asked Seiko to produce for him a special version of the Landmaster.

Mr Tokunaga responded by creating a special, customised, version of the Landmaster for Mr Ohba and explained the challenges presented by the task. "Landmaster is a watch worth entrusting your life to. There's something extremely important about a watch that is being used in explora-

'Landmaster is a watchworthentrusting your life to'

tion or adventure. When Mr Ohba first planned his solo crossing of the Arctic on foot, there was only a stainless steel series of Landmaster watches. These would have had a weight of 140 grams, including the bracelet, but he requested that we do everything possible to lighten it, even if only by a gram.

"The problem was that he planned to leave only six months after we received his request, but we decided to do everything we could to comply with his request. We took the current form of the Landmaster watch exactly as it was and decided to make a case for it from titanium. We aimed to make the watch lighter by using Metal Injection Moulding to shape the titanium case and we were able to finish the watch just in time for his departure.

"We had received one more request from Mr Ohba. He had explained that since the location of the Magnetic Pole (the Magnetic North Pole) is not at the same place as the exact location of the North Pole, there is a problem; the closer you get to the pole the more inaccurate is the direc-

tion indicated by a compass. He said that in order to know the precise location of the Pole, he needed to use the sun's location as his yardstick and he asked Seiko to provide the means to calculate this quickly."

North Poles

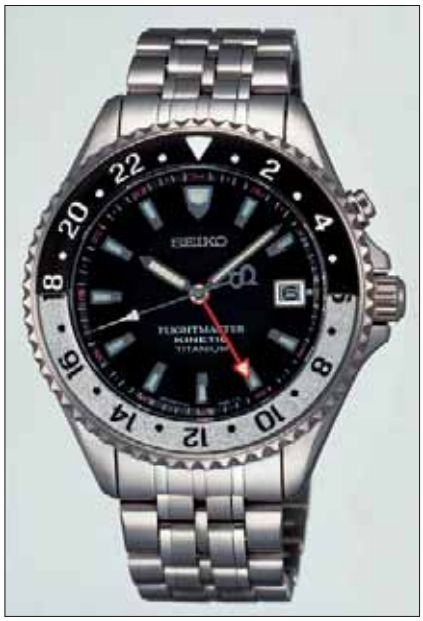
There are four North Poles, the Magnetic North Pole, the Geographic North Pole, the Geomagnetic North Pole and the North Pole of Inaccessibility. The Geographic North Pole is the one typically sought after by explorers. From here, all points on earth are to the south. Magnetic North Pole is the position that traditional compasses point towards, but it is not stationary; today, it is at 78° 18' North and 104° West, near to Canada's Ellef Ringness Island, about 1,000 miles south of the Geographic North Pole. It is this movement and the inaccuracy of a conventional compass in the Arctic region that makes navigation difficult for explorers; it explains why Mr Ohba sought Seiko's assistance.

This Landmaster Sagarmatha SBCW021 was developed specially for Ken Noguchi's assault on Sagarmatha, otherwise known as Everest. It is easy-to-read, extremely rugged and equipped with a 24-hour hand, as well as a conventional 12-hour hand.

After Mr Ohba requested a Landmaster that would assist with navigation, Mr Tokunaga explained, "Until this time, we had told people to point the hour hand of their 12-hour watch at the sun; the position half way between the hour hand and 12 o'clock on the dial indicates the north-south axis. In response to Mr Ohba's problem we added a 24-hour hand and dial. If you point the 24 hour hand at the sun, the direction indicated by 24 on the dial points to the north."

When these two changes had been made, and a Kinetic movement had been fitted (at the time it was still known as AGS), the new Landmaster created for Mr Ohba weighed only 95 grams, a substantial improvement on the 140 gram weight of the regular production model. When Mr Ohba succeeded in his solo crossing of the Arctic on foot, at his fourth attempt, he was wearing the Landmaster that Seiko had developed specially for him. Subsequently a commercial version of this watch was manufactured with titanium cases and bracelets in a limited edition of 1877 pieces. They were sold under the name Transpolar Adventure.

Next, Mr Ohba turned his attention southwards as far as he could go… to the Antarctic. The situation in the southern hemisphere is the opposite of that in the north; the sun rises in the east, passes to the north and sets in the west. To create a watch with a 24-hour hand that would help with navigation in the Antarctic, Seiko had to develop a special movement featuring a 24-hour hand that rotated anticlockwise. For Mr Ohba's Antarctic crossing, they created an exclusive timepiece with an even lighter and sturdier case that was crafted from ceramics, the space-age material that was originally developed for use on the heat-shield of space craft. A production version of this ceramic-cased watch was marketed as the Landmaster South Pole.



The Flightmaster SBCW005 was developed with the cooperation of professional pilots who fly on international routes and has a Kinetic movement to avoid the need for battery replacement. It is clear to read and has a red 24-hour hand that points to the 24-hour scale on the bezel.

Another outstanding adventurer who put his trust in the Master series was Ken Noguchi, who made a successful ascent of Sagarmatha, or

The Scubamaster SBBK002 is a multi function diver's watch with the power to display, calculate and record diving information – almost a mini-computer. It is loaded with the US Navy diving tables to ensure the safety of divers.

Everest, as part of his bid to break the record as the youngest person ever to scale the seven continents' highest peaks. By the age of 25, he had scaled all seven and achieved his aim. He is a satisfied user and a tester of the Landmaster and wore a Landmaster Summiter with an altitude gauge for the first time during his 1997 assault from the China side. Afterwards, he pointed out that minute markings are not meaningful when the effects of altitude impair one's powers of judgement. For his assault the following year from the Nepal side Mr Noguchi wore the Landmaster Sagarmatha that incorporated further improvements in legibility. This was a Kinetic model with priority given to legibility of the dial, hour and minute hands and a 24-hour hand. The bezel was the part of the watch most likely to be damaged by scraping or knocking on a rock and so it was manufactured from a ceramic-metal alloy that was impervious to scratches. It featured 24-hour marking, in relief, to make it easy to read.

Another watch in Seiko's Master series is the Flightmaster SBCW005. It was developed with the cooperation of pilots flying on international routes to ensure that it embodied all the functions that are needed by flying professionals. The result was an extremely simple model equipped with a 24-hour hand and a self-winding Kinetic movement that was used to avoid the need for battery replacement. The case and bracelet were made from bright titanium, which gave a sense of luxury, and the finished product was as thin as possible.

World record

Free diver Francisco Ferreras, better known as Pipin, is another specialist who tested watches to the limit for Seiko's Master series. When he achieved the world record for diving without oxygen tanks in 1998 he was wearing a Pipin Series Scubamaster; a limited edition of 1,000 pieces called the Seiko Scubamaster Pipin Special was produced to mark his success. It immediately found favour with the free-diving community and remains a much-demanded item to this day because of its functionality.

The top model in the Pipin series contained features that were developed in conjunction with the record-breaking diver. They included water resistance to 200 metres, a unidirectional bezel and a screw-down crown positioned at 10 o'clock. For legibility at great depth, Seiko's Lumibrite technology was used and the watch was fitted with a "diver-adjustable" folding fastener.

The Scubamaster SBBK002 is an example of the superb results that can be achieved by working closely with professionals. It is a multi function diver's watch that includes every feature a serious diver could want. It can measure, display, calculate and record dive statistics to provide all the information that is needed for safe diving. It has built into its memory the US Navy diving table that was devised for security and safety. This is used to record and analyse submersion times and depths. The watch displays in real time the information that is required in order that a diver can complete each dive with maximum safety. If necessary, it can even set off a warning alarm and it is water resistant to a depth of 200 metres. When it was launched in June 1990, it astounded the diving world.

In order to produce Master watches that can cope with extreme environments, Seiko's technicians have needed to master the use of new materials and techniques. Ceramic watch cases are a good example. Ceramics and other ultra-hard materials offer enormous advantages because of their strength and scratch resistance, but they do have one major drawback: they are very hard to work with. It is almost impossible to use conventional techniques such as cutting or milling, so Seiko use a method called Ceramic Injection Molding. With this technique, the powdered ceramic material from which these high-tech products are fashioned is mixed with a resin and forced into the basic shape in a mold under pressure. When this material is sintered at high temperature, the resin comes out and leaves the molecules of the ceramic

The Scubamaster Pipin Special was sold in a limited edition of 1,000 pieces in 1997.

material tightly bonded together. The case shrinks slightly in this process, so mold-making is a very exact science that has to make allowance for this. Each case is then ground and polished using diamond dust to produce the finished product. This state-of-the-art technology was employed for some of the special Landmaster models.

Seiko first used this ingenious technique with stainless steel and now they also use it when working with metal-ceramic alloys. They are sure that further applications will follow. (The same Near Net Precision Powder Shaping technology is being used for a growing number of applications outside the watch field, including parts in some of Epson's best-selling inkjet printers.)

Mr Tokunaga attributes Seiko's success in creating superb sports watches to its determination to work with those best placed to offer practical advice on the specifications for such watches and then to test these products to the limit. "We start by leaving commercial considerations out of the equation, but eventually we have to include them in our calculations before these new products go into production and percolate through to the public."

Ikuo Tokunaga has been consistently involved with the development of sports watches since he joined the company in 1970.

Mr Tokunaga pays attention to the smallest details and takes account of the requirements of minority users, but ultimately he has a passion for the development of new mechanisms that are out-of-the-ordinary. "In my dreams I wanted to create some device that could be called number one in the world. I thought to do so I would have to get a patent on any 'world first' technology. As I continued working and trying to develop new ideas I've ended up with 100 patents."

One of his ambitions was to create watches for use on land, at sea and in the air in a way that would satisfy the most demanding of customers in each of these environments – and he has done so with great success. To date, there seems to be no end to the challenges he is prepared to take on, because each venture that explorers undertake tends to be more demanding than the last. Mr Tokunaga often starts to develop an idea three years before it is launched.

What matters is the challenge, no matter what the sport, the application or the environment. Just as dedicated explorers such as Ohba, Pipin and Noguchi seek to push the limits further than anybody before them, Mr Tokunaga and his team remain dedicated to expanding the horizons of sports watches and to delivering the ultimate in performance and reliability.

Seiko's commitment to the creation of timepieces for sport and exploration knows no bounds. The company's technicians are dedicated to devising new innovations in order to achieve the highest possible standards of accuracy and reliability.

SEIKO

HISTORY OF SEIKO'S PROFESSIONAL & EXTREME ADVENTURE WATCHES

	PRODUCTS	USERS
1965	Introduction of 62MAS-010, the first domestically-made diver's watch with water resistant to 150m and self-winding feature	1966-8 Used by 8th Polar Observation Wintering Team
1967	Introduction of 6215-010, the first domestically-made self-winding diver's watch with water resistant to 300m	
1968	Introduction of 6159-011, a 10-beat high precision self-winding diver's watch water resistant to 300m	1970 Used by both Naomi Uemura and Teruo Matsuura of the Japanese Alpine Club for their assault on Everest
1975	Introduction of the first watch to use titanium in its case 6159-022, a diver's watch built for saturation conditions	1974 Used in the Gakushuin University Alpine Club's unsuccessful attempt on the summit of Skyang Kangri. 1978 Used by a Nihon University group for arctic exploration.
1978	Introduction of PYF018, the world's first diver's watch loaded with quartz movement and built for saturation conditions	1978 Used by both Naomi Uemura and a Nihon University group in Arctic exploration. In 1983, submerged to 1062m in JAMSTEC's (Japanese Marine Sciences Technology Center's) submarine "Shinkai 2000."
1982	Introduction of SAD017, the world's first hybrid diver's watch with alarm/chronograph (displaying in two languages, with underwater communication capability)	1984-86 Used by Polar Wintering Team, Geographical Survey Institute. 1988 Japan-China-Nepal Tri-National Friendship Expedition uses this in assault on Chomolungma (Everest).
1984	Introduction of the FIELDMASTER SAD048 (hybrid 5 type), containing 20 features for survival in the great outdoors such as water resistant, shock proofing and anti-magnetic capabilities	1984-86 Used by Polar Wintering Team. 1988 Used by Japan-China-Nepal Tri-National Friendship Expedition in their assault on Chomolungma. 1989 Used by Masako Izumi's team in polar exploration.
1986	Introduction of the SSBS018, a diver's watch built for saturation conditions down to 1000m, the world's first watch with outer casing of zirconia ceramics.	
1990	Introduction of SCUBAMASTER SBBK001, a diver's watch water resistant to 200m and the world's first with loaded dive computer functions.	1992 Used by Maritime Self Defense Forces minesweeping detachment in their work in the Gulf.
1992	Introduction of SBBW001, the world's first diver's watch with KINETIC movement, water resistant down to 200m	
1993	Introduction of LANDMASTER SBBW005, an adventure watch with the world's first case built as one piece out of stainless steel using MIM technology, and loaded with KINETIC movement in a precision designed bezel.	
1994	Introduction of LANDMASTER SBCW001, an adventure watch with the world's first case built as one piece out of pure titanium using MIM technology, loaded with 24 hour hand and KINETIC movement.	Used by Mitsurou Ohba in his four Polar expeditions.
1995	Introduction of SCUBAMASTER SBCW003, the world's first case built as one piece out of bright titanium for a diver's watch water resistant to 200m	1997 Used by Pipin Ferreras on the occasion of his 500 foot (152.5m) free diving world record.
1996	Introduction of SCUBAMASTER SBCP001 diver's watch water resistant to 200m, the world's first to have an analogue depth meter with full automatic measuring.	
1997	Introduction of the LANDMASTER Summiter SBCN003, an adventure watch that presents current air-pressure conditions (serves as a simple altimeter), and charts of air pressure trends based on a built-in air pressure sensor.	Used by Ken Noguchi in his first assault on Sagarmatha (Everest).
1998	Introduction of SCUBAMASTER SBCW017, a 200m type diver's watch with perfectly flush surface and case built as one piece, including the bezel, out of bright titanium	Used by Pipin Ferreras on the occasion of his 510 foot (155m) free diving world record.
	Introduction of LANDMASTER Sagarmatha SBCW021, an adventure watch with the world's first Cermet (ceramic/metal) rotating bezel, with one-piece case built of bright titanium.	Used by Ken Noguchi in his second assault on Sagarmatha (Everest).
1999	Introduction of SBCW023, the LANDMASTER South Pole adventure watch with KINETIC movement, the first all-ceramic watch, with backward-rotating 24-hour hand for determining direction and with ceramics used for the rotating bezel, one-piece type case and the band.	1998-99 Used by Mitsurou Ohba for his solo crossing on foot of Antarctica.

Sports Timing – The Measure of Greatness

As the economic miracle of post-War Japan developed, one organisation above all others conferred on Japan its highest honour and presented the nation with an unparalleled opportunity to demonstrate its technical and organisational skills.

The prestigious right to host the 1964 Summer Olympic Games was awarded by the IOC to Tokyo, making these the first ever games to be held in Asia. The President of Seiko, Shoji Hattori, saw the scale of the opportunity and so set the company on the path that would establish it, in the eyes of the world, as the leading technology company in the world watch industry.

When Seiko was awarded the contract to become Official Timer of the 1964 Olympic Games, it was given a relatively short time to make all the preparations, but despite this, it introduced new timing techniques and achieved flawless timing of their first Olympic Games. Until Seiko was awarded the contract, European companies had been official timekeepers for all the Games since the Los Angeles Olympic Games in 1932, so it was a great honour for Seiko to be awarded this prestigious responsibility.

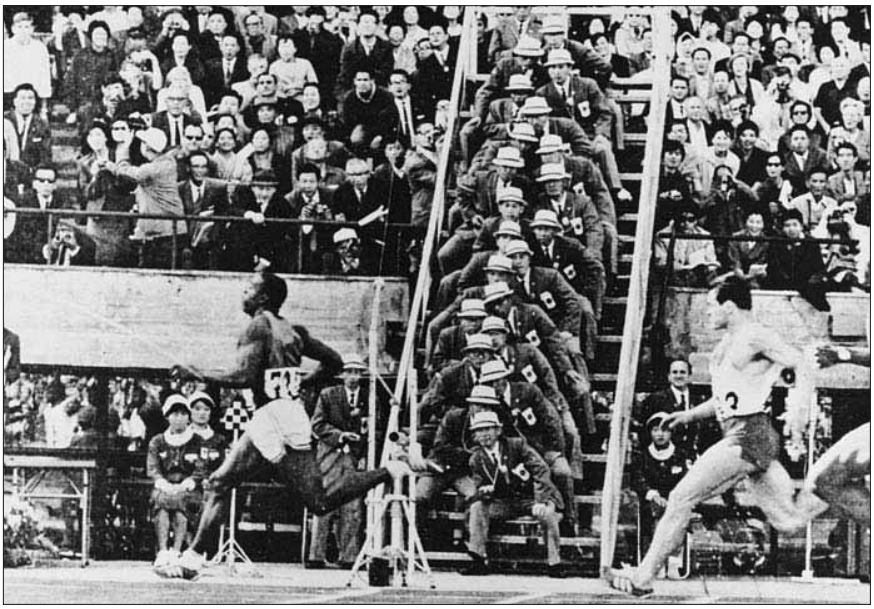
Many of the sports timekeeping systems being used at that time had been developed in Switzerland and they had earned the absolute trust of the sports world. Many assumed they would also be timing the Tokyo Games. Even within Seiko there were some who had their doubts about the wisdom of trying to take on this mammoth timing task. One of them was Saburou Inoue, who was the Watch Design Section Manager of Daini Seikosha. He said, "I was in Zurich on business in the spring of 1960 and I got a telegram from the company. It read, 'Official word Tokyo will host next Olympic Games'."

Six historic words

It added six words that were to determine the company's history for the next 50 years. "Intend to handle official timing duties." In the telegram, Shoji Hattori instructed Mr Inoue to "Go to Rome Olympics in August and observe timing procedures".

Mr Inoue recalls, "Around the time the Olympic Games were due to start, Mr Yokoyama (Seikosha Production Engineering Section Manager at the time) came to Zurich, so I told him I had to go to America and then directly to Japan from there, and asked him to go to Rome for me and observe. He gave his ready assent, so I returned to Japan without going to Rome at all. As soon as I got back, Shoji Hattori,

The opening ceremony of the 1964 Olympic Games in Tokyo marked the starting point of an important, long-term relationship between Seiko and the sporting world.



Sports timekeeping was revolutionised by Seiko when it timed the 1964 Summer Olympic Games in Tokyo. Until then timekeeping had been carried out manually. Many timekeepers were placed at the finishing line with their stop watches – providing a sight that Seiko was to banish forever.

president of K Hattori & Co Ltd, came to Daini Seikosha and asked me, 'Well then, are you ready to take this on?'

"I thought, 'Oh, this is about official timing', so I said, 'I'm sorry, we just can't do it.' He retorted, 'and why not? You have four years.' But you have to realise that four years isn't nearly as long as it sounds. We couldn't do computer simulations, so we had to work out every single thing by trial and error. So I told him, 'It simply can't be done'.

"President Shoji got angry and said, 'our timepieces are now good enough for the whole world to know about them. What do you mean, 'It can't be done?' He followed that remark with 'I'll be back in a week. You'd better be ready by then' – and he left."

He really did return in a week and he pressed Mr Inoue hard, asking "Are you ready now?" Mr Inoue finally gave in to the determination of President Shoji, who was visiting him every week, and he agreed to launch the timing effort, on one condition. "I told him, since I'd never seen timing devices for the Olympics, and didn't know how they used their stopwatches, or what types they would need, I would have

'We'll handle the next Olympic Games'

to meet with the top officials for track and swimming events. He said, 'I can certainly arrange that for you'. That sealed my fate."

One of the initial reasons for Mr Inoue's reluctance stemmed from his visit to America after his Zurich trip. "I went to America because we had to handle a huge number of complaints about the first watches we exported to the US. We even had a watch store say to us, 'And you call this a watch?' I had just come back from facing that, so when someone suddenly told me, 'We'll handle the next Olympic Games', I realised there could be a deluge of complaints, maybe enough to engulf the Olympics themselves. If that happened, I'd have to leave the company. Not only that, the company itself might fold. Even worse than the company folding I thought that the nation would be written off by the whole world, saying 'Japan just can't get it right'." A great deal of work was needed to improve quality and reliability and develop timekeeping equipment in time for the Games.

Mr Inoue added, "In this situation I couldn't see how in four short years Seiko could generate the confidence it would need to handle the Olympic Games."

Although Seiko then had so much influence in the domestic market that

Saburou Inoue was told by the President to make the equipment to time the 1964 Games – from scratch!

Tatsuya Ishiwara improved the accuracy of stopwatches for sports timing.

anything the company produced would be bought as a matter of course, the Swiss were still superior in the stopwatch market. Seiko had to approach the Olympic authorities to ask them what they wanted. They built entirely new timing systems from scratch, an immense undertaking that has never been repeated in Olympic history.

While Mr Inoue was having profound misgivings, a quiet start was made on some research that was to revolutionise sports timing. A new stopwatch was being developed that would reduce the timing errors inherent in the existing generation. At the time, a margin of error was expected when stopwatches were used for manual timing, and this was assumed to be attributable to human error.

For many years, track events were timed by at least 10 officials who were positioned vertically above one another at the finishing line. Nevertheless, there were often discrepancies between the recorded times and so an average was used. Daini Seikosha technicians set out to discover whether the discrepancies were the result of different skill levels, or reaction times, among the timing personnel.

Mr Ishiwara explained, "Partly for endurance tests we had Shoichiro Komaki and Yoshio Yamamoto construct a machine that used an electronic circuit to ensure accurate, simultaneous starts of multiple stopwatches. Mr Komaki was always ahead of the times and was already deeply involved in developing digital technology. When we tried out this machine using a row of five stopwatches, we found they wouldn't register the same time. We thought this through and decided it was probably something to do with giving the balance a big 'kick' when starting the stopwatch." The same happened whether they used Swiss or Japanese stopwatches.

"The shocking result of our Komaki machine experiments was that a time difference was always recorded, even when operation of the button was controlled mechanically to ensure that all watches were operated simultaneously. Sports organisations were aware that there was a problem, but they thought it was connected with the skill of the operator. They were training people how to operate stopwatches and licensing them, but we found the discrepancies were nothing to do with operator skills; they were caused by the position of the balance when the button was clicked. I'd hate to tell an athlete that, because they stake their professional lives on

These pressure-sensitive starting blocks, introduced in 1995, gave officials new data to detect false starts.

differences as small as one tenth of a second."

Problem solved

A heart-shaped cam was fitted to the balance staff so that the balance wheel always stopped in the optimum position to ensure that it would start with an instant and consistent impulse. Mr Ishiwara explained, "We created a model that started the balance wheel smoothly when the button was pushed and this cured the problem." The engineers at Daini Seikosha were the first ever to apply this technique to reset the balance to the same position every time the hands were re-set.

The idea was very simple, but because the parts were so tiny, it proved very difficult to manufacture them. A device was added to ensure that when the second hand stopped between marks, the time in question would always be rounded automatically so that the hand would stop directly over a mark. Finally, the development team produced a stopwatch that would provide the same results when used by any sufficiently skilled timing official.

There was a very good reason for Seiko to devote so much effort to the development of this new stopwatch. The Olympic Games embrace a wide variety of sports that require a tremendous range of specialised timing equipment, but accurate timing was most critical for track and swimming events. Seiko recognised that the most important challenge was to ensure that its new stopwatch was adopted for these "blue riband" events, and, most of all, for athletics.

An Olympic Technical Committee was responsible for determining which equipment would be used to time

Masatoshi Tohyama presented Seiko's case to the International Olympic Committee.

track events. They met in Belgrade in September 1962 to consider the timing of the 1964 Games. Mr Masatoshi Tohyama, Research Section Manager at the time, was given the task of taking the new stopwatches to the Committee for evaluation. He took six 1/5 second models (892) and six 1/10 second models (893). On the journey, the plane made a refuelling stop in Zagreb before it reached Belgrade. When passengers had to leave the plane during the refuelling, Mr Tohyama was told he could leave his bags on his seat. When he returned to the aircraft, he was horrified to find his suitcase was no longer on his seat. If it had been lost or stolen, Seiko's chance of a lifetime would have been lost forever. Fortunately, the suitcase containing his precious cargo of watches had been put on the tarmac. Chastened by this traumatic incident, Mr Tohyama arrived in Belgrade without further incident, but more problems were to follow.

"The day before the Committee meeting, the President of the Japan Association of Athletics Federations tested the stopwatches I had brought with me," he explained later. Just one of the model 892 watches seemed to have a problem – the seconds hand was not able to synchronise with the other hand. The JAAF President was sharp with me, saying 'If this happens at tomorrow's Committee meeting it will all be over in an instant'. So I wondered what to do. There wasn't enough time to fix it and testing the rest of them could possibly cause more defects, so I eliminated the defective watch. Then I listened to the ticking of the model 893 watches and eliminated the quietest. I took those that remained to the meeting the next day."

The stopwatches were tested by two Committee members, Mr Pain, the Honorary Secretary of the

Seiko has developed special timepieces for many different sports. This example measures the number of strokes per minute in rowing competitions. It helps rowers adjust their stroke rate, but is not used for official timing.

International Association of Athletics Federations (IAAF), and Mr Paulen, President of the IAAF. Mr Paulen was particularly confident about his stopwatch timing skills. He always carried a stopwatch around and was reputed to file a complaint whenever an official time differed from his own timing results.

Mr Tohyama wondered how Mr Paulen intended to test Seiko's stopwatches. He said, "He took a stopwatch in each hand, clicked both simultaneously and then, after a specified time had passed, clicked them both again and checked the difference between them. He performed this test three times – for several seconds, several minutes and for nearly one hour. The first test, for seconds, was right on target. The test for several minutes was fine, too. When Mr Paulen stopped the watches after a test of nearly an hour the difference was less than 0.1 seconds.

"That even surprised Mr Paulen and he asked me, 'What kind of technology is this?' so I got out the manual and explained the Ishiwara principle. Both Mr Paulen and Mr Pain offered hearty praise after the presentation. 'What a good idea! That's good theory!' Then they said, 'We are not assigning official timekeeping to a Japanese manufacturer because the Olympics will be held in Tokyo, but because these are actual functional stopwatches, backed up with solid theory'.

Olympic certification

"That really made me feel good. That evening I was absolutely thrilled when I heard Mr Oda Mikio, from the JAAF say, 'the best thing to come from the meeting today was the preliminary decision in favour of Seiko stopwatches'." Subsequently the new stopwatches were submitted to the National Physical Laboratory in England for inspection and for certification as Olympic timekeeping equipment.

The Seiko "slit-video" photo-finish camera provides the image from which officials decide both the result and the time, to an accuracy of $^{1}/_{1000}$ of a second.

Although Seiko received a preliminary nomination as timekeeper for the 1964 Tokyo Olympic Games after the IAAF Committee met in Belgrade in 1962, it was only one year before the event that they received notice in writing of their official appointment.

Development of the new stopwatch with its innovative heart-shaped cam was an enormous undertaking, but, without it, Seiko would probably have stood no chance in its campaign to time the Olympics.

Despite the trials and tribulations that had been endured during the development of a more accurate stopwatch, this was only the beginning of the mammoth task of developing a full complement of timing equipment for the Games.

As soon as Seiko was unofficially awarded the contract to time the Tokyo Games, it began the enormous task of developing different types of stopwatch suitable for timing many different sports events. Not only did Seiko's systems have to record the time of the winning competitor in each event; they also had to determine times for the other competitors and to record which competitor was in which place.

The gargantuan task of preparing for the Games did not stop with the development of new timing equipment. It was also necessary to produce many other items, such as giant clocks for the stadiums, as well as displays

to enable spectators to see times. A project on this scale was an entirely new experience for Seiko. It is to their eternal credit that during the entire Olympic Games, their very first, there were no timekeeping errors at all, although they had no previous experience and had only had two years to design and make all the new equipment that was required, having already improved stopwatch performance.

Having been granted the prestigious contract to time the Olympic Games for the first time, Seiko were determined to ensure that, in their hands, timekeeping should reach higher standards than ever before.

An Olympic first

They fulfilled their dream by developing a quartz crystal chronometer clock that was used to time the marathon events – and it was accurate to within 0.2 seconds a day. It was the first time that quartz timekeeping system had ever been used at an international sporting event. Spring-wound mechanical timepieces, which had set the standards for timekeeping for the preceding 60 years, were mostly only able to achieve accuracy of plus or minus 20 seconds a day. The appearance of the Crystal Chronometer clock clearly signalled to the world that Seiko had been developing quartz technology and that they were well placed in the race to develop quartz wristwatches.

Ultrasonic wind gauges measure the wind speed. A reading of more than two metres a second invalidates a world track record.

Distance measurement is provided for all field events.

The first step along the way for Seiko came in 1959, when Seikosha created a practical quartz timepiece for a radio station, but it was not portable. In the following year, Suwa Seikosha developed a marine chronometer. It was soon marketed as a commercial clock, the Crystal Chronometer QC-951, costing 129,000 yen. This revolutionary product was used to time some events at the 1964 Olympic Games in Tokyo, introducing quartz accuracy to sports timekeeping system for the first time.

The opportunity to act as the official timekeeper of the Tokyo Olympics opened up a whole new world of sports timing opportunities for Seiko. Timing the event was a mammoth undertaking, but the decision to take on the challenge proved to be one of the most momentous landmarks in the company's history and it has never looked back since. The company took its responsibility so seriously that it embarked on a four-year development programme, with no limit on development costs or the resources that could be used. It was a far-sighted project that must be unique in Olympic history. But was all the expense and effort worthwhile? Seiko timed the

Seiko's first commercial, portable quartz clock, the Crystal Chronometer QC-951, made history when it was used to time some events at the 1964 Games in Tokyo.

Yasuaki Asahara masterminded Seiko's sports timing for over 20 years.

games flawlessly and the resulting publicity all over the world helped the company to gain the international recognition and credibility it had needed so badly.

At last, Seiko was able to compete with the Swiss on equal terms for the timing of world class sports events. Since that first major sporting event, the company has tirelessly devised new and improved specialist timing systems and now it has one of the world's most comprehensive timekeeping systems for sports events. It is used to satisfy the ever-more demanding requirements of major sports events the world over. Since 1964, Seiko have timed five more Olympic Games, but their involvement in sports has grown well beyond Olympic events and they have provided timing facilities at many international multi-discipline sports events, from the Asian and Commonwealth Games to World Championships in over 20 sports.

Despite the flawless timing of the 1964 Olympic Games, the early years that followed were not without their dramatic moments, but these gave Seiko's engineers and technicians an opportunity to hone their specialist timing skills until they were as sharp as a legendary Japanese sword. In 1966, for example, Seiko were the official timekeepers for the Fifth Asian Games, held in Thailand. According to Yasuaki Asahara, a senior member of the sports timing team, the timing equipment that was taken to Thailand was much the same as had been used for the Olympic Games. This failed to take into account the dramatic difference in temperatures between Tokyo and Bangkok, and resulted in some equipment failures.

Foolproof back-ups

Quartz oscillators are particularly sensitive to temperature changes and the newly-developed small electronic printers had been developed for the Japanese climate in October. On a December day in Thailand, when day-time temperatures were often well over 30° C, the temperature inside the boxes containing some of the timing equipment rose to around 50° C. The temporary solution was a hand-held fan. Despite the failure of some items of equipment, Seiko still managed to time every event without missing a single time.

The latest transponder technology is now used to give instant times and positions in marathons, cross-country and ski races.

Seiko has served as Official Timer for every IAAF World Championships since 1987.

The lesson that was learnt from this unexpected interlude was that the timekeeping team had to develop different equipment for events in autumn, summer and winter. Mr Asahara said, "They had to have foolproof back-up systems." Mr Asahara explained, "If a piece of timekeeping equipment were to fail, it really would only be a failure if the timekeepers didn't get a time and had to ask the athletes to run the same race for us again." Mr Asahara, a keen sports enthusiast, added, "There's no way they could have said, 'I'm sorry, Carl Lewis, could you run that again?'." He added, "A watch is a machine and can break down. We haven't failed so far, but yes, our watches have broken

All results are delivered on-line and, for the official record, in print.

down. That's where back-ups come in. First, we make two identical systems, completely separate but linked to the same electric lines. For good measure, in case both systems break down, we have a third system that can record the time just as well as the other two. In addition to this, there is a fourth system to ensure that we never miss recording the time. It's all right if you have to use a calculator to compute the results.

"It is also important to remember that the athletes who come in last have also given it their best shot and so we don't want to miss their times, either. The hardest thing in timekeeping is to record the time of the last person to finish. At the moment the leading runner reaches the finishing line, officials and cameramen are waiting eagerly in their assigned positions. By the time the last competitor gets to the finishing line, they're all over the place, particularly with the 10,000 metre race."

By the time of the Sapporo Olympics, in 1972, Seiko's sports timing specialists had developed a system that could time several skiers simultaneously, between three and five at a time, and the results were

The Seiko swimming touch pads are part of a fully automated system, accurate to $^{1}/_{1000}$ of a second.

calculated without the use of computers.

Skiing events present timekeepers with more challenges, in addition to that of the weather. Mr Asahara, who retired at the end of the 1990s, explains "Alpine skiing has to rely on electronic timing because you can't see the start position from the base

Photo-finish images are produced instantly for officials to read on-screen.

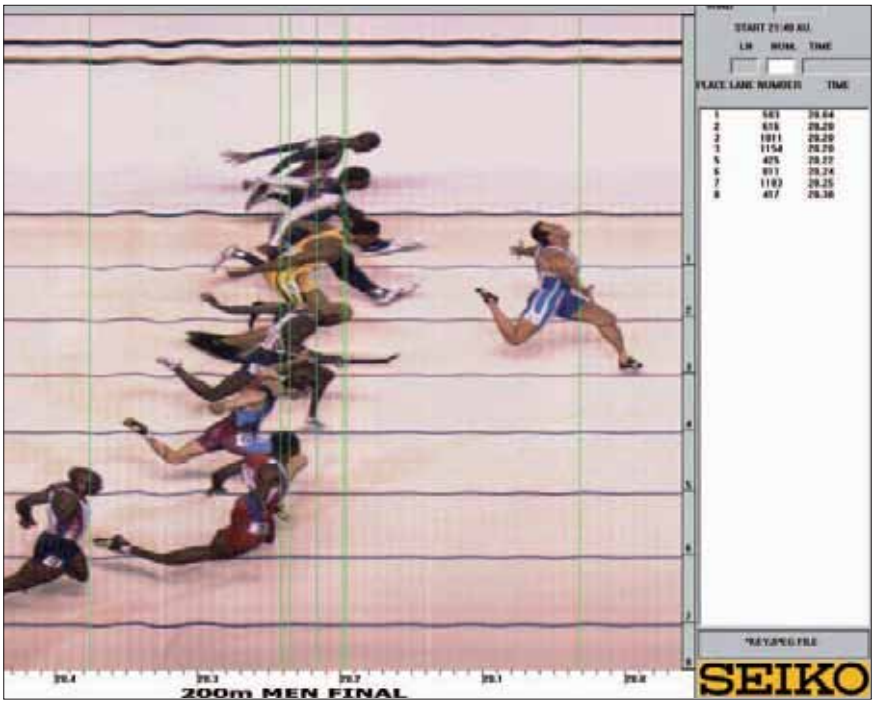
of the hill. Manual timekeeping would be impossible. In the downhill events you have two or three athletes coming down the course at the same time, but you need to time each skier separately. So now the operator needs two or three systems, too. And since there could be operator mistakes you have to be prepared for that, as well. That's how far you have to go before you can expect complete success."

New challenges

Over the 40 years of Seiko's sports timing history, since the Tokyo Olympic Games in 1964, the demands of sport have increased dramatically and new technologies have become available. These have created new challenges and Seiko's dedicated sports timing specialists have responded impressively.

Within the Group, the computer skills of Epson have been utilised and resulted in fully on-line systems for the 1991 World Championships in Athletics. Swimming events are another good example of the progress that has been made.

Downhill skiing is one of the most complex of all Alpine sports.



The photo-finish images are built from pictures taken of the finish line 5,000 times a second, This image is a picture of time, not space!

At the Tokyo Olympics in 1964, Seiko used two different timekeeping systems for swimming events; they utilised different timing methods, touch pads and grip switches. The system in use today, with two complete duplicate systems, backed up with a third, was introduced much later. Other functions have to be provided by current systems, too. They are no longer mere timing systems. They are comprehensive units that time each event and each competitor and then analyse and store this information, and provide real-time information services for radio and television commentators, for journalists and for many millions of television and radio viewers and listeners around the globe.

More than just timing

Sports timing today, for Seiko, is much more than just timing – Seiko provides end-to-end solutions designed to satisfy the needs of varies users of times and measurements. These include the athletes, coaches, television viewers and increasing numbers of internet users.

It is extremely expensive to provide all the equipment and manpower that are required to time world-class sports events and the companies who perform this invaluable service receive no payment for their work, so is it really worthwhile?

Sports timing does not directly make money, but it greatly enhances the reputation of the company that wins a timekeeping contract. After 1972, only two organisations have

Loudspeakers convey the starter's signal to each lane individually, to counteract the delay of sound travelling though the air.

timed world-class multi-discipline sports events, Seiko and a consortium of Swiss companies.

Since the very early days of its involvement with sports timing, Seiko has appreciated that although the company receives no payment for timing top international events in most cases, its involvement paid enormous dividends, in terms of publicity and increased sales. The public's purchasing decisions are clearly influenced by seeing the name of the watch company that is timing top events, whether they are present at the event or see it on television. Above all, the most valuable return on the huge investment in sports timing comes in the intangible form of trust.

Another reason for Seiko's passion for sport lies in the technical challenge it presents; participation in sports timing stimulates the company to develop new technology – the pioneering use of quartz technology at the Tokyo Olympic Games in 1964 is a good example. Sports timing generates publicity for Seiko around the world in pictures in the press, on television and now on the internet, too. At the Salt Lake City Winter Olympic Games, Seiko was the only name visible in television pictures in well over 900 hours of broadcasting transmitted to 160 countries.

The responsibility of timing Olympic and other world-class multi-discipline sports events is awe-inspiring, but the value of the resulting publicity is almost incalculable. The company has never counted the cost of its sports timing operations; it designs systems to satisfy timing needs and not to a budget. It sees its investment as "good citizenship".

The Seiko name was made famous through its timing of the 1964 Olympic Games in Tokyo, and providing timekeeping facilities at international sports events is Seiko's way of paying the world back for the opportunity it was offered – and seized – in Tokyo in 1964.

Since 1964, Seiko's commitment to the development of world sport has led to its appointment as Official Timer of many of the world most important sports events.

MAJOR EVENTS TIMED BY SEIKO

OLYMPIC GAMES

1964	Games of the XVIII Olympiad (Tokyo)
1972	The XI Olympic Winter Games (Sapporo)
1992	Games of the XXV Olympiad (Barcelona)
1994	The XVII Olympic Winter Games (Lillehammer)
1998	The XVIII Olympic Winter Games (Nagano)
2002	The XIX Olympic Winter Games (Salt Lake City)

SELECTED OTHER MAJOR INTERNATIONAL EVENTS

1966	The 5th Asian Games (Thailand)
1967	Summer Universiade (Japan)
1970	The 6th Asian Games (Thailand)
1974	X Commonwealth Games (New Zealand)
	The 7th Asian Games (Iran)
1978	The 8th Asian Games (Thailand)
1982	The 9th Asian Games (India)
1985	Summer Universiade (Japan)
1986	1st Winter Asian Games (Japan)
1987	2nd IAAF World Championships in Athletics (Italy)
1990	XIV Commonwealth Games (New Zealand)
	2nd Winter Asian Games (Japan)
1991	Winter Universiade (Japan)
	3rd IAAF World Championships in Athletics (Japan)
1993	Alpine Ski World Championships (Japan)
	World Sprint Speed Skating Championships (Japan)
	4th IAAF World Championships in Athletics (Germany)
1994	The 12th Asian Games (Japan)
	XV Commonwealth Games (Canada)
1995	5th IAAF World Championships in Athletics (Sweden)
	Summer Universiade (Japan)
1997	World Sprint Speed Skating Championships (Japan)
1997	6th IAAF World Championships in Athletics (Greece)
	World Judo Championships (France)
1998	European Athletics Championships (Hungary)
	IAAF World Cup of Athletics (South Africa)
1999	7th IAAF World Championships in Athletics (Spain)
2000	World Junior Athletics Championships (Chile)
2001	World Swimming Championships (Japan)
	8th IAAF World Championships in Athletics (Canada)
2002	European Indoor Athletics Championships (Austria)
	European Athletics Championships (Germany)
	World Cup of Athletics (Spain)
2003	IAAF World Indoor Athletics Championships (UK)
	9th IAAF World Championships in Athletics (France)
2004	IAAF World Indoor Athletics Championships (Hungary)
2005	European Indoor Athletics Championships (Spain)
	10th IAAF World Championships in Athletics (Finland)
2006	European Athletics Championships (Sweden)

SEIKO HISTORY OF TIMEKEEPING TECHNOLOGY DEVELOPMENT

1964	Developed electronic timekeeping system, first introduced at the Tokyo Olympic Games.
1972	Developed an electronic timekeeping system for winter sports (the Sapporo Winter Olympic Games)
1991	Developed on-line timing system for track events, based on the Seiko slit-video photo-finish system. (3rd IAAF World Championships in Athletics in Tokyo)
1992	Developed wind gauge for track and field events. (Barcelona Olympic Games)
1994	Developed bobsleigh and luge timekeeping system. (Lillehammer Winter Olympic Games)
	Developed a track and field starting system, coordinated with a false-start detector that picks up the pressure exerted by athletes in their starting blocks. (Hiroshima Asian Games)
1997	Developed a color slit video photo-finish system for track competitions. (IAAF World Indoor Championships)
1998	Developed a flight distance measurement system for Ski jumping events based on computer image processing. (Nagano Winter Olympic Games)
2000	Fully on-line and integrated transponder system introduced for Road and Cross-Country events

The Innovation Goes On

'Innovation and Refinement' is the guiding vision for Seiko's development teams. On three platforms, quartz, Kinetic and Spring Drive, Seiko continues to explore new possibilities in functions, forms and design – the future is only just beginning.

After its triumphant introduction of quartz watch technology, Seiko was not content to let time pass it by; instead, it continued to move forward by exploring all the creative possibilities inherent in wristwatch production. Having established quartz technology as a base, the company has ceaselessly focused its research on the quest for greater accuracy, smaller movements, ever-better reliability, more functions and, above all, alternative solutions to the provision of power to drive quartz watches – and now, mechanical watches that have the accuracy of quartz.

Quartz

From 1969 until the present day, quartz has provided Seiko with a strong platform for innovative new products that have found favour worldwide; examples include the first woman's quartz watch in 1972 and the first analogue quartz chronograph in 1983.

The Perpetual Calendar watch has been launched more recently. This future-proof timepiece has set new standards for analogue quartz watches and is a showcase for the company's expertise in microelectronics. The designers set themselves the challenge of developing a perpetual calendar movement that would be small, extremely accurate and would offer the owner uninterrupted and worry-free operation for the longest possible time. They achieved their goal by incorporating the world's smallest ultrasonic motor, a new high-frequency oscillator and a new generation of lithium batteries. The Perpetual Calendar watch adjusts the date to take into account the length of each month, as well as leap years, until February 2100, and it features a crown-operated calendar check. This moves the seconds hand to show the number of years since the last leap year. One year is indicated by each five-second interval that the seconds hand moves forward when this feature is invoked. The date change on this advanced watch is instant. At the same time, the month and then the date are displayed in the calendar window. Every model is water resistant to a pressure of 10 bars.

The Perpetual Calendar by Seiko takes leap years into account and will show the correct date until 2100.

The finished product is practical, reasonably priced and needs a new battery only once every 10 years in the man's version and every five years in the women's model. By using new components that have facilitated the creation of a smaller movement, the designers opened the way to the

In 1972, Seiko introduced the first ladies' quartz watch.

introduction of a matching pair of Perpetual Calendar watches. A new quartz oscillator has been used in this advanced calibre, using a frequency six times faster than that in a conventional quartz movement. This has made possible accuracy of ±20 seconds a year.

The Seiko Perpetual Calendar has the potential for truly perpetual accuracy, but a quirk of history prevents it fulfilling its full potential – without further programming – after 2100. All perpetual calendar watches will require adjustment in 2100, because it will not be a leap year. In 1582, Pope Gregory introduced the Gregorian calendar that we still use today, although it was only adopted in Great Britain in 1752 and in Russia in 1917. Because there is not an exact number of solar days in a tropical year, it is necessary to "insert" an extra day every four years, a leap year. In the Gregorian calendar, every year that is exactly divisible by 4 is a leap year, except for years that are divisible by 100; these centurial years are leap years only if they are exactly divisible by 400. Thus 2000 was a leap year, but 2100 will not be.

Seiko's vision of the future combines innovation and refinement; an excellent example of the response of Seiko's designers to the call for even more refinement in their creations is the Vivace collection. This embraces clarity and simplicity of design, creating a look that has enjoyed great success in Europe and other major markets, but which also has functionality that belies its beauty. Each Vivace watch is 3 bar water resistant.

Additional functionality based on quartz technology was the inspiration for the Sportura World Timer watch, launched in 2002. It includes a dual analogue and digital dial that can display the time, day and date in any one of 28 cities worldwide. Its other features include a fully automatic calendar to 2050, daylight saving adjustment, chronograph function and world time alarm. These advanced technical features are complemented by a stainless steel case that is water resistant to 100 metres, and a virtually unscratchable sapphire glass.

Since its introduction, the Sportura range has led the way forward in design and technology. In 2002, this versatile World Timer version was added to the collection.

Refinement is the hallmark of the latest Vivace collections.

Kinetic

Even as quartz technology was still being exploited, Seiko's engineers, as early as the mid-1970s, had imagined the possibility of linking the accuracy of quartz to the energy-efficiency of mechanical and automatic watches. As the company's overall commitment to ecological issues grew in the early 1980s, this dream began to take shape in the form of Kinetic – the ultimate manifestation of how Seiko could fuse its environmental concerns and its microelectronics skills to create an entirely new generation of timepieces. At the same time, alternative battery-free solutions were also tried. In the early 1980s, solar watches were developed as one of Seiko's solutions to the energy problem. They were powered by light – and required

no battery change, but Seiko dropped development of this inferior technology in favour of Kinetic, which uses the natural movement of the wearer's wrist, whereas a solar powered wristwatch may not always receive sufficient light, especially if it is covered for most of the day by a sleeve that shields it from light.

All Seiko's energies became focused on Kinetic and, by 1999, there were already five different Kinetic movements, each designed for different sizes of case and applications. Kinetic had been established – it was time to move ahead.

Seiko then surprised the watch world by introducing the Kinetic Auto Relay, a timepiece that is capable of "going to sleep" and "waking up" again at any time in the following four years. It was as though this watch could think for itself. Like all Kinetic watches, it is powered by movement of the wearer's arm and thus eliminates the need for battery changes, but it also has one very special additional feature. It has the ability to maintain accurate timekeeping over long periods, even if it is not worn, by entering a state of suspended animation if it senses inactivity for three days. Like the brain of a sleeping person, it then continues to maintain precise timekeeping within its electronic circuits, but ceases to drive the stepping motor and hands, the components that require most power. When it is eventually moved again, the hands reset to display the correct time.

Seiko's Auto Relay system enables a Kinetic watch to "go to sleep" when it is not moved for three days and to "wake up" and reset itself to the correct time as soon as it is moved again, up to four years later.

The Thermic watch is another example of Seiko's determination to adopt an environmentally friendly approach. It creates electricity by harnessing differences in temperature between the case back and the wearer's wrist.

Kinetic has not been the only technology that Seiko has developed with the ecology in mind. The Thermic watch, launched in 1998, is another good example. Instead of using Kinetic technology to generate its source of power, the Thermic watch generates electricity by harnessing the difference in temperature between the watch case and the skin of the wearer. Although the Thermic watch offers many benefits, Kinetic technology has proved to be the clear winner in the eyes of the watch-buying public, and the most recent innovative symbol of its success is the Kinetic Chronograph, launched in 2000. Its unique movement was developed to offer not only chronograph functions, but also ease of operation, adding a new level of technical sophistication. Unusually in movement design, form came before function – it was developed to create a style. It features four "eyes" for its four functions, with no overlap – the four separate dials of this chronograph are each visible through a separate aperture in the case. At the six o'clock position is a time-of-day dial; the other

Form came before function in the design of the Kinetic Chronograph movement in order to create the four "eyes".

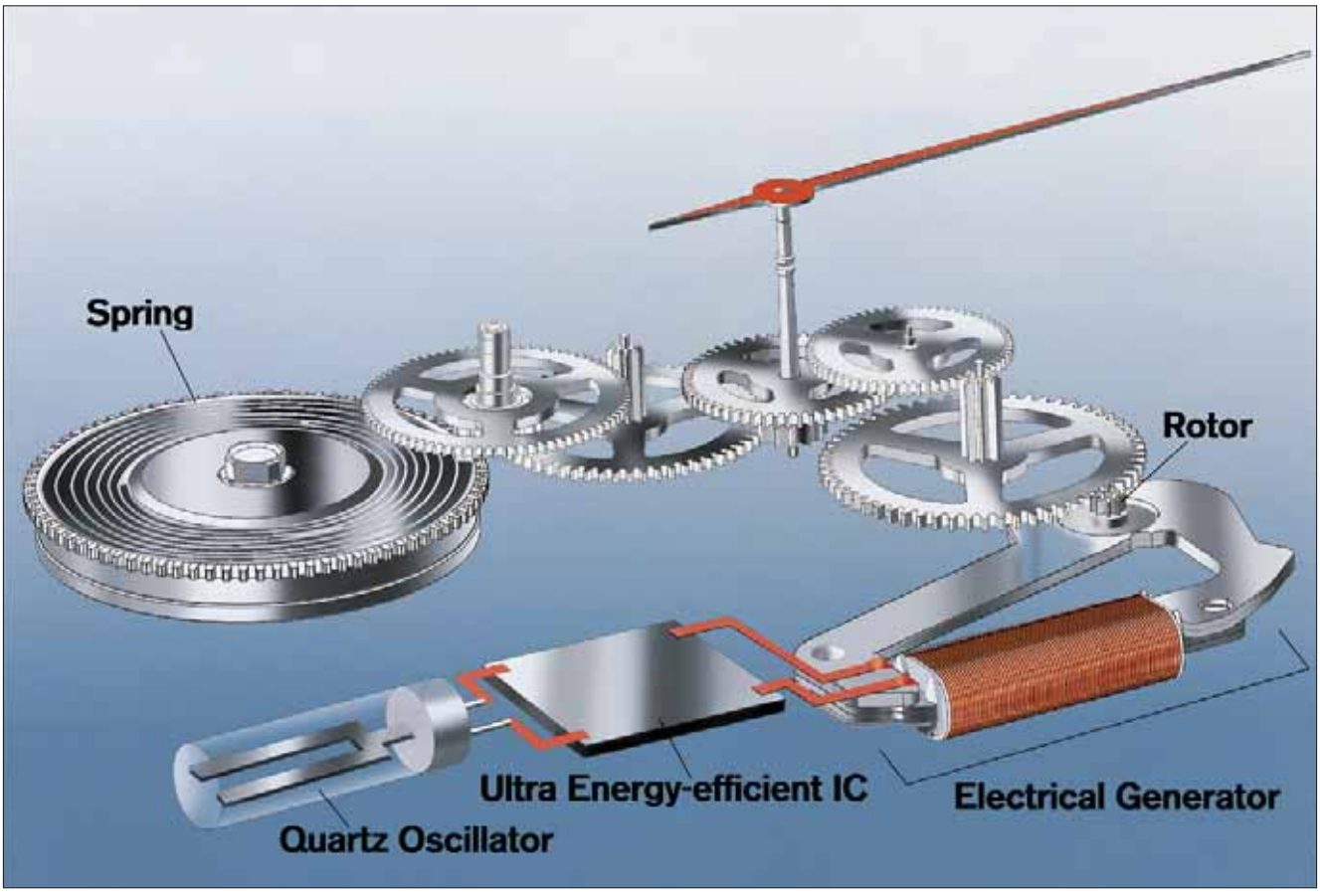
three dials show chronograph information, hours and minutes, seconds, and tenths of a second.

Responsive hands that return to their starting point instantaneously when the button is pressed are one chronograph feature that never fails to satisfy the user. This has always been a feature of mechanical chronographs and now Seiko has incorporated it in the Kinetic Chronograph, using a heart-cam snap-to-zero system. To ensure that movement of the hands is smooth and the date change is instantaneous, 38 ruby bearings have been used in the movement. To drive the fast-moving hands on this chronograph the movement requires a great deal of energy, so the power generation system in this special model produces three times more electricity than any other Kinetic watch.

This important timepiece combines the reliability and high accuracy of Seiko Kinetic technology with the traditional attributes of the mechanical chronograph. With a full charge from its Kinetic generating system, this watch will run for approximately one month, assuming the chronograph is used for three hours each day. The case is 10 bar water resistant and features a see-through back to round off the unique appeal of this remarkable timepiece and to offer a clear view of its extraordinary technology.

Until now, Seiko has produced movements first and designed cases later. Today, and in the future, Seiko movements are being developed as designs – they have become an integral part of the overall design process.

Energy-saving products are central to Seiko's policy of innovation and concern for the environment and Kinetic technology was the first manifestation of the company's long-declared mission to care for the environment by



Spring Drive is the most important development in timekeeping since Kinetic. It marries the best of quartz to the best of automatic.

searching for ways to reduce or eliminate the need for the batteries that cause pollution to our planet.

Seiko's continuing drive for excellence has always focused on functions as much as on power-saving and, in the 1980s and 90s, much attention was paid to the needs of professional divers. In 1990, the company launched the world's first diver's watch that incorporated diving tables and a depth gauge.

The introduction of Kinetic totally revolutionised the diver's watch. It was in 1992 that the world's first quartz diving watch with a Kinetic movement was launched. This eliminated the need for regular battery changes and for the costly but vital changing of the seals that maintain water resistance. Above all, the Kinetic version of the diving watch ensured that a diver would never again run the risk of a watch stopping during a dive.

Spring Drive

Just as work on Kinetic had progressed at even the early stages of the quartz watch revolution, so Seiko started to develop an entirely new watch concept in the infancy of the Kinetic age. In 1999, Seiko introduced what has been described as the watch of the future. Called Spring Drive, it holds out the promise of the perfect synthesis of the human and the electronic, the old and the new, the complex and the simple. Armband Uhren, a highly respected watch publication, has remarked that Seiko is too modest about this significant achievement. Its revolutionary micro-mechantronic technology retains the best of mechanical and quartz technology and dispenses with the weakest component of each. It has a mainspring that is wound by hand. As it unwinds, it not only drives the smooth sweeping action of the large hands, but also powers a rotor whose tiny electrical output induces a quartz crystal to emit a reference signal. An integrated circuit calculates the difference between this signal and the rate at which the mainspring is unwinding and then uses an electro-magnetic braking system to regulate the speed at which the spring unwinds.

Seiko's unique Spring Drive technology combines the best features of mechanical and quartz watches. This stylish example features a power reserve indicator on the dial to show how much longer it will run before it needs winding.

Seiko's ingenious designers have eliminated the escapement, the most troublesome part of a mechanical movement, and also the battery, the part of a quartz watch that needs to be replaced – except in Kinetic watches. Unlike a traditional mechanical watch, the Spring Drive movement runs with the accuracy of a quartz timepiece, but unlike a quartz watch, it has a seconds hand that sweeps smoothly around the

dial.

The integrated ciruit in a Spring Drive watch runs on only 25 nanowatts, half the power that is required by a conventional chip. This remarkable ultra low-power, low-voltage IC is one of the unique Seiko technologies that have made Seiko Spring Drive possible. When fully wound, the watch runs for 48 hours with an accuracy of ±15 seconds a month. With these ground-breaking approaches to the technology of time, Seiko has earned its reputation as the world's most innovative watch manufacturer.

The innovative movement of the Spring Drive is revealed by its see-through case back.

'Innovation and Refinement' continue to be central to Seiko's Vision for the future and the search for it is being conducted on three fronts, quartz, Kinetic and Spring Drive.

On all three platforms, Seiko expects to introduce new functions and new design possibilities for many years to come.

The Guardians of Time

To mark the centenary of the founding of K Hattori, Seiko set up a new institution that might not have pleased Kintaro Hattori, the founder of the company, but is certain to please future generations. In 1981, the Seiko Institute of Horology was established in Tokyo.

Kintaro Hattori, according to his grandson Reijiro, always wanted to look forwards and considered it a waste of time to look over his shoulder. Reijiro Hattori recalls, "Now, our company has an Institute of Horology, but if Grandfather had been around when it was being set up, there's no question that he would have said, 'How preposterous. Just stop it!' You see, when I was a kid and people visited Grandfather, saying 'I have a Model Number One dating from the time when Seikosha was formed' or 'Here's one of your old catalogues', he would really get in a bad mood.

"On these occasions he would always say 'I could understand it if they had gone to some foreign country and were telling me to look at a new watch they had come across, but bringing something because it was one of my old products, that's preposterous!' My father would tell me these stories and laugh, adding, 'Well, that's the nature of the founder of a business, they're always keen on new things'." When the company reached its centenary, there could be little doubt that the many great achievements were worthy of being preserved and catalogued for posterity and so the Seiko Institute of Horology was established in Tokyo.

This wall clock was made by Seikosha in 1892, the year when Kintaro Hattori set up his first clock factory.

The Institute was established not to glorify Seiko but to maintain a record of the development of watchmaking, including Seiko's history. The Institute's curators look after 16,000 watches, clocks and related items that go back as far as the dawn of the horological industry in Japan. The Institute also has a reading room and extensive literature about time and timepieces, both from Japan and overseas; industry history, horological technology, antique documents and much more.

There is a permanent exhibition and although most of the items on show relate to Seiko, others illustrate each stage in the development of the history of watches and clocks.

Kouji Kubota is the Institute's honorary director and few people could have been better qualified to head such an important museum: he was one of the key members of the Seiko team that developed and launched the world's first quartz wristwatch. He has a remarkable memory for detail and could be likened to a horological history book and dictionary, able to recall even obscure items of information. At the Institute he considered himself to be a conservationist of world timepieces, and not just those made in Japan.

The Institute houses some of the earliest oriental timepieces, including incense clocks and early Japanese

clocks with twin verge and foliot escapements, designed to show time according to the old Japanese system with each day divided into two periods, daylight and darkness and with each of these subdivided.

In its permanent displays the museum has examples of some of the early American wall clocks that were imported by K Hattori, as well as some of the early clocks made by Kintaro Hattori's first factory in Tokyo. In addition to the clocks and watches that show the development of Seiko there are some veritable treasures, such as the watches that achieved remarkable success in the Swiss Chronometer trials and the treasured prototypes of some of Seiko's first quartz clocks and watches.

One section of the Institute is devoted to what has been called horological pre-history in Japan. This covers the period up to 1890 and tells the story of the history of time from several thousand years ago, when people first began to think about time, and the first sundials created in Egypt around 4,000 BC.

This is an example of one of the earliest alarm clocks made by Seikosha. It was produced in Tokyo in 1899.

From the beginning

The subsequent exhibits in the Institute are presented in chronological order. The first section covers the establishment of K Hattori and the Seikosha factory, from 1881 to 1912. There are superb black and white pictures of pocket watch production and clock assembly at the Seikosha plant in 1903, as well as imposing views of the office building and the factory in 1909.

The Institute's second section covers the Taisho Era, from 1913 to 1926. At the beginning of this period Seikosha produced Japan's first wristwatch, the Laurel, which can be found in the museum. In 1924, the first wristwatch was produced bearing the Seiko name and an example of one of these is also on show. In 1923, the Great Kanto Earthquake destroyed the company's stocks and factories. The first wristwatch bearing the name "Seiko" was produced just one year later.

In the first period of the Showa Era, from 1927 to 1934, restoration following the Great Earthquake continued. The Seikosha factory was rebuilt by 1930 and the K Hattori Ginza building two years later. The new art deco Ginza building is still in existence today and, as the Wako store, is one of the most famous symbols of Japan's most exclusive and world renowned shopping area. The Institute includes illustrations of the company's early buildings, as well as many examples of products made by Seikosha in the early years. It also contains some of the American clocks that provided the inspiration for many of Seikosha's early models.

During the second period of the Showa Era, from 1935 to 1945, Seikosha created a separate watch company called Daini Seikosha, which literally means "Second Seikosha". In the early Showa Era, during the Russo-Japanese War, the company was directed by the military authorities to produce artillery fuses.

It was obliged to produce military items again during the Sino-Japanese War of 1937 and the Second World

War. For the duration of this war, both Seikosha factories had to be turned over to full military-oriented production, making items such as marine chronometers and military chronographs. Military output accounted for as much as 94% of production when hostilities ended in 1945. Manufacturing of consumer watches had declined year by year to almost nothing. During this time, Seiko's technical team created chronometers, at the request of the Japanese Navy, that were considered superior to Swiss made counterparts and this experience made a major contribution to the post-war development of Seiko.

The Institute includes not only timepieces recording Seiko's own history, but also other clocks that illustrate the history of timekeeping in Japan. This is a clock with a twin verge and foliot (visible below the bell), from the era when Japan used the lunar system of timekeeping.

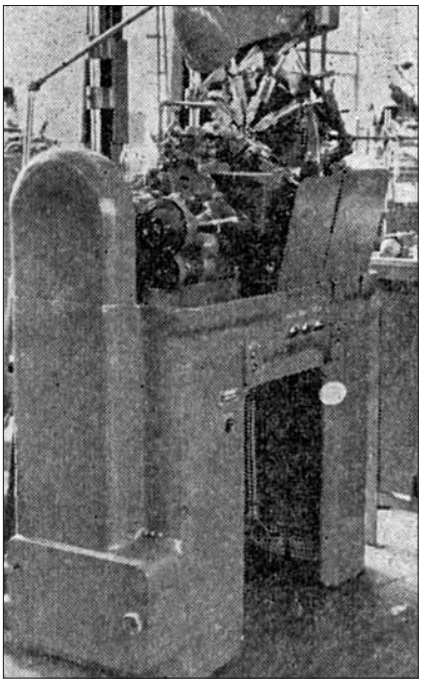
One of the American clocks that provided some of the inspiration for Seikosha's early products.

An 11 ligne watch was produced around 1941 featuring Japanese characters on the dial, in response to prohibition of the use of the western alphabet – English was decreed to be an "enemy language". Until then, the name on the dial was Seiko, in western characters, but for a period during the war the equivalent Japanese phonetic letters were used. Under government direction, the dials also had 24-hour marking.

More devastation

After the war, major rebuilding work commenced for the second time in the company's history and it dominated the first half of the third period of the Showa Era, from 1946 to 1954. During the War, the Daini Seikosha factory in Tokyo was devastated as a result of bombing raids, but wisely the company had spread its operations among other factories outside Tokyo. By the end of 1949, all but one of the factories in Suwa had been closed and the Kameido plant in Tokyo became the focus of attention. It restarted production, but because of deteriorating equipment and the poor quality of raw materials in the post-war years, it experienced many quality problems. Special procurements for the Korean War, starting in 1950, helped to revitalise the Japanese economy and, as demand increased in the watch market, productivity increased and quality was stabilised. The Institute of Horology

A wall clock with a second dial that shows the day, month, and date, made in the USA by Seth Thomas at the end of the 19th century.



Machinery to automate production processes have been a key feature of Seiko's success story. This illustration in the Seiko Institute of Horology shows a machine that was in use around 1908.

contains illustrations and old timepieces that document Seiko's growth and the development of its products.

In post-war Japan, the production of all types of consumer goods was given top priority and as part of a general policy aimed at boosting exports, special emphasis was given to the horological industry. Public and academic resources were made available in a bid to enhance the quality of Japanese watches. In 1948, the Ministry of International Trade and Industry started a domestic watch competition that was part of this effort and gave a substantial boost to quality in the industry.

A distinctive identity

The exhibits in the museum covering the fourth period of the Showa Era, from 1955 to 1964, are important because this was the age in which Seiko movements and complete watches began to acquire a distinctive identity of their own. It was the time when Seiko's designers introduced their own solutions to technical problems and introduced conveyor belt systems for the production of watches and clocks. In this era, many important new mechanical watches were introduced, including the Super, the Marvel and Cronos lines, as well as the enduring Grand Seiko line. In 1959, Seiko launched its first quartz master clock and development had already started on Seiko's first quartz wristwatch. The Institute documents Seiko at the height of its mechanical production, as well as the all-important quartz development years.

The Institute of Horology provides an invaluable resource for anyone who wants to study the development of timekeeping, especially the Japanese contribution. It is open to anybody, free of charge, but by appointment only.

Many early timepieces are on display in the Seiko Institute of Horology in Tokyo, as well as many of the watches featured in this book. This museum exhibit is an unusual belt watch for golfers, made in 1960.

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Evolution of Seiko, 1892 - 1923, by Hoshimi Uchida, edited by the Seiko Institute of Horology and published in 2000 by Seiko Corporation was an essential source of reference during the writing of this book. It is the third of a trio of publications about the History of the Japanese Clock and Watch Industry.

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