THE American Surveyor

A Foot In The Past… An Eye To The Future

November 2007

The Quad Father

Trimble Sweden
A visit to the factory

Surveying Art
Seattle artist takes to grids

New Scanning Technology
There's info between the shots

Fusing Measuring Innovation with Global R&D

The fusion of 60 years of measuring innovation with a worldwide R&D capability has catapulted Trimble to the forefront of state-of-the-art instrumentation.

One of the most enjoyable aspects of my job as editor has been getting to know many of the talented people whose work has helped to shape our industry. This month our spotlight focuses on Roger Höglund of Trimble and Omar Soubra of Trimble, formerly MENSI. What follows are really two stories, one about Geodimeter and its history as a total station manufacturer and another about MENSI and its history as a laser scanner manufacturer. Both companies are now owned by Trimble, but because key people still work for the organization, not only has institutional knowledge survived, but a strong vision for the future as well, as witnessed by the creation of a totally new platform for Trimble's latest offerings. Like most Scandinavians, Höglund dislikes drawing attention to himself. But he has been involved in the sales of survey instrumentation for 31 years, and represents a common thread for Trimble's total stations and more. Likewise, Soubra represents the common thread for Trimble's scanner offerings.

This year marks the 60th anniversary of the invention of the Electronic Distance Measuring device, or EDM. It was our great pleasure to travel to the production facility for Trimble's scanners and total stations in Danderyd, Sweden (a suburb of Stockholm) for a visit with Höglund and Soubra and their teams and a tour of the factory. Having visited the Danderyd factory in 1998 when it was still Geodimeter, I was once again struck by the

>> By Marc Cheves, LS

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Cutaway of Trimble 5600 Total Station.

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MENSI SOISIC tubular scanner, circa 1992.

thread of corporate continuity over the past three decades. The platform for the new-generation products – the Trimble® S6 Total Station, the Trimble VX™ Spatial Station and the Trimble GX™ 3D Scanner – has been developed by the same R&D and product people that developed the Geodimeter products, and the company now reaps the benefits of Trimble's global R&D efforts, particularly in software.

Höglund has been called the Father of the S6 total station. And although he humbly deflects the accolade and gives the credit to the worldwide team that helped, Höglund's vision is largely responsible for its creation. The S6 simplifies things that have always been a hassle for surveyors: maintaining true verticality of the crosshairs as the telescope is inclined, and dealing with the settlement of the tripod as a setup moves through time. (I wrote an extensive analysis of the new Trimble S6 in our March/April 2005 issue.)

Trimble GX 3D Scanner assembly area in the Danderyd, Sweden factory.

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MENSI began in France in 1986 with two engineers. In 1992 they introduced the first long range scanner, the SOISIC tubular scanner. Their biggest customer was *Électricité de France* (EDF*),* which also provided funding. Today, EDF is one of the four largest energy companies in the world. The scanners soon revealed a 15 percent difference between the design and the as-builts for EDF's 86 nuclear plants. In 1998, MENSI introduced a geomatic scanner model called the GS100, which took the form of modern scanners. They introduced the first 360° scanner at Intergeo in 2000. Next came the GS200, and in 2005, the latest model, the Trimble GX 3D Scanner, which brought survey techniques to scanning, was introduced at Intergeo in 2005. (The GS200 was the model used for scanning the LNG retrofit in the UK in our October issue).

For critical instrument sections, an assembly robot picks parts and then precisely and accurately places and attaches each part.

Soubra's Creative Career Path

Omar Soubra's connection to MENSI came about rather unconventionally. Born in Le Blanc, France in 1974, he first obtained a degree in electricity and power – including circuit boards – from the University of Dundee in Scotland. Next, he obtained a degree in laser and optical engineering from the Polytech Institute in Orleans, France. Soubra's interest in special effects for the movie industry led him to submit an unsolicited 50-page report to MENSI. The rest is history. After one week in sales training and another week in sales and marketing, he went to work for MENSI and ended up in sales for the UK. While there he obtained a Master's degree in sales and marketing. In 1999 he spent three months in Atlanta, Georgia as the liaison between MENSI's European and American operations. In October 2003, MENSI was acquired by Trimble and in 2005, Soubra moved to the Denver facility with his wife and two children.

Soubra speaks highly of his mentor at MENSI, Tristan Grimbert. Grimbert now resides in California and works for EDF on power-generating windmills. Soubra also spoke highly of Trimble

Omar Soubra, Portfolio Manager of Trimble Spatial Imaging on Robert Jung's boat at Vaxholm, Sweden.

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One of many pre-check stations before components are moved into the final S6 production line. For the 5600 series of instrument, one person performs all the steps in the assembly. For the new-gen instruments such as the S6, production takes place on a line, with each person in the line performing one or more steps.

managers and mentors Bryn Fosburgh and Jürgen Kliem, saying that being a part of the Trimble and the Denver operations is like being a part of a large family. When Trimble took over, MENSI was part of the 3D Scanning Solution Division. Now, it is part of the Survey Division of the Engineering and Construction Group, and Soubra is the portfolio manager of Spatial Imaging.

Soubra's passion for our business is obvious. He says that the acquisition of INPHO – a photogrammetry and digital surface modeling company – fits with Trimble's imaging business plan, and that Trimble's new VX Spatial Station will allow surveyors to take an intermediate step to get into scanning. The VX shares parts of the same platform as the S6 (more about that later) and both run RealWorks Survey™ software. He adds that the best thing about scanning is that users are dealing with a picture that reflects reality, and pointed out that one of the cool features of the VX is that the rodperson can see himself or herself on the controller screen.

On the Road Again

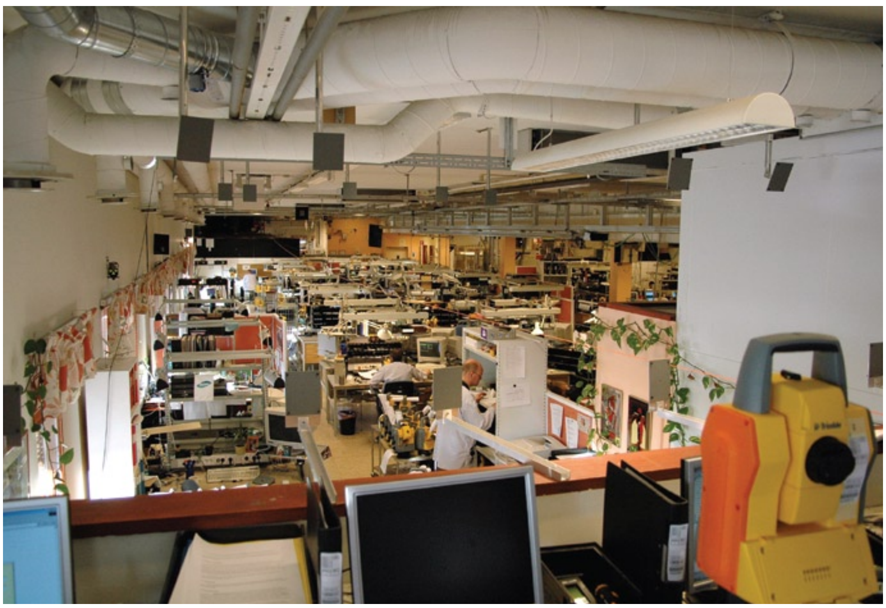
Before we began our tour of the Danderyd factory, Höglund explained the benefits of the continuity to the customers. Some of these products have taken years to develop, and forward-thinking is the main thing that makes these new products possible. The company was already thinking about putting video in an instrument, so as the S6 was being designed, room was made for the camera. In addition of the scanning knowledge from the MENSI acquisition, this helped to enable the VX Spatial Station. After spending five years in the Denver office, leading the worldwide group that developed the S6, Höglund's title is now "Segment Manager Survey, Europe" in Trimble's Raunheim, Germany office. Raunheim is a suburb of Frankfurt. His travel schedule is heavy. Outside of the U.S., Trimble has a worldwide outreach program called Trimble Express. Once when I called Roger I was surprised to hear that he was in Viet Nam in Ho Chi Minh City (formerly Saigon) at one of the Trimble dealer meeting events. He proudly mentioned a recent two-month road show in Europe that attracted more than 4,000 potential customers. The company is also having great success in Russia. Höglund emphasized the importance of the distributors – or partners as Trimble calls them – and the trust that exists.

Assembling the Components

In addition to Höglund and Soubra, our co-hosts for the factory tour were Thomas Wäsbom and Robert Jung, both of whom I had the pleasure of meeting on my previous factory visit. Previously, Geodimeter made all of its own circuit boards in cooperation with a high-level university group. Today, most boards are purchased in Sweden, with the factory only producing highly specialized boards. The diodes for the EDMs are also purchased outside.

I was fascinated to learn that Trimble makes extensive use of fiber optics in its instruments. At the former Zeiss factory in Jena, Germany, lenses are ground and the fiber optic assembly is manufactured.

To the right are the heat and cold chambers used as part of the final testing. In the background is the assembly floor.



Close-up of above picture. Barely visible to the right is the Invar band that spans the assembly floor. It rotinely detects 2mm of movement between summer and winter.

L-R Marc Cheves, Robert Jung and Roger Höglund inspect the new MultiTrack prism. Note low-cost GPS receiver mounted on top, which can be used by the instrument to predict where the prism should be.

Because the latter is somewhat fragile until combined with the other components, it is transported from Jena to Danderyd by special truck.

Getting the fiber connection right takes almost as long as the rest of the assembly time for an instrument. The connection interface is polished with four grades of very fine sandpaper with alcohol swabs to clean the fiber in between steps. We wore special anti-static clothing and shoes as we walked around the factory. I learned that even though static electricity can develop more than 2,000 volts (of course, at very low current), as little as 30 volts can damage components prior to full assembly.

Many familiar Trimble products are manufactured in Danderyd, including the Trimble S-Series, the Trimble GX 3D scanners, the Trimble Control Unit (TCU™) controller, the more traditional total stations like the 5500s and 5600s, and even the "legacy" Geodimeter keyboards used for the Trimble 3600 produced in Jena. As an example of continuity and compatibility, the TCU works with the Geodimeter 600. This allows a Geodimeter 600 purchased, say, in 1997 to benefit from the latest TCU technology. Furthermore, the TCU and TSC2 controllers can be used on all of Trimble's instruments.

All robotic total stations use servos, and all but the S6 total station and VX Spatial Station use gears to drive the motions. Normal servos, because they use gears, are subject to friction and wear. The difference between the normal servo-driven platforms and the S6 and the VX, is MagDrive™ technology (which I wrote about at length in the March/April 2005 article). MagDrive works like a mag-lev train with no touching surfaces, resulting in faster, quieter and smoother operation.

Our next stop on the tour was the GX area. The GX is assembled in Danderyd, with the final calibration taking place in Paris. As part of its platform commonality, the GX employs the same

fast tilt sensor as the S6. Soubra spoke about leveraging the optical history and expertise of the Zeiss group, and proudly stated that Trimble has seen nearly a threefold reduction in the amount of time it takes to build a GX since moving the assembly line from Paris to Danderyd.

Trimble keeps long-term statistics as a quality check on the instruments. Because each instrument is unique, two databases are kept, one for specs and one for testing. Modern manufacturing techniques have resulted in much higher quality across the industry. One way that Trimble ensures quality for component assembly is through the use of assembly robots. These machines are fascinating to watch as they pick parts and then precisely and accurately place and attach each part. With the new-generation Trimble instruments, the encoders for reading angles are incorporated into the MagDrive. For 5600 series instruments, one person performs all the steps in the assembly. For the new-gen instruments, production takes place on a line, with each person in the line performing one or more steps.

We finished our factory tour in the final testing and calibrating area. Cold

Roger Höglund on Providenciales Island in the Turks & Caicos Islands, circa 1972.

Höglund's Road to Success

Roger Höglund was born in northern Sweden in the town of Sikås in 1947. Following high school he attended business school, completing the two-year-program in one year. But he longed to be outdoors, and wanted to visit new places and delve into new tasks. One day while Höglund was still in school, a surveyor happened to be working nearby measuring distances at night. He came to the school looking for volunteers to sit with the equipment. A flame was lit. After 21 months in the Army, Höglund attended the Royal Institute of Technology where he received a diploma in surveying. During the summers he would survey, and after the first summer he had his own crew. To help pay for his time in school, he drove a taxi.

While in school, Höglund received a call from Bengt Soderquist, who was working in Florida and needed a surveyor. Because Höglund still had two months of school left, he turned the offer down. Time passed, and Soderquist called again. That call resulted in Höglund's move to Providenciales Island, part of the tropical Turks and Caicos Islands (TCI) in the West Indies, where he accepted a job with developer Provident Ltd. Because the islands are a British colony, the Crown Surveyor approved the development plans, and Höglund spent the next two years setting control monuments, staking roads and lots, topographic mapping, and drafting on Mylar. An HP35 was used for calculations. Photo control was established using existing rock outcrops. Equipment included a Wild T-2 and a Geodimeter 4. Höglund was happy to be able to make daylight distance measurements with the 4 because he'd had a bit of a problem getting the local helpers to work in the dark. One night, for example, they feared that a commotion in the brush was a zombie. Upon closer inspection it turned out to be a half-wild cow.

After two years Höglund was eager to return to Sweden. Armed with honesty and product knowledge, he increasingly developed his skill in making presentations. Shortly thereafter, he parlayed his newfound sales ability with his surveying background to become the sales manager for Zeiss Jena in Sweden. AGA's Model 12 was out, and in 1976 an agreement was made between Zeiss Jena and AGA to sell each other's equipment. Thus began Höglund's association with Geotronics. In 1979 he rose to become Geotronics sales manager for Sweden. In 1981, he became the Scandinavian sales manager, and in 1982, he became the worldwide marketing manager. He worked closely with sales, and his survey background enabled him to be solutions-oriented. Along the way, he married Amalie, an American who was the sales coordinator for Geotronics in North America. Today, he has seven grandchildren.

I mentioned earlier that Höglund's job has involved extensive travel. The Model 400, because it incorporated servos and other new technology, required extra training for customers, so he traveled all over the world for that. Likewise with the 600. In 2000, Trimble purchased Spectra-Precision, which had already purchased Geotronics and the survey operations of Carl Zeiss. In 2001, Höglund moved to Denver to oversee the development of the next-generation instruments. That done, he moved to Germany in 2006 to work in the European operations.

I inquired about how the worldwide development of the S6 worked. Höglund explained that there were many, many video and phone conferences. He also traveled to Danderyd once a quarter for face-to-face meetings with the R&D staff. With a worldwide market, it was also important to manage cultural differences between the various technology centers around the globe.

Höglund celebrated his 60th birthday in August of this year, also marking his 31st year of involvement with Geodimeter. His background as a surveyor has provided invaluable input to the company's product offerings. And even though Trimble's current position in the market is the result of a group effort of long-term planning and thinking, in his humble Swedish way, as Höglund says, "Someone needs to pull the train." The survey community is fortunate to have had Höglund as the conductor.

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Trimble S6 total station. Note bar code that is part of the factory's automated tracking.

A Company of Firsts

From its origin as AGA (a company that made a name for itself in optics and mirrors for lighthouses), to a global powerhouse in measuring technology, Geotronics (now Trimble) has always been an innovator. Geodimeter stands for GEOdetic DIstance METER. The Geodimeter 4 allowed daylight measurements. Model 8 was the first to a laser to replace visible light as the measuring beam. Models 700-710 provided the first reduction to horizontal and vertical distances, and are considered to be the first total station. These models also began Geodimeter's involvement in data storage, with the 120 being the first standards-mount EDM that displayed a horizontal distance. It was at this time that robots were first employed in the assembly process. At the same time, software was employed to track the correction constants for each individual instrument. The company began focusing on stakeout. The 140 model introduced the TrackLight which used red, green and white lights so the rodperson could get on line. The 440 brought onboard software and memory, and became the first upgradeable instrument. This also began the era of customer choice in a total station for such things as range, angle accuracy, onboard software, and onboard memory. In 1987, in response to the worldwide shortage of surveyors, Geodimeter began work on one-man robotic total stations. The 460 was the first servo-driven model and also brought with it the first complete data chain and a step-by-step upgrade path. Geodimeter's technology has been very popular. In 2000, before the DR200+ was even released, British Railway ordered 60 units, and the Professional Golfers' Association of America ordered 110. The year 2004 marked the end of infrared EDM measuring beams, replaced by lasers and Direct Reflex (DR) technology.

A Look Back

1941	Dr. Erik Bergstrand begins experiments to determine a better value for the velocity of light.
1947	**Field test with prototype**
1948	**Geodimeter 0**
1953	**Geodimeter 1** Two frequencies; 2-3 hours measuring time; 1 hour to calculate the result; 5 days of training
1955	**Geodimeter 2** 45-minute measuring time; range 50 km
1956	**Geodimeter 3** 20-minute measuring time; range 50 km
1958	**Geodimeter 4** 10-minute measuring time; range 50 km
1964	**Geodimeter 6** Transistors used for first time; coaxial optics
1968	**Geodimeter 8** Range 60-120 km
1971	**Geodimeter 700-710** First total station; data stored using a paper punch
1974	**Geodimeter 12** First EDM with everything (except battery) in one small box
1978	**Geodimeter 120** First EDM to automatically give horizontal distance
1981	**Geodimeter 140 Series** and **GeoDat 126 Data Collector**
1984	**Geodimeter 220**
1986	**Geodimeter 440**
1990	**Geodimeter 460** First conventional servo-driven total station
1990	**Geodimeter 4000** First robotic total station in the world
1992	**Geodimeter 500** Mechanical and servo coaxial distance meter; first long-range 3D scanner (SOISIC)
1994	**Geodimeter System 600** First fully upgradeable total station: conventional, Autolock, robotic
1997	**Geodimeter System 600 Pro** and **Geodimeter 600** Bergstrand (limited edition honoring the 50th anniversary of Dr. Bergstrand's invention)
1998	**GeodatWin Controller**
2000	**Geodimeter 600 DR200+** First reflectorless total station
2001	**Trimble 5600** Servo, Autolock, robotic
2002	**Trimble ACU** Advanced Control Unit controller
2005	**Trimble S6 Total Station**
2007	**Trimble VX Spatial Station**

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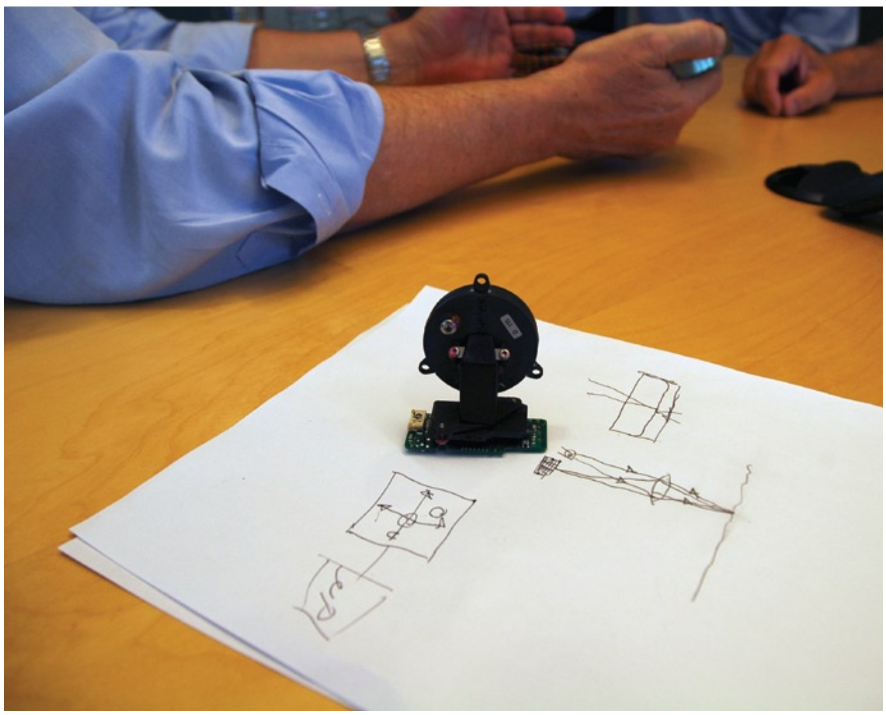
Roger Höglund watches as 27-year employee Technical Specialist Mikael Hertzman explains the workings of MagDrive (upper two parts in lower left) and the level sensor (lower part).

tests to -20ºC and heat tests to +50ºC are performed. Special glass is used in the angled windows in this room to allow technicians to make long-range prism shots in the winter. The instrument test pillars are sunk to bedrock, but because some of the test prisms are attached inside the building, to ensure that the test results are correct, building movement is monitored with an Invar band stretched across the factory floor. This band is checked once a week and routinely detects 2mm of movement between winter and summer.

Because I had expressed interest in how these new-generation instruments work, Höglund arranged for us to spend some time with the resident chief rocket scientist, Mikael Hertzman, whose official title is understatedly Technical Specialist. Hertzman has been with the company for 27 years, and he, like Höglund, is part of the thread of continuity. Technology of these instruments is similar to that developed by Hewlett Packard in the 1970s, most notably the tilt sensor. Without revealing proprietary information, Hertzman explained that through the clever use of folded optics – to keep the size of the sensor small but still enable it to "act big" in detecting very tiny movements – a beam of light is shined onto a pool of liquid silicone. The reflection of this light is sensed and converted to digital information, which is then used to determine the level-ness of the instrument. This, combined with the ability of the MagDrive to make very small movements, is what allows the instruments to work so well in Face 1-only measurements.

We finished our tour with an outdoor session to receive a sneak-preview of Trimble's new MultiTrack™ Target, which was introduced in May of 2007. Codenamed Project Lighthouse during development, the unit solves the problem of erroneously acquiring a nearby reflective surface such as a road sign or a reflective vest. Not only will the unit allow up to eight targets to be in use at the same time on a project, a user can also incorporate an inexpensive GPS receiver (approximately $100) so the instrument can calculate where the prism should be. This shortens the search time by the instrument should lock be lost. The MultiTrack can act as a normal passive prism or an active target. In active mode, the 360º LED ring ensures that the correct target is tracked from any angle.



The level sensor (the circular vial is mounted horizontally in the instrument) along with Hertzman's sketch explaining how it works.

Marc Cheves is Editor of the magazine.

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