USER'S VOICE

Vol.8
2011

Machining Navi

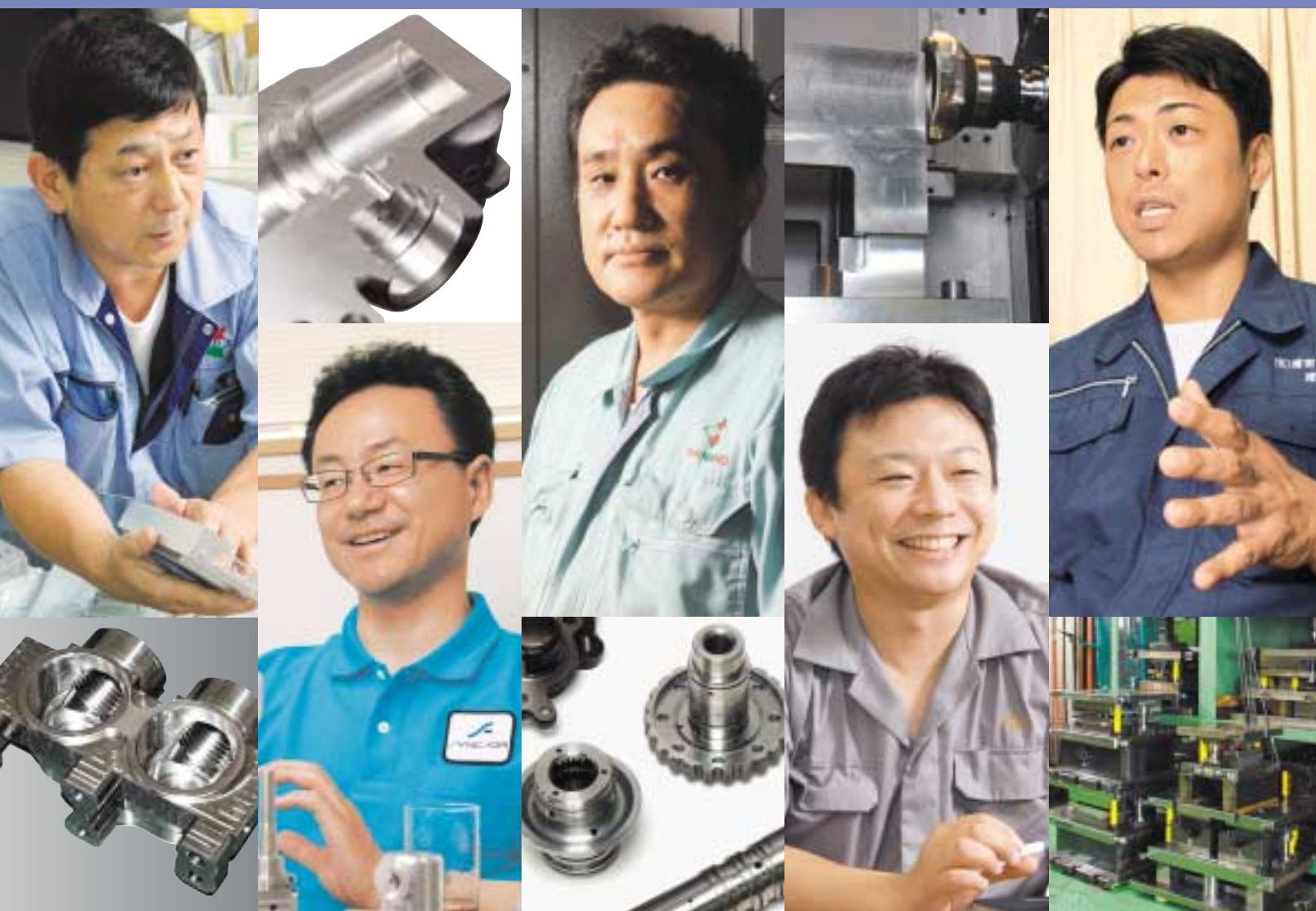
User Testimonials

Tool lives became longer, and cycle times became shorter
A useful tool that reduced the number of operations, tools, and cost
Essential for providing “both high quality at low-cost”

Developer Stories

Making chatter “visible” and providing optimum cutting conditions

Symbolic of the high regard for the shop floor perspective



With Machining Navi's "visual" approach, the productivity of ID jobs has really increased

To suppress chatter, "harmonic spindle speed control" searches for the optimum cutting conditions

At our Yawata Factory, which was the location for NHK's TV series called "Furinkazan," is near Chikuma River where we mass produce car air conditioners, clutches, engines, and transmissions for the auto parts manufacturers in nearby Gunma Prefecture. From our main factory we also supply Okuma with a "high-pressure tool cooler" designed and made by us. We are strong in providing "both high quality and low-cost"—that's what we strive for. To beat tough competitors, we have to have the best process, machine, and people with strong cost competitiveness. I am a tech-head from the core, so when I can work with the machining software and come up with good results myself, techie chatter with the Okuma engineer and sales rep is fun for them too.

I discussed "machine chatter" with Okuma in 2009. We got chatter when boring 80-mm deep with the LB3000 EX. We thought about the workpiece material, lathe and tooling performance, for example a ø10-mm boring bar with recommended 50-mm overhang (L/D ≤ 5), but to rapid increase for CVT (continuously variable transmission) parts we had to somehow overcome this problem. That's when Okuma's sales rep suggested we "try using the installed 'harmonic spindle speed control' option." This adjusts the programmed spindle speed where it's needed to suppress chatter—the forerunner of "Machining Navi." So we tried it right away and it worked beautifully. The chatter disappeared, but with this software you have to change parameter settings every time cutting conditions change and tools get dull, and finding the right conditions took time.

Yawata Factory employs 150 people. Most of them run 4-5 machines to increase productivity.

"Machining Navi L-*g*" improves productivity, and supports process-intensive applications

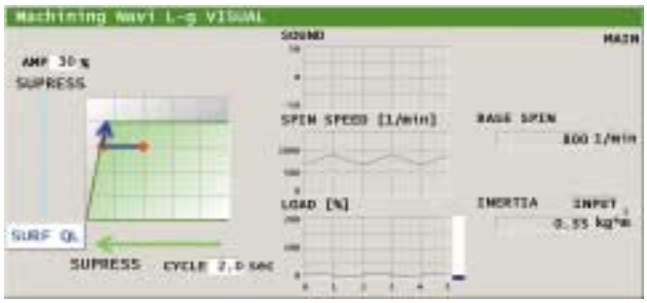
When "Machining Navi **L-*g***" was released in August of 2010, I sounded Okuma out about becoming a monitor. After hearing that "the recommended values for spindle speed wave amplitudes and cycles are calculatedly instantly, and without reducing spindle speed, you are guided to chatter-free cutting conditions," we had it installed on our LB3000 EX.

What surprised us after testing it on several types of workpieces, were the large "visuals" of the machining sound and spindle load, and the recommended values. We were able to check the machining sounds we heard and the surface roughness that we saw in the actual data taken (on the Navi). By looking at the graphs provided by the Machining Navi, we discovered that we could increase the spindle speed higher than the harmonic spindle speed control settings. Then, it occurred to me that this feature could help us improve process-intensive machining.

For example, when machining on a long shaft, we were able to prevent chattering and streamline, or reduce, the machining process for a workpiece that usually took 3 - 4 machining operations to just 1 - 2 operations by following the recommended values from the Machining Navi. More than anything, you save yourself time spent on mounting a steadyrest that only gets in the way when machining, and you also don't have to use expensive specialized tools or chucks. As a result, the Machining Navi not only reduces defective products but improves production speed and decreases manufacturing costs. This means you improve your operating rate while maximizing the performance for your standard equipment, in an economic climate that does not allow a lot of room to invest in or use specialized equipment.

Machining Navi

LB3000 EX + L-*g*



With a visualization of the machining sounds and spindle load, you can increase spindle rotation even more and improve productivity.

We offer an 800,000 to 900,000 unit production capacity for automotive air conditioner clutches, as well as machining experience with a variety of parts including CVTs and critical safety parts for engines.

The Machining Navi we use (for lathes) features process-intensive machining (milling tools) which is also suitable for mass production of auto parts—and essential for providing "both high quality and low-cost."

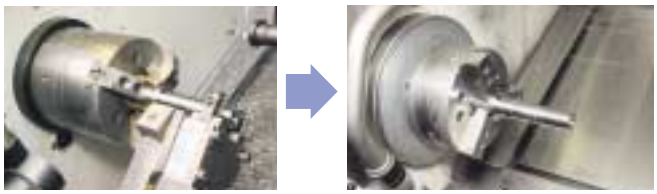
Each time our engineers visit their plant, Mr. Kitamura is always happy to talk about technology, such as programming operations or the latest software.

Maximize machining and the OSP performance in order to minimize the rejection rate

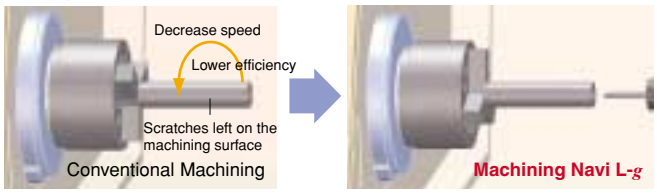
Our company equipment from Okuma that is currently in operation includes approximately 60 units. The LB3000 EX and the LT2000 EX Twin Spindle Turning Center are equipped with the Machining Navi. In addition, we are able to control chattering on other lathes by using the harmonic spindle speed control.

35 years ago, our company introduced the first NC lathe into our production, Okuma's LC10. At first, I felt as though the machine was a little difficult to operate compared to other NC lathes. But once I got used to the operations, I could even do complex programming in a snap. The more you get to know the OSP, the more you realize how much it has to offer. The Machining Navi function is also one example of this.

Automotive parts production can be described as an industry that involves tens of thousands of production units per day with no room for manufacturing error or defects. In these types of circumstances, just like with the Machining Navi, the competitive edge we have in our quality assurance comes from the "Thermo-Friendly Concept," a powerful approach to handling thermal deformation. The employee daily reports also show: "Okuma machines are easier to work with mentally speaking, because they can ensure dimensional accuracy through simple corrections, even when restarting operation after taking your lunch break."



When using a steadyrest (left), it can leave roller marks on the workpiece or cause swarf buildup, but with the Machining Navi (right), you don't need to use a steadyrest.



Machining efficiency is 1.5 times higher without the steadyrest.

While the industry conditions are tighter due to global competition, which in turn cause cost reductions, a strong yen and demands for power conservation, we believe reinforcing plant quality is a must and can be achieved by actively using technology such as the Thermo-Friendly Concept and Machining Navi.

Shinano Kiko Ltd.
Mr. Kazuhiro Kitamura, Vice President

Yawata Factory: 5484-1 Yawatadai, Chikuma, Nagano
Phone: +81-26-273-3667
Founded: December, 1971
Business: Manufacture of core clutch parts for automotive air conditioner, automotive functional parts and industrial machine parts, and manufacture and development of high-pressure tool coolers (original product)

The Machining Navi is a reliable tool, for the “21 century machinist” who has mastered the NC lathe and software, as if it were an extension of your arm.

The company adopted a unique name that is easy to remember and pronounce for overseas partners—Mr. Yamashita.

Our best machinists produce prototypes from diverse materials Eager to tackle the more complex and difficult jobs

Our company business focuses on machining prototype or test pieces that are ordered by R&D departments for manufacturers. Our best feature is the wide variety of materials that we can support. We have a long history of dealing with “glassy carbon (impermeable carbon material from a black glass gas),” which is used in electrodes for etching systems and substrate holders for semiconductors, and as a result, we have applied this experience toward machining applications of SiC (silicon carbide) and built up the corresponding know-how. That is also to connected to the know-how required for machining difficult-to-cut materials, such as glass fiber, CFRP (carbon fiber reinforced plastic), C/C materials (carbon composite), titanium and ceramics.

In addition, parts from equipment such as vacuum based systems, precision equipment and semiconductor fabrication systems, many times require not only tolerances at the micron level for prototypes or trial manufacturing but a smooth finishing surface (surface roughness example: Ra 0.1 – 0.2) as well. Furthermore, the configuration of the workpieces is distinctive, or not necessarily typical. For example, it is not uncommon to come across difficult machining such as a die with 4,000 dimples on its curved surface, as if a bowl was turned upside down. We have about 15 staff on hand, ranging from their twenties to thirties, who operate multiple tools and conduct this type of machining that have both a high level of accuracy and a high level of difficulty. All are versatile machinists, and we not only make our own original jigs, but manipulate holders to the point that would even surprise tool manufacturers, making it possible for us to convert a drawing by just looking at it into tangible parts.

Left: Sample of a machined square pyramid without burrs, that is 6 mm tall, made from a machining center.
Right: Polyhedron machining created from 2011 small flat surfaces using cutting processes with an NC lathe and a 5-axis machining center.

Highly accurate sample cut that created an opportunity to use the Machining Navi monitor.

With the "Machining Navi," quickly identify the direction, and improve productivity by reducing time used for trial-and-error

I knew about the existence of the Machining Navi when it was initially announced for use with machining centers (**M-*i***, **M-*g***), and I thought about using it with the LB3000 EX and whether it could be mounted on later. But a sample cut we prepared in order to confirm the LB-EX performance prompted discussion about using the "Machining Navi **L-*g***" monitor that was being developed for lathes at the time.

That sample was from a part in which a blind hole was machined in the multi-level, small diameter boring using the Okuma lathe LU300-MY and an electric discharge machine. We machined while adjusting the wave amplitudes and wave cycles produced from the spindle speed and using G codes to control the chattering. That is, we were able to use the same function with the Machining Navi on the LU. Thereafter, the Okuma engineer was interested and proposed that we "mount the Machining Navi on the LB3000 EX and try it out." In order to achieve a smooth and clean finished surface with standard turning, since the tool mark changes when the spindle speed is increased and decreased with the unit of time, it is great that you can avoid and focus on controlling this with the Machining Navi.

When actually testing out the Machining Navi, we were able to improve the cutting speed by 70%, without any chattering and at boring depth of L/D = 8. Using the Machining Navi for repeat orders proved to be particularly effective. Our company was able to complete around 120 orders in a month for prototypes and trial manufacturing with a two-week delivery period on average. Using it even reduces the time required for trial-and-error in order to maintain this pace of use and to maintain the machining quality with difficult shapes and hard-to-cut materials. In this sense, using the Machining Navi data as a guide helps the machinist get a quicker feel for the machining direction.

Increases the cutting speed by 70%

Conventional Machining
Cutting speed: 40 m/min

→ Machining Navi **L-*g***
Cutting speed: 68 m/min

Workpiece:
Stainless steel
Tool:
L/D = 8 (ϕ20 × L160)
Carbide boring bar
Cutting Conditions
Feedrate: 0.16 mm/rev
Cut depth: ϕ0.1

Machining Navi
LB3000 EX + L-*g*

Striving to get new orders in a 7 company partnership, while trying to launch our own brand

I developed a growing interest in motorcycles, majored in mechanical engineering at university and then jumped into the machining industry that focused on trial manufacturing. Since I was a student, I have competitively raced as a motorcycle rider for more than 20 years. In 2006, I won the All Japan Road Race Championship in the GP-MONO class. Now, I have used my experience as a racer and engineer to develop custom parts for motorcycles and have continued to develop prototypes engaged in trial manufacturing while trying to launch our own brand.

Winning the championships in 2006, and using technology to develop customized parts to help launch our own brand.

In addition, in 2009 the Chigasaki Manufacturing Circle (CmonoC) was launched as a group of manufacturers that included 6 small to medium size companies from Shonan (home town), and we are currently participating in trade shows and in other activities to increase sales. This group collectively uses its technical expertise, equipment and staff that specialize in metal parts machining, cutting and welding, and we offer design, manufacturing, aftermarket sales and support services to meet the customers' needs. Each company offers a distinct set of technical skills and equipment, and we stimulate and cooperate with each other all the time for both sales and operations.

Recently as well, we had conducted cast iron manufacturing operations in China, conducted burr-free drilling at our factory with short lead times, and then deliver these goods to Europe. Yet despite the tough global market and competition, there is still quite a bit of work which is available that "can only be machined because of the conditions available in Japan." Surviving or beating the competition in these circumstances often depends on how one uses the same machinery, or how to maintain your value and position yourself in the market. Our company name "SYNCFOR" derives from striving to provide manufacturing services that are synchronized (or in sync) with the needs for customers all over the world.

One of our young experts, Mr. Kageyama, frequently makes adjustments to the spindle speed by matching it carefully with the noise and oscillations.

SYNCFOR INC.
Mr. Yu Yamashita, President

Location: 370 Enzo, Chigasaki-city, Kanagawa,
Chigasaki Machinery & Metal Works Industrial Park
Phone: +81-467-86-4194
Homepage: http://www.syncfor.co.jp/
Founded: February 2010
Business: Development, prototype tools and machinery design and production, high precision machining and production (such as for semiconductor fabrication systems), advanced materials, ceramics, carbon, nickel and inconel, electric discharge and graphite machining

We actively offer VE proposals to suppliers who are positioned upstream on the supply chain from a machining perspective, in order to keep a competitive edge in manufacturing.
—Mr. Nagasawa

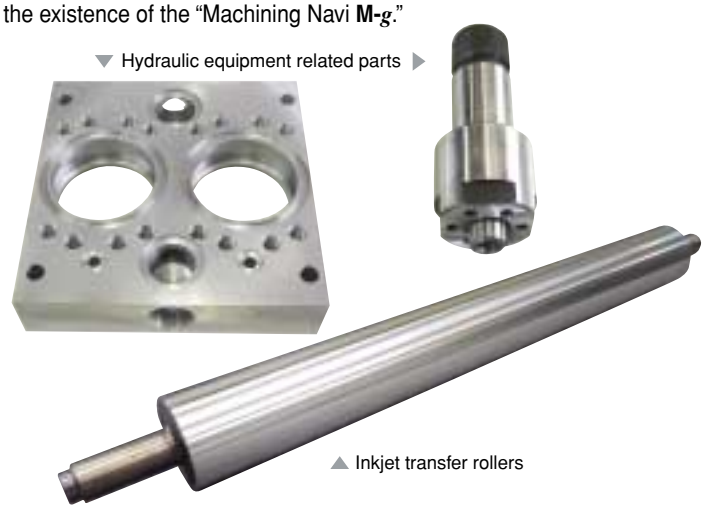
Tool lives became longer, and cycle times became shorter. We expect the effects will be the same even when integrating it on the lathe next.

The time and effort required for repeating the trial-and-error process, in order to find the optimum cutting conditions and understand when the tool insert chips, is a waste

Our company specializes in lot production machining for mold workpieces, such as casting or forging products and aluminum die casts. We are capable of mass producing from several hundred to around twenty thousand pieces per month, using an NC lathe line and machining center line, and also utilizing our own jig that we creatively developed in-house for clamping workpieces. Automotive parts used to represent the majority of our production, but recently, we are heavily involved with parts machining for printing machines, semiconductor fabrication systems, hydraulic equipment and LED related applications, etc. At the end of 2010, our company introduced the horizontal machining center MA-400HA for the first time. Our goal was to integrate operations, such as the aluminum and stainless steel machining operations. With this goal in mind, the "Machining Navi **M-*g***" came strongly recommended as a mountable option.

We used to perform a lot of cutting on the machining allowance for forging materials that ultimately became the casting or forging products. However recently, we have seen an increase in drill machining, on rod heads that fit onto hydraulic cylinders, and metal block drilling, for ϕ60 holes. As a result, we have become more involved with helical drilling, rather than drilling, in order to improve our efficiency. Different factors in this type of work, such as the materials, shapes and machine rigidity, form a complex relationship that also leads to chattering. As a consequence, the tool insert can chip, etc., and we have had difficulties trying to figure out the right cutting conditions to control the chattering that occurs onsite.

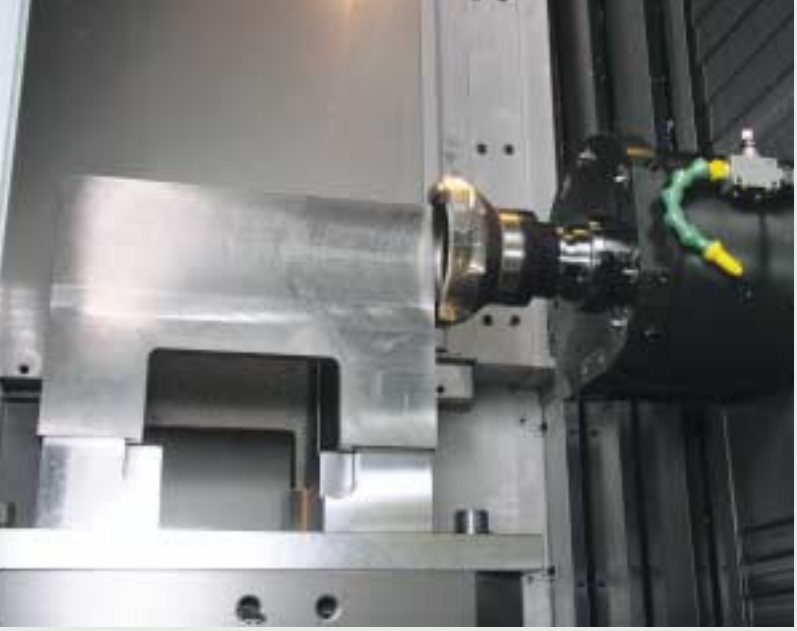
Even if the tool and jig cost a bit more, if the productivity per piece improves, these costs can easily be absorbed. However, trying to find the optimum cutting conditions through the repetition of trial-and-error is quite inefficient. This is when I found out about the existence of the "Machining Navi **M-*g***."



▼ Hydraulic equipment related parts ▶

▲ Inkjet transfer rollers

MA-400HA + Machining Navi M-*g*



When extracting the optimum conditions with the "Machining Navi" while face milling vacuum chamber parts, the tool life becomes approximately twice as long.

At Tec Nagasawa, MA-400HA was the first horizontal machining center. Equipped with 6 pallets, the tool magazine can store 160 tools.

Mr. Abe, who is in charge of MC machining, takes advantage of the tool strengths from the "Machining Navi" and the user friendly OSP.

Experience the difference with the "Machining Navi" even on a face mill, and quickly find the optimum conditions and significantly extend the tool life

According to machinists who operate machining centers, on the MA-400HA when setting the conditions following the "Machining Navi **M-*g***" screen guide for helical machining on carbon steel (S45C) rod heads, the chattering disappears, there is no insert chipping, and the tool life lasts approximately 2 to 3 times longer. In addition, the "Machining Navi **M-*g***" was used while face milling vacuum chamber parts, that previously caused problems like severe insert wearing. By following the Machining Navi instructions, the feedrate was left unchanged, but with a simple adjustment in the rotation speed from 800 min^{-1} to 700 min^{-1}, the tool maintained itself better and the tool life lasted two times longer. It was only a matter of the rotation speed being a little too fast for certain materials and shapes. Even on other workpieces, changing the cutting conditions by following the "Machining Navi **M-*g***" reduced the operating time and improved productivity.

Our company is currently focused on machining rollers for printing machines and is already developing our own finishing innovations without grinding. However, controlling the chattering that occurred in the center section on long workpieces was still a major issue. This is where we decided to select and introduce a new NC lathe model with the "Machining Navi **L-*g***." The LB4000 EX equipped with Machining Navi offers high precision for runout and chatter control, and now we are hoping and expecting to be able to perform roller machining with high accuracy.

Pursuing intelligent manufacturing alongside the customer, offering modification proposals that even include supplier manufacturing processes, in order to reduce the machining points

Although we are involved in the parts machining business, we always consider the issue of "how to reduce the machining points," and gear our business toward companies that are positioned upstream on the supply chain. We actively propose modifications from a machining friendly approach. Not only do we meet with the customer where the product is delivered but we even enter discussion concerning the materials stage. We try to consider how to produce efficiently with high quality, but at a low cost. There are few companies who offer this type of coordinating service and this gives us our advantage.

Our coordination and negotiation services are vital in creating a day-to-day network which establishes partnerships with local factories and provides opportunities to give presentations in our customers' meeting rooms and help create business and sales together. While major companies accelerate overseas production and global delivery, we have to create a win-win network that has mutual advantages for the continuous growth for the industry in Kashiwazaki City and expand the breadth of work available to them.

On the other hand, the city's plant management and operations style must also change. Right now, I am involved with projects that include providing open platforms to share information within a company, setting up bar code management systems to make the work progress more visible and creating a work environment where anyone with computer access can check information, such as sales data categorized by customer. I want to establish a work environment where the employee can not only access this information but figure out what he or she needs to do to optimize the work flow overall. This is the first step toward a more autonomous or self-reliant employee, and I think it is necessary for creating a strong organization.

Tec Nagasawa Co., Ltd.
Mr. Tomonobu Nagasawa, President
Location: 1358-4 Fuji, Kashiwazaki, Niigata
Phone: +81-257-24-1125
Founded: October, 1963
Business: Production equipment machining (automotive, hydraulic equipment, printing machines and semiconductor parts, etc.) and high-mix, low-volume machining (production equipment parts for valves and automotive parts, equipment jigs and testing jigs, prototypes for automotive parts, and test pieces, etc.)
Homepage: http://www.tec-naga.com/

The “Machining Navi” is a threat to skilled machinists. However, I think that you can improve prototype machining or trial manufacturing by mastering it well.

Highly skilled operators (frame left to right), Mr. Nagare, Mr. Doi and Mr. Nishimura, before a spread of certifications for special grade, Class 1 technicians.

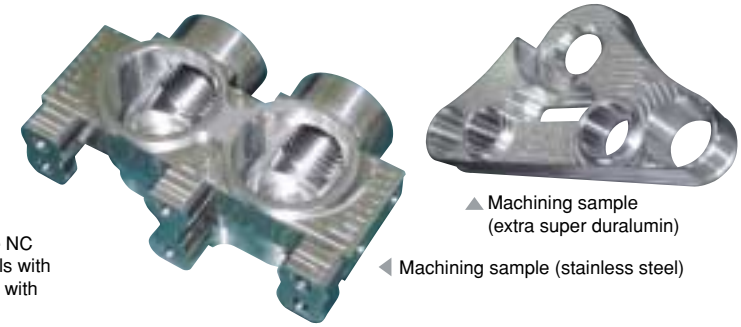
When I first saw the “Machining Navi,” I thought: “Have we really come this far with software in this day and age?”

When I first saw the Machining Navi at a trade show in the fall of 2010, I honestly thought: “Have we really come this far with software in this day and age? We have really pushed the limits in the performance of automatic control in the field of technology.”
The selling point for skilled machinists in trial manufacturing and high precision machining is to be able to use your long experience and knowledge and provide quick dimensional accuracy without chatter. For example, when performing deep machining on long pieces, etc., there are times when you don’t know what is causing chatter, the tool or the shape of the workpiece. Here is where you rack your brain by lowering the rotation or raising the advance, not knowing how to control the chatter, or debating whether to increase the work speed while trying to maintain the tool life. This is even the place where we would show our skilled touch.

Mr. Nagare was able to remember the NC fundamentals with OSP, refine his skills with the LB15 and even become an expert with machining centers.

However, the prototype pieces only number from one piece to just several. Therefore in this case, rather than focus on efficiency like in mass production machining, and raise the rotation assuming the risk of possibly producing a defect, we decide to lower the rotation even if it takes more time. However with the Machining Navi, you can maximize the cutting conditions with its noise analysis, and therefore control the chatter and improve productivity. This type of idea had never occurred to us. We actually intregrated the MB-56VA which is equipped with the Machining Navi **M-*g*** in January, 2011.

We found that machinists who even had little experience were able to improve productivity without any concern for chattering. Given these new circumstances, how can veteran machinists like us use the Machining Navi to its full potential? One way is to use our experience and knowledge for controlling chatter as a technical base and apply the Machining Navi data and establish a cutting conditions guide in order to improve the work speed. Since the Lehman collapse, not only have the shapes become more complex in the field trial manufacturing, but the lead times and costs have become more competitive and tougher to meet. As a result, we would like to raise our productivity even if it is just by a little. Another way is to match the advancing tool with the right tool holder, and draw out more potential use or options with the Machining Navi. The Machining Navi on its own does not necessarily solve every problem nor guarantee chatter control for all machining conditions, but when used in conjunction with the right combination of jigs, tools and tool holders, solutions to problems and successful machining are also possible.



▲ Machining sample (extra super duralumin)

◀ Machining sample (stainless steel)

Instantly decide on the machining order, tools and jigs from the drawing or blueprint And, try out machining that also includes post-processing

Since I was a kid, I always liked meddling with machines. After graduating from a technical high school, I began working at an industrial clutch manufacturer for power shovels and forklifts, etc. This is where I first came across an Okuma NC lathe and was able to remember the operations using the OSP. At that time, the NCs were made with paper tape and programming was also performed using calculators. Even then, skilled veteran machinists had trouble and problems with machining on standard lathes, and I, being the rookie, did the same work using an NC. My senior colleague saw me working and told me, "You should refine your technical skills that cannot be done on the machine."

Four years later, I transferred to a trial manufacturing company, and for 25 years I was involved in a wide range of fields, such as electric appliances, automobiles and cameras, but those words from my former colleague still rang inside my head. Actually, after advances from NC programming with paper tape to automatic programming and again to CAD/CAM usage, the onsite work became easier. However, on the flip side, the technical skills advances that we made in more than twenty years can now be acquired in 5 to 6 years. As a result, with regard to the question of how we should put our strengths to good use, the answer is using that know-how for machining procedures and machining with jigs.

For example, when the prototype drawings are provided, we can instantly come up with a machining procedure, the right tool selection and which simple jigs should be used, etc. If any mistake is made with the procedure, it costs time and money, and it can also cause problems like missing the position that grabs the workpiece. So, when

Mr. Doi checking the workpiece finish.
Four Okuma MC units operating onsite.

actually machining, we have to also consider a procedure that does not bend or deform the material, and one that does not make the post-processing difficult. It is not just important to machine according to the drawings, and since you cannot necessarily be independent, you must interpret or imagine "what type of product the customer is requesting?" That represents the know-how that we can provide and also supports our value in the work process.

As an effective, local technical group, continuing to support the Japanese manufacturing base

The special grade, Class 1 technician certifications shown on the wall are proof that all of the employees, including myself, continue to study and train. Since there are many types of machines…equipment machining, NC lathes, face milling, machining centers and equipment testing, there is skill training and academic tests available for all of them, so we must study up when possible. If I do not continue to always learn new things, I risk getting left behind with all the current advances. That is why I recently renewed my national certification in 2007. This insatiable attitude toward learning new technology like in the Machining Navi represents the type of spirit that we embrace. In addition, it is because of the idea that we constantly learn and build upon our experience, which enables us to provide modification proposals for the drawings given to us or enables us to do machining that cannot be done by our competition.

Right now, there is concern that Japan's manufacturing is losing its substance or edge. Of course, the economic circumstances are forcing production overseas, but even so, there is also work that cannot be taken outside. One type of example in trial manufacturing and precision machining that we cannot lose to overseas companies is work that requires "high quality production at the right cost with a short lead time: from 1 to several days." While large companies stop their operation during weekends, consecutive holidays and summer vacation, our company operates virtually year-round, using rotating shifts to cover time-off. This type of adaptability and our skills also represent our strength.

In addition, while our company specializes in aluminum type machining using MCs, we can support various types of materials and machining requests through our partnership with specialty machinists, covering areas, such as peripheral lathes, panel machining, thermal and surface treatment processing and grinding, etc. These types of connections also represent one of our assets. Recently, we were able to use a network of 6 to 7 companies for a job that required urgent repair of a deformed cast iron part that was produced overseas. This type of collective technology among the local plants may be the underlying power that will support and maintain Japanese manufacturing.

AIDE Corp.
Mr. Hideki Nagare, President
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Homepage: http://www.aide-corp.jp/
Founded: February 2008
Business: Precision parts machining and prototype machining

Machining Navi
MB-56VA + M-*g*

Continuing to raise the bar by using the detection and control function for chattering, by reducing the number of tools used and machining processes and by cutting the tool costs.

The Die Department was started from nothing, and after merging with the press working operations, sales expanded significantly

My father (director) created the base for the Hamada Press with press work for slot machine parts. I had always thought that someday I would succeed my father, and after I graduated from university, I began working at a press die machining manufacturer for automotive parts. That company had 100 employees and was a technician group where the technicians used general purpose non-digital machines to manufacture and repair dies, and to form presses. There was a wire electrical discharge machine but there was no machining center available. As a drafter I created drawings, and also learned the fundamentals such as die layouts and lapping, and how to use lathes and drilling machines.

Now, I am extremely thankful to have gained experience with a die designing technique using general purpose machines and analog computing. However, at the time I had questioned the inefficiency in the working method, so I purchased a pricey computer with my own money and began studying about die design using CAD/CAM on my own time. Thereafter, I left the die technicians to carry on at the die manufacturing plant and began working at Hamada Press when I was 30 and thus launched the Die Department.

We did not have a large initial investment available and there were concerns: "is this really going to work trying to start die-making this late in the game?" Yet, we had a lot of support from others, we had old tooling equipment available and we were finally able to set up a complete system that could take on orders from dies to press work. When we finally started actual operations, the benefits from designing and manufacturing dies together were huge. We were lucky to acquire slot machine manufacturers as our customers, and we were also able to increase sales for automotive parts. Then in 2009, we were finally able to introduce the MB-66VB, a new vertical machining center from Okuma.

The dies for automotive parts and slot machines are neatly organized on the rack.

The MB-66VA improved productivity significantly due to the high precision on the drilling pitch and the ease of the precision output after set-up changes.

I want to maximizing the "Machining Navi M-*i*" as a tool to reduce processes and the number of tools needed

Chattering is cause by various factors which include the workpiece clamp, the rotation speed, the feedrate, the tool length, the blade shape and the rigidity of the machine. However, if I listen to the machining sound, I can approximate and get an idea of what to adjust. The "Machining Navi **M-*i***" is useful to quickly get a clear picture of that adjustment. Yet if anything, I use it to push the envelope in order to reduce the number of tools needed, extend the tool life and cut down the number of processes by utilizing its ability to respond and control even subtle chattering.

The trouble with die-making for a single die is, more than

Machining Navi
MB-66VB + M-*i*

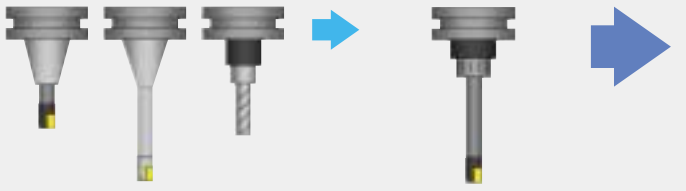
When using multiple tools…

× Tool correction setting error
× Interference
× NC programming error

Customer request

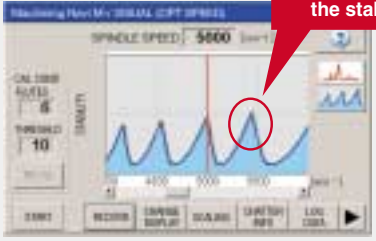
Wish to conduct various machining operations using 1 tool

ϕ12
Overhang: 80 mm
(carbide shank)



Improve efficiency by more than 20%!

Manually adjust the speed two tools ahead while referring to the stability graph.



If you can find the right conditions on a long tool, it is possible to machine many points on the same tool.

Spindle speed : 3,185 min^{-1}
Feedrate : 382 mm/min
Chatter level high

Machining Navi

Spindle speed : 3,885 min^{-1}
Feedrate : 458 mm/min
No chatter

The "Machining Navi **M-*i***" not only controls chatter but it is a useful tool that can be used to reduce the cost, and the number of processes and tools needed. – Mr. Hamada

anything, how many tools it requires. When drilling small size holes on a flat surface and trying to use 3 dimensional machining at the same time, I end up quickly filling the tool magazine with over 20 deformation. In addition, after changing out the tooling depending on the workpiece, it is particularly easy for an error to occur when doing a tool change. If I am able to find the right conditions so I can machine multiple points with one tool and then fix those conditions, while preventing wear on the tool caused by chattering, I can not only reduce the number of tools needed but minimize the risk of errors.

We were specifically concerned about the "excessive load on the small size tool." Then, we discovered that we could apply the "Machining Navi" to 1 small size end mill and thereby merge the machining section for multiple tools, including one wide end mill. Not only did we reduce the tool costs significantly but we were able to fix the machining process bottleneck and reduce the 7 processes into 5. This has a huge impact.

When I try to do difficult machining or use new tools, I start with slightly out of reach cutting conditions and my goal is to aim for the best data possible. If the "Machining Navi" features chatter detection during the middle stages and up to the finishing stage, then I can try it with the rough finishing as well. If there are recommended conditions from the manufacturer, such as avoiding small diameter machining with long overhangs on side surfaces, I discover new methods or breakthroughs by changing the tool blades from 6 to 3, or trying a low speed high feedrate setting. By repeating this type of approach and trying new settings, I am able to unlock the hidden potential or performance in my machining center or in the "Machining Navi," and I believe I am able to develop machining know-how that is unique to Hamada Press.

Die design using CAD/CAM. The optimum cutting conditions are set, the work is standardized and the data is transferred to the production site.

Knowledge and ingenuity that comes from the top down are essential for simplifying the processes and maintenance as much as possible

For press die design, we can make the design as elaborate as possible, but more than anything, what we need to concentrate on is coming up with ways to reduce, even if it is just a little, the strain or difficulty on site where the press is formed. For example, we draw up designs so certain places, that reach their limit after tens of thousands of stamping or pressing operations from the characteristics of the shape, are equipped with removable bolts that enable those places to be changed out with spares. If the entire die is removed from the press for repair, this can put a lot of strain or impact the production site. The die designers that lead the process watch out for this point when designing, which can make it much easier and simpler when conducting maintenance.

In the same way, the number of machining processes is minimized as much as possible, and the procedure is simplified to avoid unnecessary strain on the production site and create consistent quality products. Now is not the time to spend time and money on training skilled technicians. For thermal deformation control, the correction on the precision output has been reduced with machines that are equipped with our Thermo-Friendly Concept. We will continue to maximize the "Machining Navi" as a tool that not only improves the surface roughness but to shorten processing. In this way, the role of the people on top is to continue to collect the know-how that has been learned and smooth out or simplify work on production sites. I think that this is the road that will enable us to survive even in these tough economic times.

Hamada Press Ltd.
Mr. Hidekazu Hamada, President
Location: 2-76-2 Ohata, Nakagawa, Nagoya, Aichi
Phone: +81-52-352-0871
Founded: 1965
Business: General metal press work, and die design and manufacture

Machining Navi

The Machining Navi creates visuals of the chattering, and shows optimum cutting conditions, it can reduce the impact or problems on the shop floor and dramatically advance the efficiency and quality.

Before engaging in machining quality and efficiency improvement, is there any way to easily control "chatter"?

"Chatter" is an old and new issue for machine shops, and also represents a problem that has been hard to overcome. If the rotational speed is increased to haphazardly improve efficiency, chattering may occur, workpieces can get damaged or scratched and the tool life can be shortened. As a result, in most cases, if chattering occurs, we stop trying to improve the efficiency and we return the settings to the original conditions. I know that the skilled operator, from experience, can find spotted "areas without chattering" by increasing the rotational speed when machining or milling. However, finding the optimum cutting conditions is not easy because there are many complex factors that are involved such as, the quality and shape of the workpiece, the tool and holder, the chuck, and the specification and rigidity of the machine. And even more specifically, a wide variety of new materials have entered the scene recently which makes setting the cutting conditions even more difficult.

Following the "Thermo-Friendly Concept" that helped provide accurate control of manageable thermal deformation, our company developed and created a "collision avoidance system" application known as the world's first "collision-free machining." In 2004 we set up a company-wide project toward achieving "chatter suppression and control" which has been a long-pending problem and decided to pursue the development of a support function. Current theories, related to the mechanism behind chatter occurrence and its suppression control, offered many findings that were the product of joint research conducted between our R&D department from years before and a university. However, there was a big gap between the theories and the actual machining, and we still could not see or determine what method to use or how to produce the best results through supporting the operator. Many issues have piled up in trying to achieve this.

Focusing on how to suppress the chatter and not try and eliminate it to zero when it occurs

Harumitsu Senda, a leader in our R&D department, came up with a basic policy to commercialize this idea with: "Focus on how to suppress the chatter and not try and eliminate it to zero when it occurs." "The mechanism behind chatter occurrence varies, depending on an infinite number of cutting conditions. Going beyond this, if the chatter occurrence and stable area test data is thoroughly measured and analyzed, we can develop a function that matches a way to lead us toward the optimum conditions with the actual data from the shop floor." When the Thermo-Friendly Concept was developed, they did not try to suppress the complex thermo deformation unnecessarily. They developed a machine with strong thermo stability by designing a structure that could control the heat more easily, and this same concept has been applied to chattering.

Nonetheless, to put this into more specific or concrete terms, a vast amount of machining data must be collected and analyzed, and specialized staff must be placed in charge of this over a long period of time. However, there is no direct road to overcome this general topic of "eliminating chatter" that many researchers and manufacturers could not do successfully. Thus, our R&D department first started collecting data on machining and milling. The procedure was to place a machining center in the test room, use a variety of tools and holders on different workpiece materials, machine while changing the cutting conditions, and try and find the stable areas and rotational speeds that generated chatter. We change the tool diameter, number of blades and overhang for each process, which includes end milling, ball end milling, face milling, side cutting, roughing, drilling, boring, reaming and tapping. We change the rotational speed, take the data from the acceleration sensors, and record it at an interval of1/100,000 sec.

To obtain accurate data, knowing how screws are tightened, for example, is necessary for organizing the controlled conditions, and it is also essential to control the torque when changing the workpieces and tools. In addition, the machine cannot be run unattended because too much swarf may be generated depending on the workpiece. Depending on the degree of wear on the tool, it is necessary to investigate how the tool keeps pace. In addition, in order to find out the "rotational speed without chatter" that exists in multiple areas, we have to put a significant load on the tool, and as a consequence they get damaged one after another.

Mr. Tomoharu Ando, our R&D team leader in charge of the "Machining Navi **M**" has continued to collect data and gain experience over several years while distributing this workload among his colleagues. He recounts the following episode that occurred at that time. "We named the tools we had broken and bent the "collection" and stored them accordingly, but over the years, we could not find any more space to store them, so after a while we stopped collecting them and just recorded them."

Conceived breakthrough "screen visuals" and a "guidance function" from the user's point of view

The project team programmed vast amounts of data acquired from the measurements and also verified the movements of the machining center equipped with a test controller. Thereafter, these results were put into the development designs for the OSP and the machinery. Then, we came closer to creating a more definitive application for the cutting conditions search function, the "Machining Navi." Then, at this stage, the breakthrough idea was formed from integrating the perspective of the machine shop.

One of the ideas was to develop "screen visuals" that would display the chatter analysis results and optimum spindle speed on the screen. This had extremely large implications for the machine shop. Traditionally, the

Mechatronics Module Development Section, R&D Department
Tomoharu Ando, Supervisor

Graduated from Nagoya University in the Engineering Department with a focus on Mechatronics Research and later got a masters in the same graduate department. Researched automatic scraper systems, etc. Entered the company in 1998. After being assigned to the R&D department, developed tooling machines for parallel links, then was involved with lubrication technology research for spindle bearings, and now Machining Navi **M-*g*/M-*i*** development.

The various factors that cause chattering include workpiece quality and shapes, tools and jigs, cutting conditions, and machine rigidity, etc.
We analyzed this unstable phenomenon and developed a support function that can display the optimum rotational speed and conditions according to the machining.
All of us at Okuma strived hard to achieve this dream.

operator would try to find and identify the area where chatter would not be generated, using his or her experience and understanding. Now, the operators could feel more at ease by confirming the machining status with graph and values displayed on a screen. In addition to his or her know-how, operators would also have a means to pursue efficient machining.

The other idea was to record the chatter sound with a microphone, and then analyze and display the sound on the screen at the same time. This came to be the "guidance (***g***) function" which shows a selection of optimum spindle speed candidates. The operator can choose one from the selection of multiple speeds displayed, and then be able to quickly confirm the result of this selection on the screen. (Refer to **M-*g***, p.14). The project team initially made advancements with the development of "intelligent (***i***) type" which automatically decides and controls everything: (vibration measurement → optimum spindle speed calculation → command change). However, as an alternative specification in which the operator could use his or her machining know-how, we developed the guidance type Machining Navi into a product.

Raising the standard for stable areas without chattering and continuing Machining Navi development for lathe turning

Right around when the "Machining Navi **M**" was being targeted as a product, the R&D department came up with another project. That was the development of the "Machining Navi **L-*g*** for lathe turning." With long shafts, boring with long overhangs, and grooving on internal and external diameters, etc., one of the problems we were coming across was chattering during lathe turning. The operator was racking his brain trying out different ways to resolve this, such as changing the steadyrest, tool usage, cutting speed and the feedrate. However, the lathe turning differs from machining and milling. Normal spindle speed is rather low, so if it is increased, controlling or suppressing the chatter is difficult.

However on the other hand, as a method to suppress chatter for lathe turning, many lathe operators know that you can avoid chattering by continuously raising and lowering the override for the spindle speed. While the rotational speed changes, you can take advantage of its mechanism, because the chatter does not grow in level. From this, our company created a product (option), "harmonic spindle speed control." This system suppresses the chattering by continuing to change a certain range of fluctuation in the rotational speed commanded by the operator. However, sometimes it is necessary to make fine adjustments to the parameter settings, depending on the tool machining, tool or cutting conditions. Finding the optimum conditions requires time and effort.

This is where the "Machining Navi for lathe turning" automatically processes the annoying calculations and setting operations, matches the machine specification and workpiece characteristics, calculates the wave amplitudes and cycles for the spindle speed that suppresses chattering, does not lower the spindle speed and guides the operator with the optimum conditions using the "screen visuals" (Refer to **L-*g***, p.13). That is, it is a method for raising the standard for stable areas without chatter.

However, the base that is essential for this as well comes from the root of the various conditions, that is the measurement and analysis work, and like the development for machining, the collection of vast amounts of data. Kiyoshi Yoshino, the team leader in charge of the "Machining Navi **L-*g***" made the following comment at that time: "In order to obtain accurate data, the cutting conditions must be fixed precisely, and it is also necessary to accurately reproduce the unstable phenomenon, chattering. If a workpiece is cut, the workpiece rigidity will lower, and you cannot cut two times under the same conditions. Continuing measurements requires tenacity, and there were times when the chattering sound kept ringing in my ear even when I went to sleep."

Received high praise all over the world for mechanical and electrical system technology that made big advancements with chatter suppression control

In September, 2009 at the Machine Fair held at Okuma headquarters, a demonstration was given for the "Machining Navi **M-*i*/M-*g***" mounted on the vertical and horizontal machining centers. It gave a big stir among customers and as they leaned forward and gazed at the workpiece's machined surface. In addition, at the JIMTOF (Tokyo) held in November, 2010, after a machining demonstration with the "Machining Navi **L-*g***," the person in charge was swamped with questions from the attendees. Not long ago, customers who had made using the Machining Navi as a monitor made the following comments: "We were shocked at the rotational area that was beyond our experience and knowledge." "The work efficiency improved several times more because we could confirm it using the screen guide for chatter suppression." "We were able to reduce the processes when trying it with unfamiliar cutting conditions." These comments gave us confirmation that it would be a powerful strategic force in the machine shop. In addition, between 2010 and 2011, the "Machining Navi" development has received high praise from both domestic and overseas conferences and journals, etc., and received award after award for its development (refer to back page).

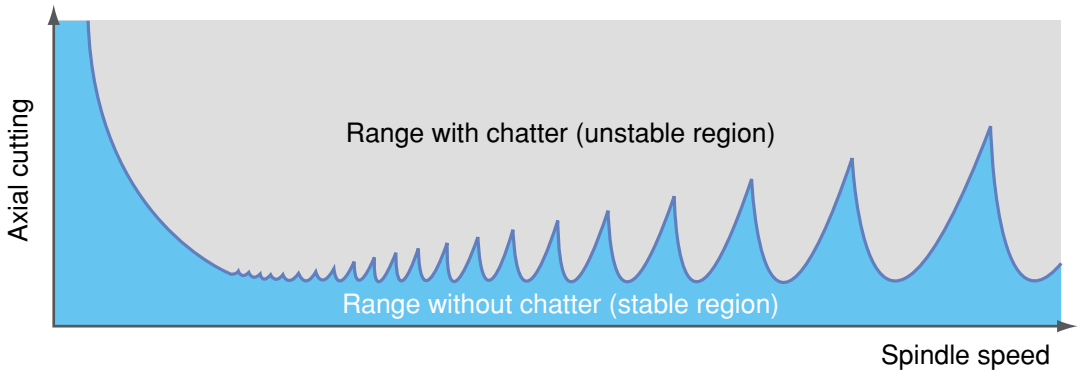
The "Machining Navi" has materialized into an easy-to-use program for vast amounts of data analysis, and it has faithfully reflected its machining precision capability. What enabled us to create this new technology into a product was due to the "mechanical and electrical system technology" that has acted like a pulse for all departments from development to design and manufacturing. Our company is continuing to advance the "machining visuals" in various fields right now. The machining method has changed with this visualization and it makes it easier to pass on technology and skills. As a countermeasure for problems, it enables you to find the cause quickly and improve the machining efficiency significantly. The "Machining Navi" is a unique support function that shows our company approach which focuses on the machine shop perspective more than anything. It also represents that type of direction for technology that Okuma is striving toward going forward.

Mechatronics Module Development Section, R&D Department
Kiyoshi Yoshino, Supervisor

Graduated from Nagoya University in the Engineering Department with a focus on Mechanical Engineering and got a masters in the same graduate department. Conducted research on cutting composite materials, etc. Entered the company in 1997. After being assigned to the R&D department, became involved in spindle reliability improvement and mirror-like finishing machine development. Participated in joint research covering elliptical vibration cutting at a symposium in the Chubu region. Engaged in the Machining Navi **L-*g*** development.

Maximizing machine tool performance

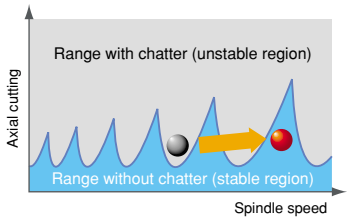
We know there is harmonic motion, or periodic vibration, related to machine tool spindle speed and chatter. As the wave cycles below show, chatter occurs in the unstable region, while the stable region is chatter-free. Machining Navi helps the operator quickly find the optimum cutting conditions within the stable, chatter-free region.



Machining Navi M-*i*, M-*g*

Optimizing spindle speed

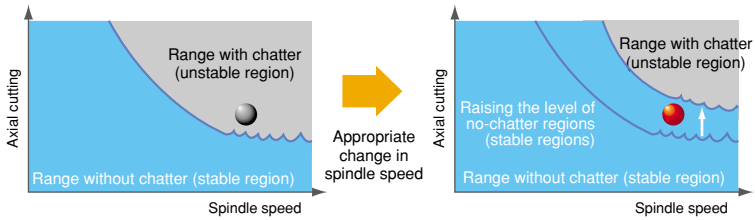
Especially suitable for high-speed machining center applications, to effectively suppress chatter by shifting rpm's to an optimum, and even faster chatter-free zone.



Machining Navi L-*g*

Expanding the chatter-free zone

For lathe applications, suppressing chatter requires a different approach, especially when turning at low speeds. Okuma's solution provides a wide chatter-free zone, while maintaining safe spindle speed options.



Cutting condition search for turning

Machining Navi L-*g* (guidance)

Chatter-free applications for lathes

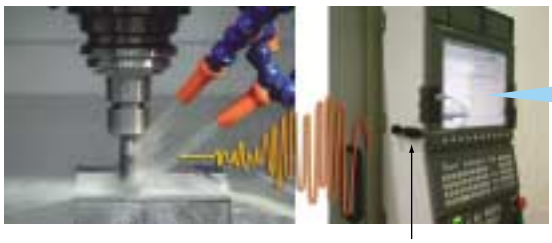
Chatter in a lathe can be suppressed by changing spindle speeds to the ideal amplitude and wave cycle—without decreasing spindle speed.

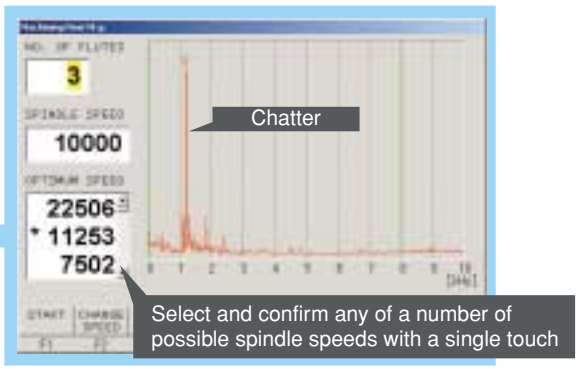
Cutting condition search for milling/machining

Machining Navi M-*g* (guidance)

Adjust cutting conditions while monitoring the data

Based on the chatter noise captured by the microphone, Machining Navi displays a number of optimal spindle speed possibilities on the screen. The operator can change to the indicated spindle speed with a single touch and immediately confirm the result.





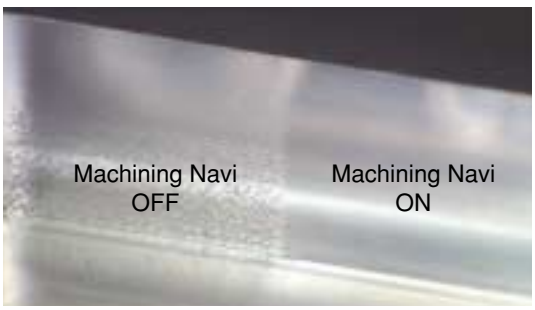
Microphone attached to operation panel captures sound

Cutting condition search for milling/machining

Machining Navi M-*i* (intelligent)

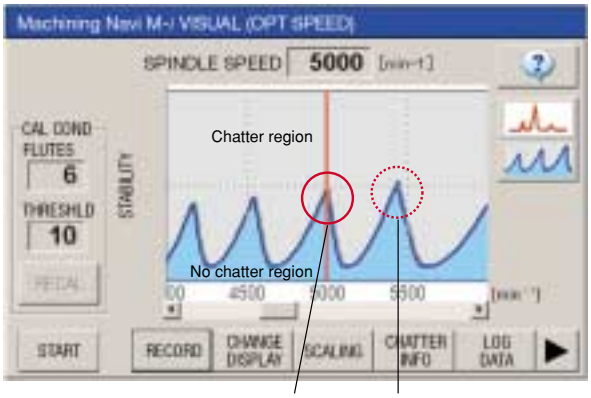
Simple, auto-mode —leave it to the machine

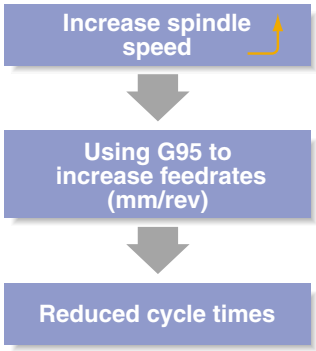
Chatter vibration is measured by built-in sensors, and Machining Navi automatically changes spindle speed to the optimum speed. In other words, vibration measurement, optimum spindle speed calculations and spindle speed adjustments are made automatically.



Increased productivity you can see with Machining Navi's graphic display

There is harmonic motion, or periodic vibration, related to machine tool spindle speed and chatter. In addition to the various auto control functions, the system is an applications tool for checking and improving the cutting conditions of all your jobs.





"Automatic Control" adjusts to chatter-free region

Machining Navi indicates even higher speed could be used

OKUMA

[Germany]

2010
MM Award

Given by leading German technical journal Maschinemarket for innovative products and technologies.

[France]

2011
Innovation Award

Presented to innovative products reviewed by prominent French technical journals.

Machining Navi Garners 4 Awards

Machining Navi productivity improvement technology acclaimed in various countries

2011
Japan Society of Die/Mold Technology (Incentive Award)

Awarded to outstanding papers presented at the die engineers meeting and die technology workshop.

2010
Japan Society of Mechanical Engineers Medal (Technology)

Presented by JSME to encourage further advancements in Japanese mechanical engineering and industry.

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