Mr. Nakano spent close to 40 years with Toyota Motor Corporation from 1964 until the early part of this decade when he retired. During this time he was a leader in the area of tooling and regrind operations supporting various engine plants for Toyota. In addition to domestic support in Japan he aided the start up of engine and component plants overseas in Indonesia, China, and Thailand. Officially he was attached to Production Engineering Department #1 which is a central engineering support group in the company. The group contains sections that plan equipment for processes that involve machining, as well as sections for tooling engineering, gauging, controls technology and specifications, as tool regrind. Primarily Mr. Nakano was a supervisor and expert in the area of tooling and tooling regrind.

Summary Notes from Interview with Mr. Nakano

TOPIC: Production Management, Toyota - July 31, 2006

Art:

Thank you for agreeing to spend some time together and answer some questions about the tooling regrind section and TPS.

Mr. Nakano:

My pleasure. I'm not sure what I can tell you but I will try.

Art:

Well I think you worked in a very interesting section of Toyota. It is one that gets no attention from the outside world but internally you are viewed as a very important group with a lot of expertise and influence.

Mr. Nakano:

I suppose so. The essence of Toyota and TPS is about "making things" and in machining operations the heart of making things is a cutting tool removing metal in the most efficient

manner possible. We have learned to treat this detail of cutting metal, chip formulation, tooling conditions, and tooling regrind as very important.

Art:

For most companies this is indeed something of an after thought.

Mr. Nakano:

Yes I was surprised when I spoke with people in other countries with experience in other shops like ours. They told me that many companies out source not only the planning of the process sometimes but also the entire decision on tooling and then outsource the regrind operation for tooling as well.

Art:

What is different in Toyota?

Mr. Nakano:

We plan the manufacturing process internally to a very high degree and issue specifications for the process. We also stay on the leading edge of tooling internally and specify this as well.

Art:

What is there so much emphasis on this in your department?

Mr. Nakano:

Toyota historically is a company that made some type of machines. Originally it made automatic looms then it became a car company. But if you notice it always had an internal machine tool division. As much as we focus on the product we also put a tremendous amount of attention onto the production process and tooling.

Art:

What is the benefit of doing this?

Mr. Nakano:

The process and tooling greatly affects quality, cost, productivity, downtime, and other factors in machining. You can't just ignore these items or allow other people to dictate them if you want to have a strong process.

Art:

Mr. Haga the former head of tooling engineering at Toyota once told me that machining is very different from assembly. The value add in machining is the removal of cutting chips from the work surface whereas in assembly it is humans attaching things together with bolts and screws etc. Can you elaborate further?

Mr. Nakano:

Yes our type of shop is very different from an assembly style of operations and it requires tremendous attention to detail and collaboration with our tooling suppliers. TPS started in the machine shops though first and then spread to assembly. Most people don't know this.

Art:

Who are the suppliers that you work with mainly?

Mr. Nakano:

Generally for our type of processes we deal with tooling companies such as Sumitomo, Mitsubishi, OSG, Toshiba, Fujikoshi, and Kyocera for example. Each one of these tooling companies has its special niche and area of expertise. We work in close collaboration with them to conduct tests, improve tooling, and improve the process. These relationships are very important to the company.

Art:

What else is key in your section in tooling regrind?

Mr. Nakano:

We have a lot of special knowledge that can't just be put in a book or a work instruction. We have to focus a lot of training, development, and improvement with people in our sections. A lot of regrind work has been automated but a lot of it is still quite human intensive and requires plain old attention to detail.

Art:

So how does TPS apply to your area?

Mr. Nakano:

It applies but you have to extrapolate and emphasize the right parts. For example we pick and deliver cutting tools from the line on a standard timed route. We regrind the tools within a fixed lead-time window. The tools are delivered back to the line on a Just-in-Time route to small tooling receiving locations in manufacturing. We standardize our work so that we are consistent and reduce variation. We develop people to be good leaders and problem solvers. We have to stick to the spirit of TPS and not the letter. What is important is that we contribute to help produce the highest possible quality, with the shortest lead-time, and the lowest possible cost. Tooling regrind plays a role in that in many ways in machine shops.

Art:

Can you give me an example.

Mr. Nakano:

A certain tool such as a drill for example might be rated to last for 800 cuts before it needs to be re-sharpened. We look at the tools even more closely than the production workers and get an idea of how exactly it is wearing, how long it will last, how it is affecting quality, and how it is affecting the machine. Sometimes we can extend the life of the tool from 800 cuts to 1000 cuts as an experiment. Sometimes we slightly change the tool profile to make a better cut or change the shape of the cutting chip being formed. We can do lots of little things that affect quality, cost, and productivity in machining over time. Of course we have to do this in conjunction with production so everyone knows what is going on.

Art:

Sounds like you guys are the masters of detail!

Mr. Nakano:

Yes we take great pride in our work and how it influences the process. The tool cuts the metal and makes the part features in accordance with the specifications for the product. We sharpen the tool and inspect it very closely. It is not too much of an exaggeration that we control quality in machining to a large degree.

Art:

Can you give me an example of how you affect quality and help reduce defects.

Mr. Nakano:

Okay for example let's take a simple drill that is used to make a hole. There are a lot of little problems that can and do go wrong in drilling a hole. The first step for us of course is to regrind

the tool to the exact specifications for the tool as designed. However sometimes a defect still occurs in production due to wear on the machine or changes to the process, etc.

I have a spreadsheet that we have created over the years that lists over several dozen different types of detailed problems that relate to either the drill or the hole being made. I have them for other tools and types of defects as well. For example a hole drilled to a diameter slightly too large or one too small, a hole where it is too large at the entrance but not after a certain depth, holes that are out of position, holes that are bending or not concentric, etc. Drills that break, drills that get dull faster than expected, drills that exhibit early failure, drills that vibrate or chatter too much. For each of these problems and many others there are 4 or 5 investigation items that we have catalogued as standard ways to troubleshoot the problem as it pertains to tooling and regrind.

Art:

You were not kidding when you said detailed. I am guilty of taking Toyota's tooling prowess for granted when I was with the company in engine machining operations.

Mr. Nakano:

It can get very specific. Here is just one sample troubleshooting item that might apply on a drill for example. For a certain type of defect I might need to check something we call the second angle on the drill to make sure it is correct. We would do something like the following:

Note: A short explanation followed and the following chart was used. It was one of the over 100 different investigation items Mr. Nakano had catalogued for troubleshooting problems in drilling holes. In a sanitized form Mr. Nakano was willing to share with me one of the investigation items he had developed to troubleshoot and investigate tooling problems that related back to his area.

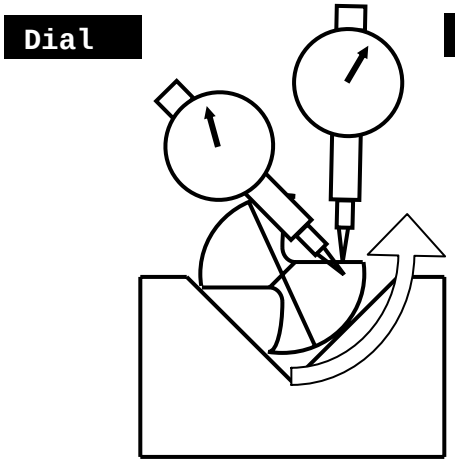
EXAMPLE:

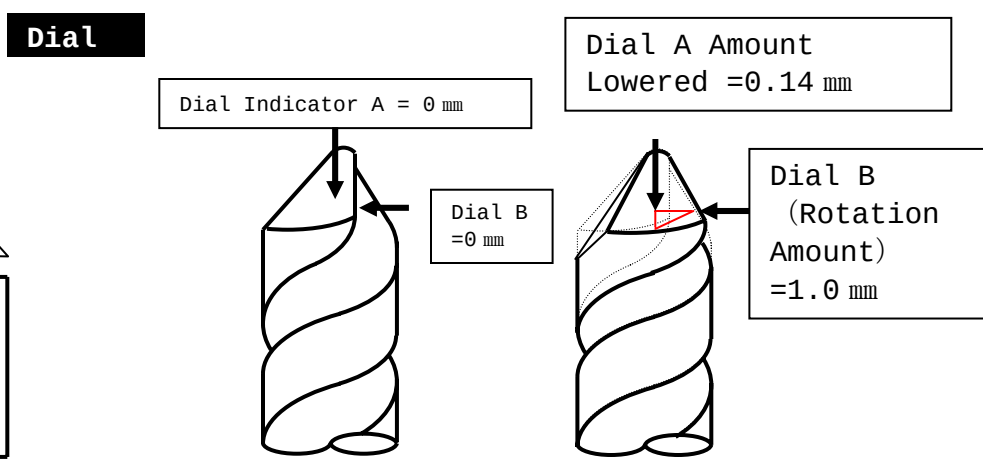
Main Step	Key Point
1. Place the drill in the holding fixture	Seat the drill
2. Align Dial Indicator A as shown	Zero the gage
3. Align Dial indicator B as shown	Zero the gage
4. Rotate the drill	Appropriate pressure
5. Rotational amount on indicator B is 1.0 mm	Do not exceed 1.0mm
6. Read the value now on dial indicator A	
7. Compute 2nd angle using the formula below	

Formula Second Angle = **Tan-¹** $\frac{\text{Amt. Lowered}}{\text{Rotation}}$

Actual Example **Tan-¹** $\frac{0.14}{1.0}$ = 7.97°

Top View





Art:

I'm not even sure I can still do enough trigonometry any more to even check something like that.

Mr. Nakano:

There are only a few formulas that get used very often but the people in regrind that become Team Leaders and Supervisor as I did have to know them in order to check things certain types of problems that occur. The root causes for many problems are in the specifics of tooling or can be dealt with by altering the tool in some small manner. In this hypothetical case the angle of 8° for example on the tool may be critical in some applications.

Art:

So you have something like this for every type of cutting tool you regrind.

Mr. Nakano:

We have a variety of different documents and materials that we use. Of course we have normal drawings like the specifics of the tool whether it be a drill, or a tap, or a ream, or end mill, etc. That drawing is provided by the supplier of the tool. We also have specifics on how we regrind the tool. Then there are also specifics on how to inspect the tool after we regrind it. And then there are the manuals we have made over the years for example about how to deal with certain defects that happen on the part feature or damage that happens to the tool. The main point is to get to a root cause and make sure we are keeping to our standard. And when things are steady we constantly test and probe for kaizen or improvement.

Art:

My boss use to tell me the following about TPS "Don't worry, you'll be a good beginner in seven years".

Mr. Nakano:

In seven years I could teach you how to regrind all the different types of tools we use in the machine shop. You could also learn how to do most of the basic trouble shooting but it depends upon the situation and environment. After that there is more learning about how to become a team leader and manage people. How to handle problems. How to lead improvement activities and how to communicate and interact with other departments. I have done this for closer to 40 years and I still only understand the specifics of TPS in my little area of control!

Art:

In other departments there have been outside trainers or people that influenced TPS to some extent. For example in quality there were different Japanese quality control professors that lectured at Toyota. Many years ago in production Mr. Shingo taught a basic course on Industrial Engineering, etc. What about in your area?

Mr. Nakano:

No, that type of general knowledge and basic training does not really help here. Well basic problem solving taught in the company applies anywhere I suppose. Basically however, this type of tooling knowledge we have here is pretty specialized and technical. It is learned from trial and error over many years internally for the most part. The most special and relevant training we take on occasion is at our tooling manufacturers taught by their in-house tooling engineers. We are in our own little world I guess.

Art:

Well it is a very interesting and detailed world. I will never sharpen my kitchen knives or my woodworking chisels the same. Thank you for your time and cooperation.