Visit to Hitachi-Seiki, Abiko Works, Aug 21, 1991

Background

Our hosts were Mr Kubota, R&D Center Director, Mr Ishihara, Controls Design Manager, and Mr Takeshita, General Manager of the Technology Development Center. Other interesting participants were Mr Otani, General Manager of the Design Department, and Mr Katoh, Manager of the Technical Research Department.

H-S makes machine tools very similar to Yamazaki's, but the company is about 1/4 Yamazaki's size. It is in a similar state regarding CAD and is less modern in its manufacturing facilities. However, H-S uses its own FMS's for making almost every part it uses. No other kind of machine tool or system was observed. In fact, H-S uses not only FMS's but also several temperature-controlled rooms for machining and assembly for the purposes of improving quality and of impressing customers. The company has 1700 employees and makes about 3000 machines per year.

Unlike Yamazaki or any of the "big 5" in Japanese machine tools, H-S makes special transfer lines for the auto industry. These are totally different in technology and structure from the NC lathes and machining centers which comprise 80% of its sales. Like Yamazaki, H-S has trouble selling FMS's. Customers want simpler machines and systems such as the 6-pallet storage machine. The pallets can be loaded in and the machine left overnight to work the parts. H-S has not yet resorted to high-pressure sales tactics for FMS's the way Yamazaki has. Yamazaki even makes its own 6 pallet machines look bad in economic comparisons in the hope of selling more FMS's.

H-S's main business problem is managing fluctuations in demand. Five years ago the transfer line business fell apart and many people had to be relocated. Today they have 50% more design business than they can handle. "It's a big panic." Their CAD does not help them much. They work nights and weekends, and take on marginally capable subcontractors whose work they must often redo. H-S is the only company to admit to me that this type of overwork hurts product quality, including design quality.

However, you can't say no to a sale, especially from a car company. They know when to buy, that is, when the suppliers are hungry. H-S notes, in a fascinating aside, that they used to be able to count on a lot of design help from the car companies' own engineers but that's not true any more. Those engineers now have only two or three years' experience and H-S ends up teaching them!

A major reason why H-S is having trouble is that they are behind in CAD and cannot utilize many sophisticated concepts such as data archiving that would

permit them to use past designs more quickly. All they have is a home-made alphanumeric database consisting of part names, machine models, part size and material, and year the part was designed. It is a memory-jogger system that behaves like a library card catalog. Any way the designer can think of to help him remember a part is available to help him narrow the search. The output is a part number. He must then go to the CADAM system and punch in the drawing number in order to get a picture of the part.

They have brought in outside consultants in the hope of making their factory floor more efficient. Right now a few hours of actual cutting time takes 10 days. All they got from the consultants over two years was advice to group all the needed machines around the parts, which is a variety of flow shop. Such an approach is bound to be costly and inappropriate for a job shop environment. Analytical techniques exist to address this problem, but it is a tough one. The FMS was invented in the first place to address just such situations, and nothing much better has come along since. Only Yamazaki has learned how to design its parts to make FMS's particularly efficient. H-S's president has challenged his people to become more standardized in their design methods. They are still in the process of interpreting this challenge and may again utilize outside professional consultants. Right now their only response is to consider more reuse of existing designs and more modularization of their subassemblies. They do not have a strong tradition of the "series method" described by Yamazaki. In general, they do not have a clear view of the importance of design methods, designed characteristics of their machines, and design technology to improving their company.

Use of CAD/CAM/CAE

H-S relies on CADAM. Ninety five mechanical engineers access 28 terminals and about 20 drafting boards. They would buy more terminals if they were not so costly (average ¥400,000 / month including the host IBM 4341). They think workstations will be their next move.

All the facilities of CADAM are used, including generation of NC data. This is sent via fiber optic cable to the factory control room.

Eight months ago they got CAEDS, the IBM version of SDRC's I-DEAS solid modeler, and they are just learning how to use it for stress and deformation analysis of machine tool beds.

Even if they get a terminal for every designer they will not abandon paper because the CAD screen is too small. Other companies have said the same thing.

Product Design Methodology

H-S has two product lines, medium size NC lathes and machining centers, and transfer machines. The NC machines take about two years to design: one year for concept design, 6 months for detailed design, and 6 months for preproduction tryouts and performance documentation. This leaves out fabrication of the prototypes, but I assume it is included in the first 18 months.

The transfer lines present a totally different kind of design task, since they are made up of a linear string of standard modules. Each module drills a set of holes, machines a flat, taps a hole, or does some other simple operation on an engine block or other similar item. Figuring out what each module should do and wiring up the controls are the major challenges. Such a machine takes about a year to design and build. A set of four almost ready for delivery to Nissan were scheduled for customer buyoff the day we visited. Our hosts and I together estimated that about 112 man-months of design effort were involved in this system, which had over 75 modules. Half these man-months were obtained from subcontractors, as were many of the machines' more standard elements like conveyors.

As far as I could tell, there were no computerized methods in use for determining line balance or job assignment in the design of these transfer machines. One experienced person accomplished these essential conceptual steps in about 3 months.

To support all of this design activity, H-S has 95 mechanical engineers and 35 electrical / electronic engineers. Another 20 engineers are in R&D. About half of the engineers are in production and manufacturing. They comment extensively on the product designs but apparently do not take a large part in product design itself. About half the product designers are skilled in production techniques already. Even so, H-S agrees that there is too much delay and correction to the design drawings; about half are returned for changes or questions.

Engineers gain their breadth of experience from a short 4 months initial training plus continuous rotation until age 45 or so. After that, an experienced designer stays put. Those that do not understand production methods and new technology are "a headache."

H-S is having trouble attracting new employees. North of Tokyo is not considered "in" territory. Other Hitachi companies located in the area said the sme thing.

Mr Otani, the Design Manager, operates with a number of rules of thumb. For example, to do cost estimating, his first test is to count the parts and multiply by ¥10,000. To determine if his designers will be over- or under- loaded, he

multiplies the predicted sales by 10% and compares to his shop's salaries. He can support ¥6000 million of design effort per year, so annual sales over ¥60,000 million will force him to go to outside contractors or overtime.

There are few systematic design techniques in use. Tolerances are determined by reference to previous "experienced parts." Only recently have they begun to adopt the idea of the "error budget" for allocating tolerances with the aim of obtaining a final accuracy requirement. This is much more sophisticated than their current method of just using higher accuracy components.

Similarly, cost analysis is based on past data, especially since 80% of the parts are identical to existing ones or nearly so. New parts are hard to predict. The main components of cost are materials, vendor costs, and machining time, expressed in standard hours.

R&D Activities

H-S has originated a number of interesting concepts. From their own experience using their products, they realize that setup time is a major headache for customers. So they have developed novel techniques for easy setup and programming of their machines, and easy in-process measuring of parts. This is based on programmable logic controllers that they build themselves and link up to Fanuc controllers. The PLC's do the work while the Fanuc controllers provide a familiar name and an easy user interface.

Other R&D activities include direct drive spindles (like Mazak's, I presume) and two-component casting of machine ways. These castings are cast iron underneath plus a layer an inch or so thick of steel on top, where the ways are machined. My hosts could not explain how these parts are cast.

New products include laser heat treating and machines that grind ceramics, especially for bearings. Kyocera is a big customer. Their product has half the market because it is priced aggressively, the result of its being just a modified NC machining center with some novel tool attachments.

Factory Floor Tour

This factory makes more specials and fewer ordinary machines. The "mass production" work is at another factory where five machines a day come out "right on schedule." Assembly line repetitive working conditions drive many of the employees away. They can easily get jobs nearby since the whole area's manufacturing economy is growing.

Regardless of the kind of work, the Abiko plant is fully automated in machining and partly so in material handling. No Automatic Guided Vehicles are visible as at Yamazaki, however. There are several FMS lines,

most about 8 years old. Rescheduling them is a problem, since it takes half an hour. It appeared that the larger systems were not very efficient and not well utilized. At least one suffered from an old design error, namely a single straight line parts transfer vehicle with one-part carrying capacity and no buffer positions at the machines. Moving parts around is like solving the cannibals and missionaries problem. This error was discovered at Caterpillar in the mid 1970's. The more successful H-S FMS's have more buffers at each machine and a continuous flow conveyor system with parts circulating past the machines all the time. The advantage of this setup was also recognized in the mid 70's.

Significantly, H-S plans to junk the oldest and least efficient FMS's and replace them with stand-alone CNC machines. It may arrange some of these into part-type-specific cells. One L-shaped cell for spindles has already been tried successfully.

The most interesting system would interest Prof Okino of Kyoto University. It is called "Holonic" and won a prize for H-S in 1988. This system consists of a number of machine cells and continuously circulating parts. There is no overall schedule. Instead, parts are marked with bar codes that permit each machine to recognize the part and its required remaining work. A part can go to the next machine that is capable of doing the work it needs next. The operators have "human involvement" consisting of giving certain parts priority in this unstructured environment, and of determining the overall behavior of the system by choosing which parts to load into it. This system resembles in both physical layout and human involvement a system build by Sunstrand for Ingersoll-Rand almost 20 years ago. It was very efficient and easy to schedule.

Future CAD Needs

I got in English only part of the long list Mr Otani gave in Japanese in response to this question. He sees the potential of solid modeling as an input to CAE such as static and dynamic analysis. The main use for this is to shorten the 6 months of performance validation that is currently required of new designs. He also wants to be able to design one of a kind machines, such as transfer lines, more efficiently than he can now. These are not money-makers in the current environment and use up a disproportionate share of his engineers. More extensive use of standard elements would be a likely outcome. He calls this "automated design."