Visit to Hitachi Construction Machine Co, July 11, 1991

Mrs Whitney and I visited Hitachi Construction Machinery Co and had a short visit at the nearby Hitachi Mechanical Engineering Research Lab. Our host was Dr Kozo Ono, whose main research activity for several years has been multi-axis force-torque sensors and robots that use such sensors for grinding and deburring. He collaborates with Prof Hatamura of Todai and funds research there on similar topics. Dr Ono recently became General Manager of the Technical Research Laboratory. This was my second visit there.

Background

This company is part of the Hitachi group but is an independent company. A strong point of the Hitachi group, says Ono, is that the member companies have close communication with Hitachi's research and development labs. They conduct joint research, and member companies receive research results which they convert into products. They also follow the parent company's lead in CAD/CAM, as I learned during this visit. The Mechanical Engineering Research Lab is part of Hitachi proper rather than a group affiliate.

The construction machine business is mature but not in the trouble it was a few years ago when I last visited. Yet HCM Co has been diversifying for at least 5 years into such far-flung areas as non-destructive testing equipment for the electronics industry, YAG laser products, force-controlled robots, piezo-actuators for "nano-robots," and so on. Their main product lines include excavators and cranes, tunneling machines, digital-analog controllers for same, and several lines of small excavators that they make under the John Deere label.

The company has an image problem, namely that it makes old fashioned equipment. This hurts them in hiring new graduates and, apparently, in selling their main line of equipment. This latter impression can be gleaned from their introductory video, shown to the two of us alone on a super wide screen in an ultramodern 300 seat auditorium. It was called "Crossings," meaning technology combinations to create imaginative new products. The exclusively commercial (non-military) use of these products, such as for environmental projects, was emphasized. The video showed extensive use of welding robots, lasers, ultrasonic testing of welds, computer simulation of crane performance, use of flexible manufacturing systems to make parts, and generally "adoption of new technology as soon as it becomes available." The video claimed that CAD and CAM are linked directly, but this is not so, according to Dr Ono and based on answers to my questions.

Products and Design Methods

The company's main plant covers 430000 sq m and a subassembly plant nearby covers 186000 sq m. Production capacity in excavators is 1700 / month. These are mainly tracked vehicles of medium size including front hoes, back hoes, and clamshell excavators. No large draglines are made as far as I know. A typical excavator has about 2000 to 3000 parts, but bought items like engines (mostly from Isuzu) count as one part.

There are about 400 designers, of whom about 150 work on excavators. Approximately 40% of the designers are university graduates. About 10 to 15 products are under design or redesign at any one time. They agree that this is a very heavy workload for a small group of designers. Of the 400 total, about 300 have access to CAD, but the penetration is about 1:2.9 with the objective being 1:2.3 by this time next year, at which point they will be "finished" facilitizing for CAD. The approximately 125 CAD terminals include 27 Apollo workstations with the DDM 3D modeler. The first four Apollo terminals were bought in 1986. More recently they have bought 109 seats comprising Sun 3's and a few SPARCs with "Advance CAD," a 2D CAD product of the CTC company of Japan. CTC wrote a translator to convert DDM data. All of these workstations are on one or more LANs and there is a link through exactly one of these workstations to a Hitachi mainframe.

The product redesign cycle is about four years. However, everyone in the industry is exhausted by this pace and a "consensus" seems to be emerging that the cycle should be stretched. This "feeling" has emerged from informal discussions (at conferences and trade shows?) that designers and managers have with their counterparts at their main competitors Komatsu and Mitsubishi Heavy Industries.

Use of Computers in Design and Manufacturing

HCM is relatively new to CAD and has surprisingly little CAM. When I visited four years ago I was impressed by the robot gas metal arc welding of the main structures of cranes and excavators. The robots use simple sensors to find the weld gaps, which are beautifully flame cut and polished. In this way, an enormous amount of production welding is done almost unmanned. However, the parts are cut out by hand-programmed flame cutters and the robots are similarly hand-programmed. Since the parts in question are made of simple planar sections, it is surprising that there is no link between the simple 2D CAD and the CAM of cutter and robot programming. Mr Moroshita, the director of CAD / CAM, said that until they install a data management system (a commercial item) there will be no such links. For this reason, the entire visit focussed on CAE, that is, analyses of mechanical performance of entire cranes or large subassemblies.

Visit to Hitachi Mechanical Engineering Research Lab CAE Lab

This lab has 40 programmers who work mostly in FORTRAN and C. Their "products" are mostly analysis programs for determining various performance factors about cranes and excavators. Some products are developed for sale outside the company. We saw:

- Geometric modeling, based on converting a 2D drawing to a 3D wireframe model
- Automatic mesh generation for FEM studies (written at the request of Hitachi's Software Lab and intended to be sold commercially)
- A variety of kinematics, noise, flow, heat, vibration, and similar analysis programs. Since most of these could have been purchased, I asked why they were developed inhouse instead. Two answers emerged: some were developed for special purposes not available commercially, while others were developed for sale.

Visit to Hitachi Construction Machinery's CAE Lab

First we were shown a scrapbook of hard copy examples. This consisted almost entirely of output from SDRC's I-DEAS package versions 3.1 through 4, dated 1987-91. One example used ProEngineer Level 5. These consisted of pretty shaded images, analyses using IDEAS + ADAMS, several FEM studies of stresses in welded shovel buckets during digging, and so on. One interesting study was of the dynamics induced on the excavator and its tracks while swinging the arm rapidly. Another showed the excavator driving over a bump and experiencing oscillations in the arm and its hydraulics. Yet another showed what shape a bent hose would take depending on the internal pressure. I was also shown a demo of the robot simulation program Cim Station. The robot was "welding" a complex item.

Future Needs and Trends

HCM Co is clearly just starting down the road to CAD/CAE/CAM.
I believe that this reflects the company's old-line background.
On the other hand, in only a few years they have explored many meaningful areas in product performance analysis and will probably continue to do so.

In other respects, HCM is typical of the non-automotive companies visited: they use the best US workstations and software, and their engineers work until late in the evening. Much of the software is what the parent company of the group uses, but HCM's workstations are US made, not Hitachi's own.

Other Comments

Dr Ono's English is very good and he is quite open, so some other topics of interest came up.

1) Is it true that Japanese university engineering education is very broad but not very deep? I have been told that the reorganization of Todai's Mechanical Engineering Department looks like an upheaval but in fact it just adds new electives while eliminating old ones, there being no required core.

His answer is that engineering education is indeed broad and shallow, but it exposes students to a lot of different technologies and leaves them malleable. When they enter a company, their initial training shapes them as the company wishes. Some standard training is given every new hire but in later years the manager decides what specific training each employee should get.

[I happened to read an article in a private circulation newsletter called Japan Design Today, covering graphic arts and product styling, that described Sony's training program for new designers (stylists to us). This is apparently a bit like boot camp in the sense that group bonding is a major aim of the one year course. The teachers are practicing designers who take time off from ongoing responsibilities that they must make up later in the evening. Design in this context includes carefully choosing exterior materials, colors, textures, "handfeel," "button-feel," and so on. The young designers are taught the "correct" view angle from which to draw a video camera. A student who chose his own view angle found that his model camera had been confiscated overnight and replaced by a Polaroid shot taken from the correct angle. In this way, Sony molds its new hires.]

Dr. Ono told of his company's difficulty hiring electronics and software engineers. To remedy this, they took the best of the mechanical engineers who showed up and promtly retrained them in electronics and software. In the US, such an act would cause the student to regret his university education and its typical committment to a discipline. Apparently this does not happen in Japan. US companies rankle at having to supplement the education of their new hires; Japanese companies take advantage of the opportunity.

2) Since I am told that the Japanese language is not very precise or quantitative, how come Japanese people are so good at science and engineering?

His answer is that most of the time Japanese people do not notice any disadvantage stemming from their language or methods of thinking. However, communication can sometimes be slow. Most Japanese sentences have no subject, and verbs do not distinguish number or gender. Also, he recalls translating one of his papers into English and discovering in the process that one of his Japanese sentences made no logical sense. He had been unaware of this when he first wrote it. He also added that logic is not the only component of practicing engineering. There is also "informal communication, group work, and a different way of thinking than the so called logical way."