Visit to Fujitsu Technical Center and Fujitsu Labs, Kawasaki, August 22, 1991

Background

Our hosts were Mr Fujii, General Manager of Corporate Manufacturing Systems Development and his assistant, Mr Asada.

Fujitsu is a large diversified company focussing mostly on computers and electronics. Its major products are mainframe and super computers, as well as laptops, high performance disk drives, array processors, low noise super transistors for use in space telescopes, and so on. Unlike IBM and Hitachi, Fujitsu has not suffered a drop in mainframe computer sales (although sales have been slowing for years) because mainframes are used in large communication systems and commercial systems like those for banks, ATM's, and airlines.

Fujitsu's introductory video stressed use of computers to do things "the way people do." Applications under study include neural net machines for machine translation and robot controls. Other work is on x-ray lithography at 0.2 micron line width, coherent light digital optical communication, optical memories, ceramic circuit boards with approximately 50 layers (probably for use with multichip modules although that terminology was not used), and real time image processing.

Mr Fujii's people mostly do electronic design, so most of their CAD/CAM is in that area. He showed only mild interest in our group's work in feature-based design and modeling of mechanical assembly processes. He may have felt that I was proposing to replace the designer with a computer program, whereas I was proposing a tool to help the designer sort through many possibilities. His final judgement was diplomatic: when solid modelers become easier to use, then our work will be of great interest. However, he stressed that design is very complex and the designer considers comprehensively all the factors at once. Such a process cannot be given to a computer.

Design for Assembly

Mr Miyazawa gave a short presentation about Fujitsu's home-grown DFA methodology. It employs a PC to take in data from the designer about the assembly, including part descriptions, part mate types, and so on. I remarked that all of this data would be in the feature-based solid modelers of the future.

The DFA method has four characteristics: to provide a quantitative estimate of ease of assembly; to give a rough estimate of (manual) assembly time; to improve the design; and be easy to use. Its objectives are to reduce the cost of the product, to shorten the development time, and to provide an easy way to communicate to factory personnel about assembly problems.

In these ways the method remarkably resembles Hitachi's, which they know about but have not bought. My report is sketchy since, like Hitachi, they do not want to give out all the details.

To use the method, the designer makes an assembly flow chart (presumably an assembly sequence) and types in data about the parts and mates. The computer scores 30 different characteristics, such as direction of assembly motion, part size in relation to direction, the method of attachment, whether the part is flexible, how many moves or actions are required to affix the part, and so on.

Unlike Hitachi, Fujitsu's method includes some interesting twists on part characteristics. Parts are designated as "main," "subsidiary," and "fastener," among others. Fastening methods are designated as single action, snap action, and so on.

The scoring is done separately for each class of part and a profile is made up. A perfect score would be a product with one side, one direction, single action assembly of rigid, little parts. The score is presented either as a spider chart or a profile, and is accompanied by the scores of recent similar products. From these charts, obvious ways the product is worse stick out clearly: too many awkward fastening methods, too much effort to put in subsidiary parts, not enough simple actions, and so on. Using this method, the estimated manual final assembly time of a laptop computer was reduced from 6' 20" to 5' 10".

After this presentation, Mr Fujii remarked that DFA is part of Concurrent Engineering, whose job in his opinion is merely to make the product easier to make, shorten development time, reduce costs, and reduce the number of prototypes needed. He specifically feels that CE does not (cannot?) address product quality and function. The DFA / DFM aspect of CE makes it hard enough already for the designers, and he worries that they cannot remember everything. So he is in favor of computer tools to help them.

Aside

Several companies have their own DFA. Each shares basic properties but each has interesting additional elements that reflect characteristics of the products or of the underlying philosophy of what DFA ought to be able to accomplish. Nippondenso is the broadest, but Fujitsu is the most careful in identifying different kinds of parts and thinking that they should be scored differently. No basis is given by any company for the different emphases; they just appear obvious to the developers.

New Method for Mold Design Linked to Rapid Prototyping

The brief presentation was in Japanese with interpretation. The overheads were also in Japanese, so I could not follow too well. The lab tour afterwards was better.

The old method of mold design was a series of steps, each with an approval before the next one could start. The steps are, approximately: initial part design, design verification, mold design, and mold feature evaluation. Each step was conducted by an expert. Too many people had veto power, too many steps were done sequentially, etc.

The new method uses the same experts but launches them simultaneously. Significantly, it was stated that merely doing this does not save any time. In addition, the team needs some computer tools. The ones in use at Fujitsu are 3D structural design using SDRC's I-DEAS solid modeler, mold flow software, and stereolithography. The latter is implemented on a machine called SOUP (Solid Object U-V Laser Plotter) made by Mitsubishi. Input to this machine is via I-DEAS.

(Stereolithography is a technique for making rapid prototypes of solid parts. It functions by forming a part layer by layer, either from a liquid or a powder. Laser scanning is commonly used to form each layer. In the SOUP and similar machines, the laser scans the top free surface of a UV-curing liquid plastic. When the layer has formed, the object is lowered about half a mm and the process is repeated. Parts with re-entrant features can be made as long as a hole is left to remove the uncured plastic. The layering gives the part a stepped outer surface finish just like "jaggies" on computer drawings. These are usually hand sanded off.

Stereolithography is capable of creating the shape of a part, and methods exist for using it to make metal molds from which parts of the correct material and strength can also be made. The method permits people to quickly "get their hands on the part," including communicating to factory or subcontractor personnel in ways that drawings cannot.)

Fujitsu uses the SOUP output to make a mold from silicone rubber. Accurately made silicone inserts are used to create some mating surfaces, with the result that mating pairs of molded ABS parts assemble with surprisingly close-fitting mates.

A companion rapid prototyping facility is a Fanuc NC machine, which is programmed from a Pro-Engineer system. (Pro-Engineer was chosen specifically for its easy user interface, suitable for the technician they have assigned to operate this facility.) This machine makes smooth profile molds for items like telephone hand sets, which are also molded from ABS. The handfeel of such items can then be assessed.

The cycle from sketch to solid prototype part is three days, most of it taken up by 24 hour per day operation of the SOUP machine itself.

Other Uses for CAD/CAE/CAM

These are fairly routine, compared to the rapid prototyping. Typical FEM is done using NISA 2, commercial software from the US. Vibration, deformation, and stress analyses are done on a Fujitsu workstation. Fujitsu also uses FEM5, an in-house product, and ABAQUS. The preprocessor is called Concept Station, made by Unigraphics. CADAM is used for ordinary engineering drafting.

Another in-house program is coincidentally called ICAD, but has nothing to do with the US company of that name. This inhouse ICAD is for mechanical design. They did not show it to me and said that it needs improvement. They are more proud of ICAD's circuit design capability, but did not show that either.

Other Tour Sites

Mr Uchiyama hosted us on a tour of Fujitsu Laboratory's robotics activities. These included a simulator for zero-gravity robot operation, robot off line programming, precision class 10 cleanroom robots for disk drive assembly, and a space mechatronics lab. The latter is making experimental modules for Space Shuttle or Space Lab activities in the late 1990's. Fujitsu has about 100 of its FAROT precision PUMA-style robots in use, mostly for precision assembly and circuit board probing. These robots have about 30 micron repeatibiity. Mr Uchiyama was the designer of the first prototype for this robot over 10 years ago.