Computer Science 773

Robotics and Real-time Control

GROUP TECHNOLOGY

Automation of manufacturing systems came about in the same way as most automation : the first automatic versions were machine-driven versions of familiar manual systems. We do that because it's comparatively easy, as we can continue to rely on our understanding of the familiar manufacturing process while working on the unfamiliar mechanisation.

A very common second stage of automation is the redesign of the familiar process to take advantage of, or improve the efficiency of, the new facilities. This has happened, and is still happening, in manufacturing systems. The results appear in various forms; one example, in a fairly obvious physical form, is the organisation of machines in groups called *workcells*, where a group of related machines are clustered round a server (perhaps a robot) so that workpieces can be passed around among the members of the group in arbitrary orders, thereby increasing the flexibility of the manufacturing process without investing in more machines for more elaborate production lines.

A less visible direction of development has led to differences in the design of the automated factory. The transport of materials and workpieces through the system is much simplified if the number of routes required to produce the desired products is small. One way to achieve this result is to design the parts in the different products so that they can be made with the same set of machines. In the limit, this would lead back to an assembly-line organisation, where every product passed through the same set of machines (*very* easy transport !), but each machine produced a rather different component for each product type.

This (slightly, but not unrealistically, contrived) example illustrates the idea. This first diagram shows a typical factory organisation as it might be set up for a traditional manufacturing organisation. The machines are grouped by type, and the material transport paths (the arrows) are complicated. The advantages of this organisation is that the large-scale flows are rather simple : with few exceptions, they go Receive - L - M - D - G - A - Ship. A machine breakdown therefore makes very little difference to the path; one just uses another machine of the same type. (That's oversimplified, because most machines have to be set up to make a particular sort of part, but the principle is sound.)

If the products are designed on group technology principles, the parts can be made on fewer machines. Parts used in different products might still be different, but if they are sufficiently similar that they can be made using the same machine without changing the setting up. The number of machines needed is therefore reduced, and by rearranging them a bit the material flow can be simplified to the pattern shown in this diagram :

(I have not checked all the paths in detail, but I haven't found a path in the first diagram that isn't there in the second one. Try it.)

The group technology approach works because in fact the constraints on what sort of parts you can use are not necessarily very tight. While the parts made by a machine will have the same basic structure, there is commonly a lot of scope for variation. Here's a picture of 13 parts which can be made by the same machine in a system of this sort.

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