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(EDITORS NOTE: This explanation of the APT
System is primarily for the non-technical press.)

HOW THE APT SYSTEM WORKS

"ON KUL, ON SPN, GO RGT, TL LFT, CIRCLE/CTR AT, + 2, +3, RADIUS, + 5."

This strange sentence is written in the language used in a new method for operating machine tools. Called the APT System -- "APT" means Automatically Programmed Tool -- the method was publicly disclosed today at the Massachusetts Institute of Technology.

Translated, the sentence says: "Turn on the coolant, turn on the spindle, go right with the tool on the left side along the circle whose center is located at x equals 2, y equals 3, with a radius of 5."

KUL, HYPERB, FEDRAT, and some 100 other " words, " none containing more than six letters, are the vocabulary of the system for automatically programming machine tools. A growing number of machine tools can be automatically controlled by means of electronic "directors." Automatically programming means to use a digital computer to automatically prepare detailed instructions for the director to obey, from general directions written in an easy-to-use language.

Computers do many things for industry, science and education. The large, complicated machines make vast number calculations by electronic impulses at fantastic rates. In the case of the APT System, computers not only make calculations, but also have been taught how to "understand" a language -- such as the above sentence.

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NON-
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To understand this new system, think of the paper roll that is used in a player piano. A series of punched holes in the roll order the piano to play selected musical notes. In one method of machine tool operations, punched paper tape operates a machine that cuts out a metal part. Instead of ordering the playing of musical notes, the holes in the tape specify the many cutting movements that the machine tool must make in turning out the desired item.

This method of controlling a machine tool without a human operator is known as numerical control. It was first demonstrated at M.I.T. nearly seven years ago, when an electronic device automatically operated a small milling machine.

Instructions punched on tape in the form of numbers make it possible for this device -- which itself is a small, special purpose computer -- to control the machine more effectively than if a skilled machinist were on the job. Intricate metal parts can be milled with great accuracy.

Numerical control for machine tools has since been adopted by plants throughout the country. The system has saved time and money for many companies, but a new bottleneck has become serious in recent years -- that of preparing the instructions for the machine tool. For every new production item, a programmer (the person who prepares these instructions) must spend long hours in calculating the moves of the machine tool, and express these in numerical form for the tape. This laborious task is known as manual programming.

At M.I.T. today, a solution to this problem was demonstrated. It is now possible, through use of a large, general purpose digital computer, to develop thousands of separate machine control instructions with a minimum of human effort.

By using the written APT language, the large computer actually works out the series of instructions which control the machine tool. The language is the key to the system.

In simplified form, here's how the APT System works:

A company determines that a metal part is needed for one of the end-items being manufactured. The first step is to have a designer conceive the part. He turns his rough

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sketches over to a draftsman, who makes a drawing of the part. A part programmer then takes the drawing and writes a general outline of the machining sequence to be followed. This outline is written in the easily-learned APT language. These directions are punched on cards which are used to feed the problem to the computer. Ordinarily a general-purpose computer could not understand these English-like directions, but by first reading-in a fixed master deck of program cards, the general purpose computer is effectively transformed into a specially designed APT computer. This computer can then understand the directions and transform the general information supplied by the designer into the numerous detailed instructions required to produce the part.

Two years of intensive research at the M.I.T. Servomechanisms Laboratory, sponsored by Air Force contract, produced this new technique in programming for numerical control. The cooperation of 19 aircraft plants in various parts of the country aided materially in the development of the system.

The APT System was developed under USAF-AMC sponsorship because AMC realized the financial and technological benefits to be gained by using automatic programming.

AMC also looks to the APT System as a method of reducing the all important lead-time necessary in developing new weapons systems.

It was mentioned today that the APT System is not the first automatic programming system devised. Interim systems are now in operation, but they have limited applications. APT is the first standardized system that can be adapted by any company with a large computer, and is also the first designed to meet the long-range requirements of advanced numerical control applications. Its easily used language allows persons with no knowledge of computers to control the complex calculations that are required to program the machining of parts.

Douglas T. Ross, who is head of the Computer Applications Group at M.I.T.'s Servomechanisms Laboratory, explained the importance of the new method. "Since the first demonstration of a numerically controlled milling machine," he said, "various improvements, including interim methods for automatic programming, have been developed.

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Each improvement was helpful, but all were limited in scope and growth potentiality."

"The universal nature of the APT System approach provides the technical basis for a common meeting-ground in which many techniques for using numerical control can be welded together. The continued cooperative development of the APT concept will lead to industry-wide compatibility and increased productivity from numerical control applications. Further improvements are expected to evolve from continued research, and can benefit our whole industrial economy."

The transfer of program coordination from M.I.T. Servomechanisms Laboratory to the AIA's APT Project Coordinating Group, enables M.I.T. to concentrate on further research in support of targeted refinement of the APT System.

The cooperative effort for refinement and development of the current APT System will be managed by the APT Project Coordinating Group of AIA's Numerical Control Panel which operates under the Technical Service section of the AIA. The AIA program provides for participation by qualified and equipped non-AIA members. Prerequisites for participation are possession or access to a suitable computer and a willingness to accept and execute task assignments from the Coordinating Group. AIA forecasts a two-year program to accomplish certain targeted refinements of the APT System. This time will be substantially foreshortened if qualified segments of national industry participate in the effort.

Present scheduling calls for the early release of the remainder of the APT documentation prepared by M.I.T. under Air Force contract. These data will consist of six separate volumes with a total of more than 600 pages of text, diagrams and charts. Initial distribution will cover 19 participating AIA member plants, as well as a broad segment of national industry, research organizations, etc.

Documented revisions resulting from the APT Project refinement effort will be available at a nominal charge (reproduction and mailing costs) from AIA's Los Angeles office. Inquiries should be addressed to Technical Service, Aircraft Industries Association, 7660 Beverly Boulevard, Los Angeles 36, Cal.

AIA member participants believe that the optimum combining of APT with nu-

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merically controlled machines holds promise of an evolution of manufacturing processes to proceed to new realms of product quality. Further joint development of the APT System will foster compatibility which in turn will provide industry an important communications link between prime manufacturers and their subcontractors.

A hint of the technological break-through in programming complex part shapes using the APT System is typified in the example of a programming task for a typical wing rib shape which required 200 manhours to program manually and 5 hours by the APT-Computer method. Manhour reductions in the range 80 to 95% can be expected. This advance in the state-of-the-art represents only the initial break-through and proves conclusively that the APT System, properly coupled with numerically controlled machines, offers substantial economic advantages. These advantages are now ready for large scale exploitation by machine tool builders, systems builders and American industry in general. To this end, AIA, M.I.T. and the Air Force are anxious to cooperate.