# NASA TECH BRIEF

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## Computer Used to Program Numerically Controlled Milling Machine

In order to use a numerically controlled milling machine to its ultimate capacity, a computer program has been devised that automatically directs the machine, on command, through a series of cutting and trimming actions whose extent is unlimited from zero through 360 degrees of swing.

Called the Flight Simulate Cam Program, it accepts engineering data points, passes smooth curve segments through the points, breaks the resulting curves into a series of closely spaced points, and transforms these points into the form required by the cam mechanism. It then calls the APT numerical control programming system to produce a control tape that is used to produce the desired cam profile with a numerically controlled milling machine.

The series of closely spaced points obtained from the curve fitting routine is checked to determine if the input data has caused an unusable "smooth" curve to be created, as a curve that reverses the time axis, a curve that extends beyond the zero to 100% cut boundaries, or a curve containing slopes too steep for the follower to track. If any of these conditions exist, an error comment is printed and that case is deleted. A printer plot is generated that shows the function curve produced by the cam program. The plot also contains tabular data for each degree of cam rotation in terms of cam angle versus percent cut and the corresponding values in the same scale as the original input data. The curve points are transformed by mapping them into the quasi-circular configuration required by the cam mechanism. Allowance is made in this transformation for the angular progression and regression, relative to the camshaft axis, of the follower center as it moves within the zero to 100% cut radial limits. The radial distance of the follower from the cam center is computed at each point to produce the proper angular rotation of the cam follower arm. These transformed points are used as the profile cutting data points in an APT part program generated by the cam program.

When all cases have been processed, the cam program turns processing control over to the APT system, which uses the APT part programs generated by the cam program, to generate a machine control tape for each case. These tapes can be used on a numerically controlled milling machine to produce the desired cams.

**Notes:**

Inquiries concerning this innovation may be directed to:

> Technology Utilization Officer
> Marshall Space Flight Center
> Huntsville, Alabama 35812
> Reference: B66-10541

**Patent status:**

No patent action is contemplated by NASA.

> Source: T. C. Harris
> of General Electric Company
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