
TA202A - Manufacturing Processes II

Machining Processes and Machines

Lecture 3 – Part 2: CNC machines

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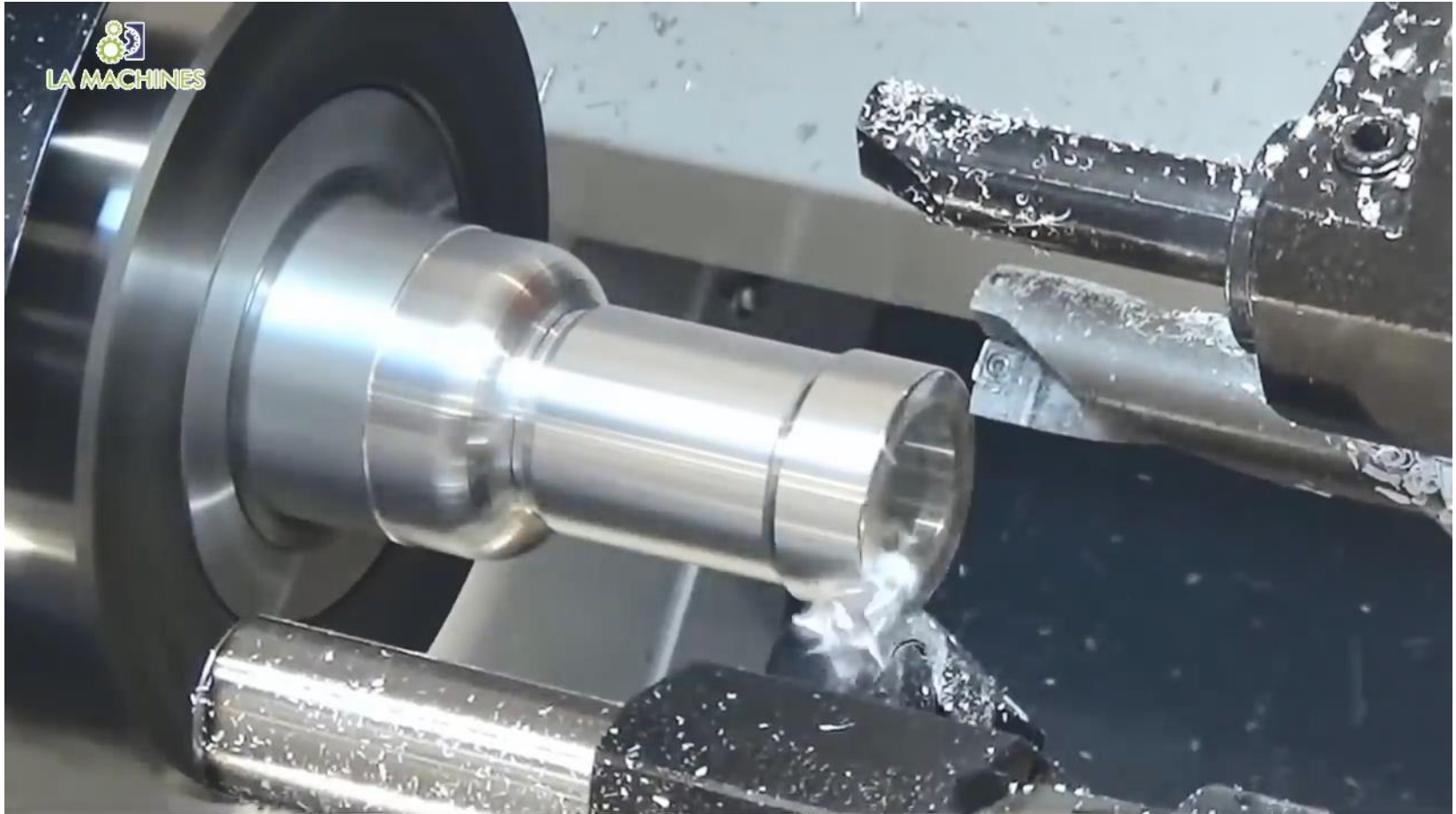


Machine Tool
Dynamics Laboratory



IIT Kanpur

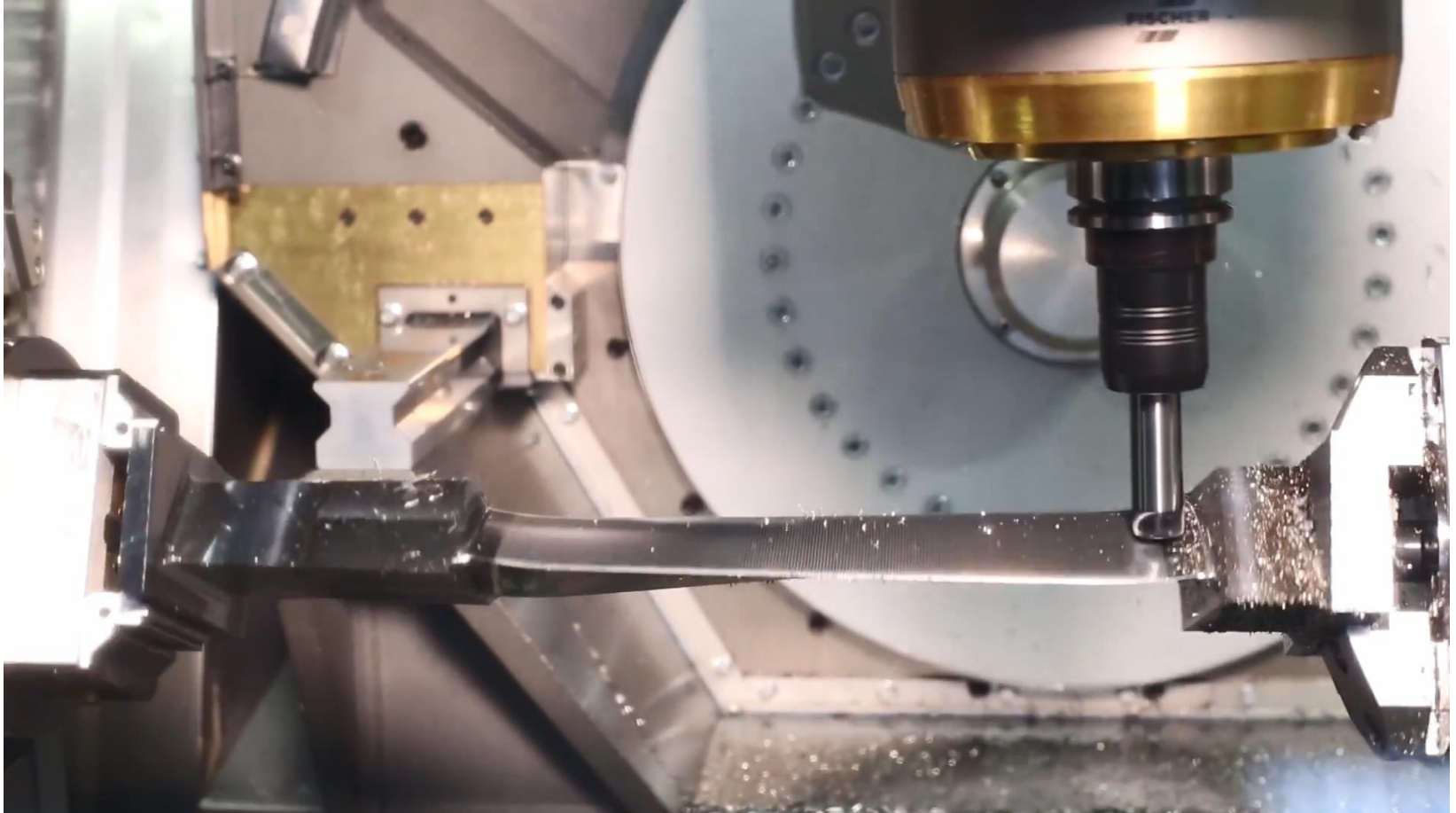
Possibilities on CNC turning machines



<https://www.youtube.com/watch?v=-9htuGLegbl>



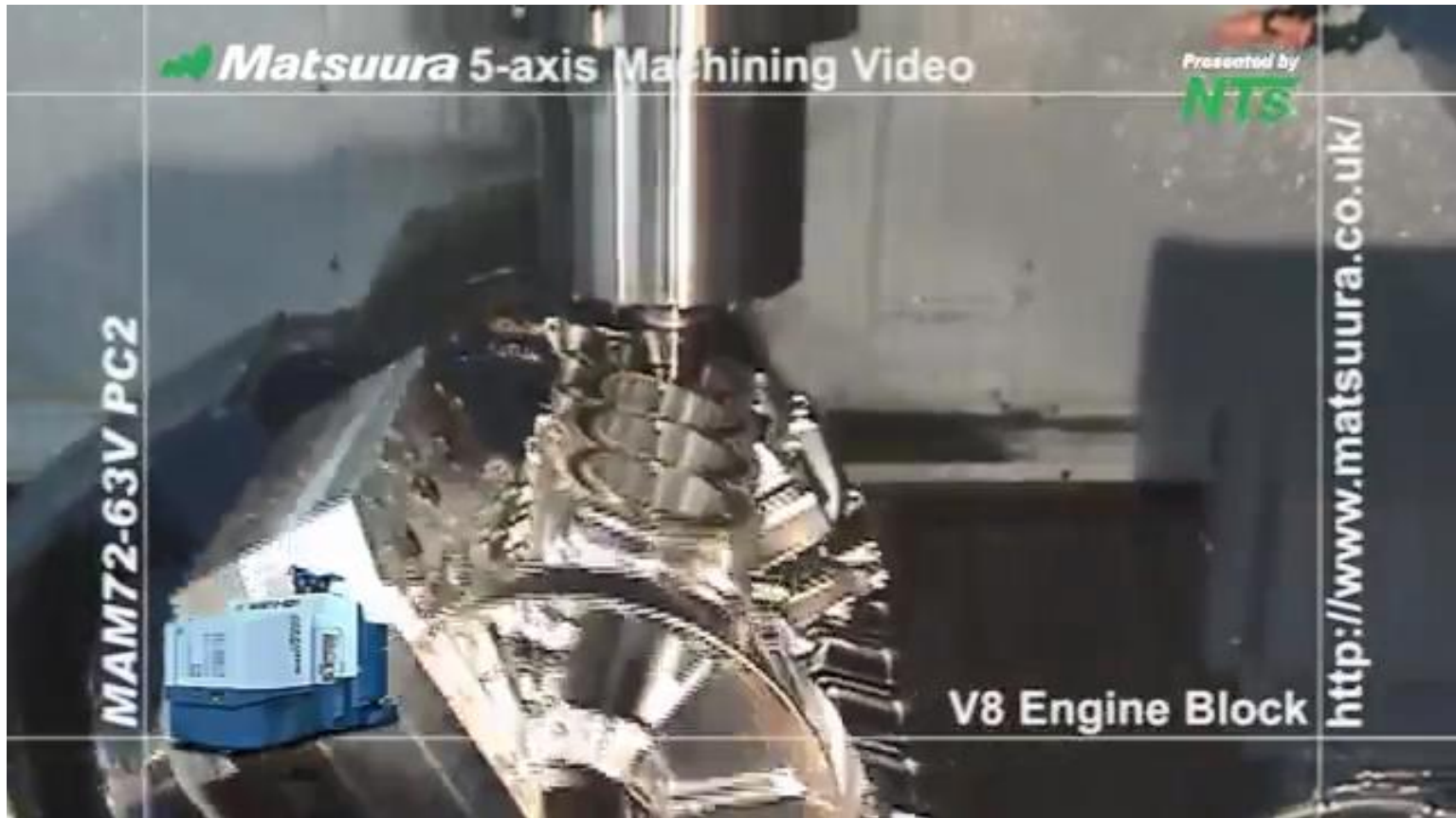
Possibilities on CNC machining centers



<https://www.youtube.com/watch?v=IbV4vIYUg1U>



Possibilities on CNC machining centers



<https://www.youtube.com/watch?v=s5si6YMxJTo>



What is a CNC machine?

- Numerically controlled (NC) machine tools were developed (1952, at MIT) to fulfill the contour machining requirements of complex aircraft parts and forming dies.
- *Computer numerically controlled* (CNC) machine tools were developed with minicomputers used as control units in the 1970s.
- Current CNC systems allow simultaneous servo-position and velocity control of all the axis, monitoring of controller and machine tool performance, online part programming with graphical assistance, in-process cutting process monitoring, and in-process part gauging for completely unmanned machining operations.

Source: Altintas's Mfg. Automation book

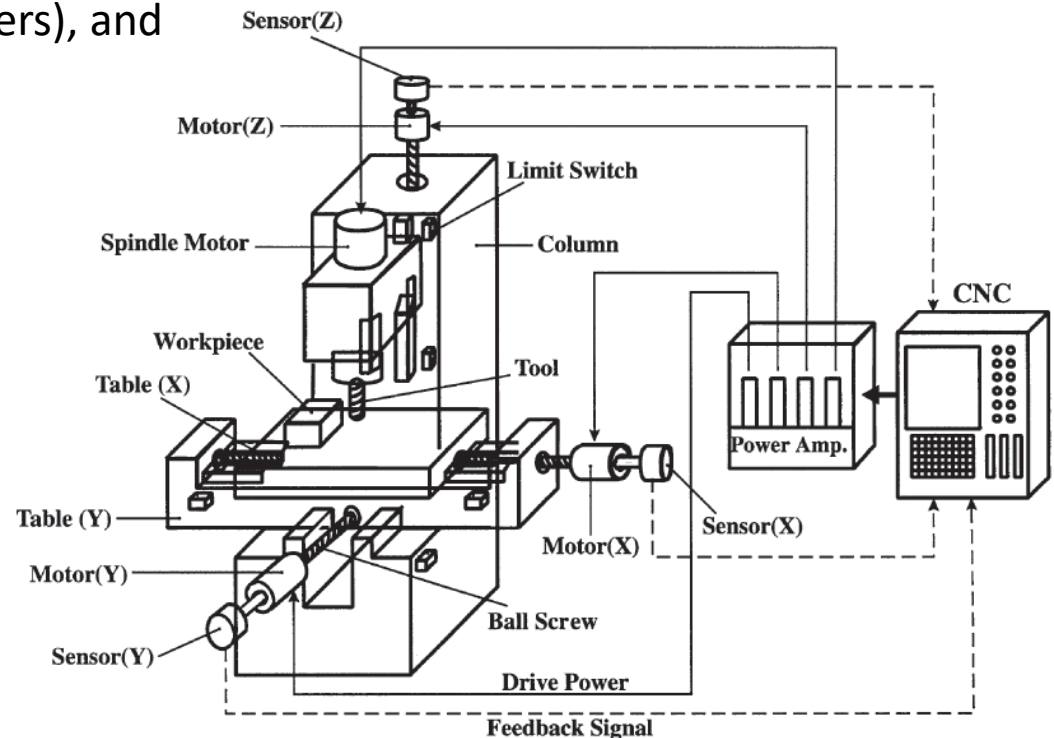


Fundamental units of CNC machine tools

Fundamental units of CNC machine tools:

- The mechanical machine tool unit
- Power units (motors and amplifiers), and
- The CNC unit

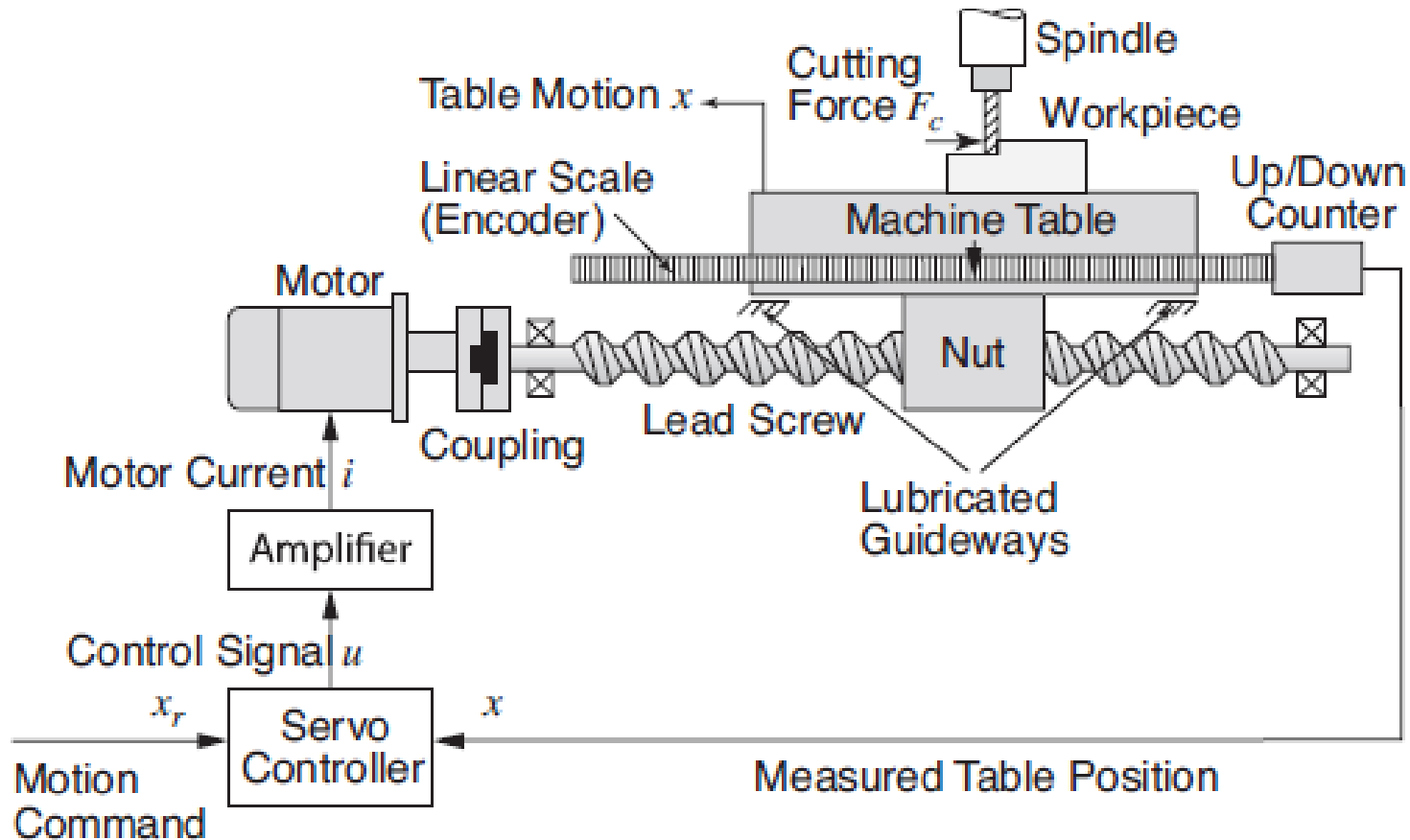
Primary difference between manual machines and CNC machines is that CNC machines have servo-controlled feed and spindle drive systems, i.e., there is feedback.



Source: Altintas's Mfg. Automation book



Servo-controlled feed drive system with feedback

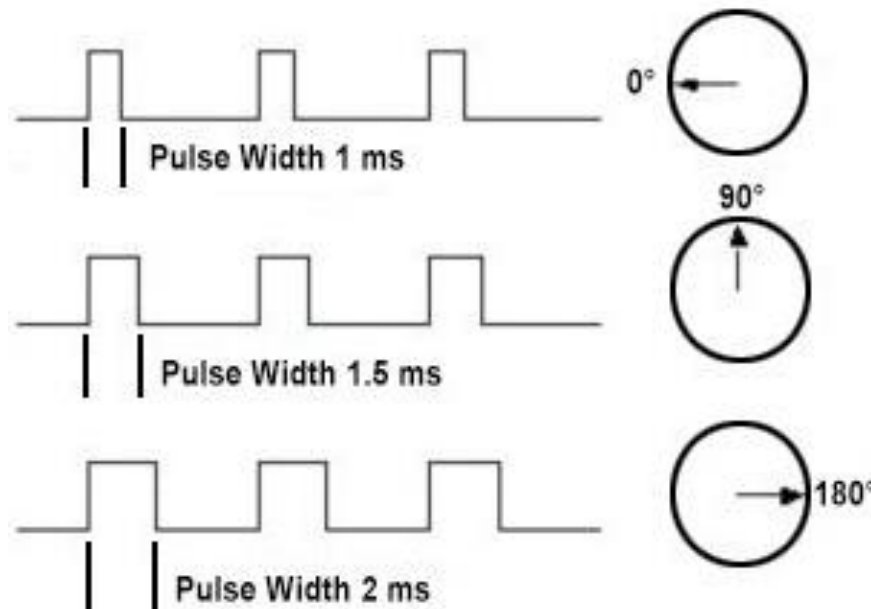


Source: Altintas's Mfg. Automation book



Servo motors

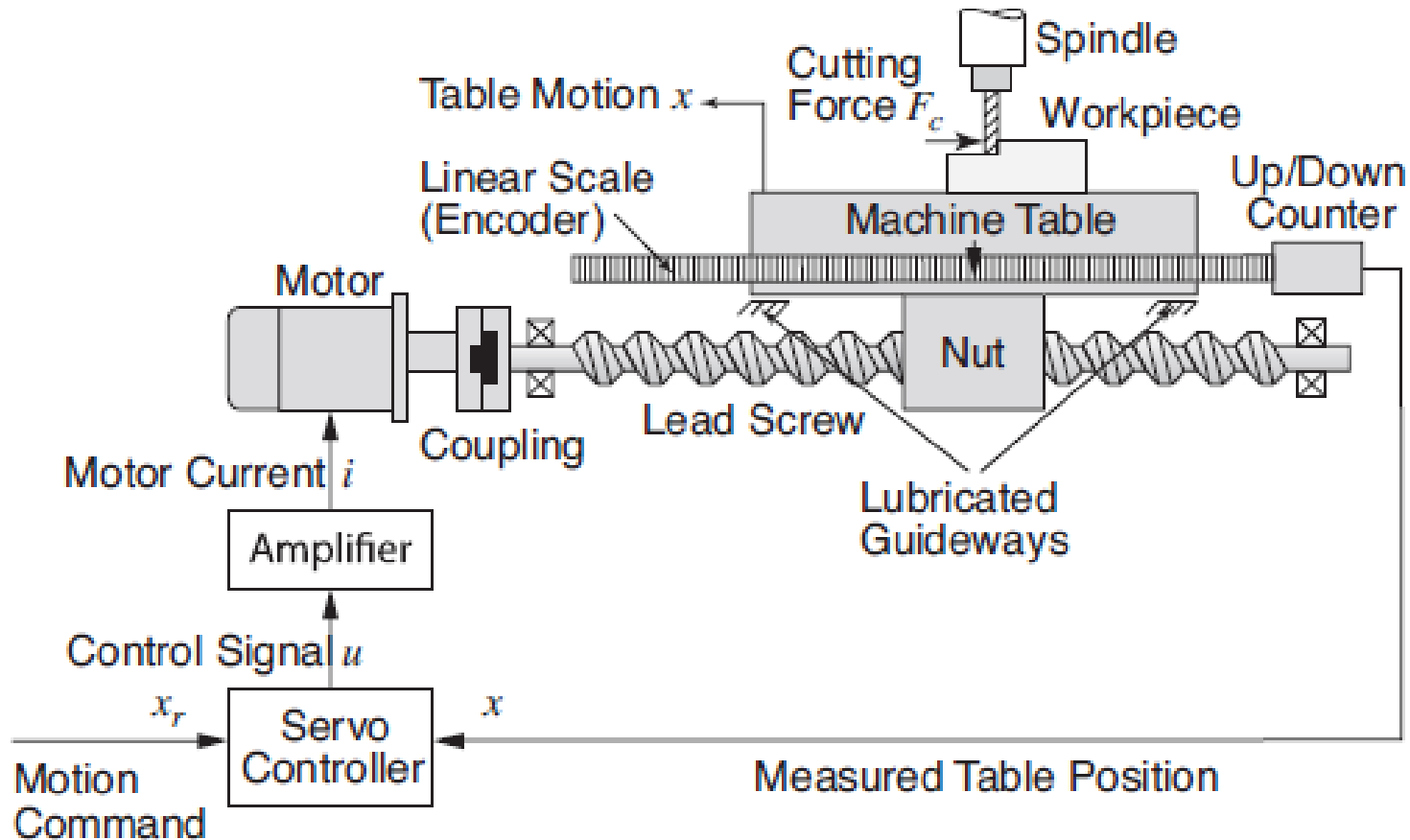
- Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. There is a minimum pulse, a maximum pulse, and a repetition rate. The PWM sent to the motor determines position of the shaft and based on the duration of the pulse sent via the control wire; the rotor will turn to the desired position.
- For example:



<https://www.jameco.com/jameco/workshop/howitworks/how-servo-motors-work.html>



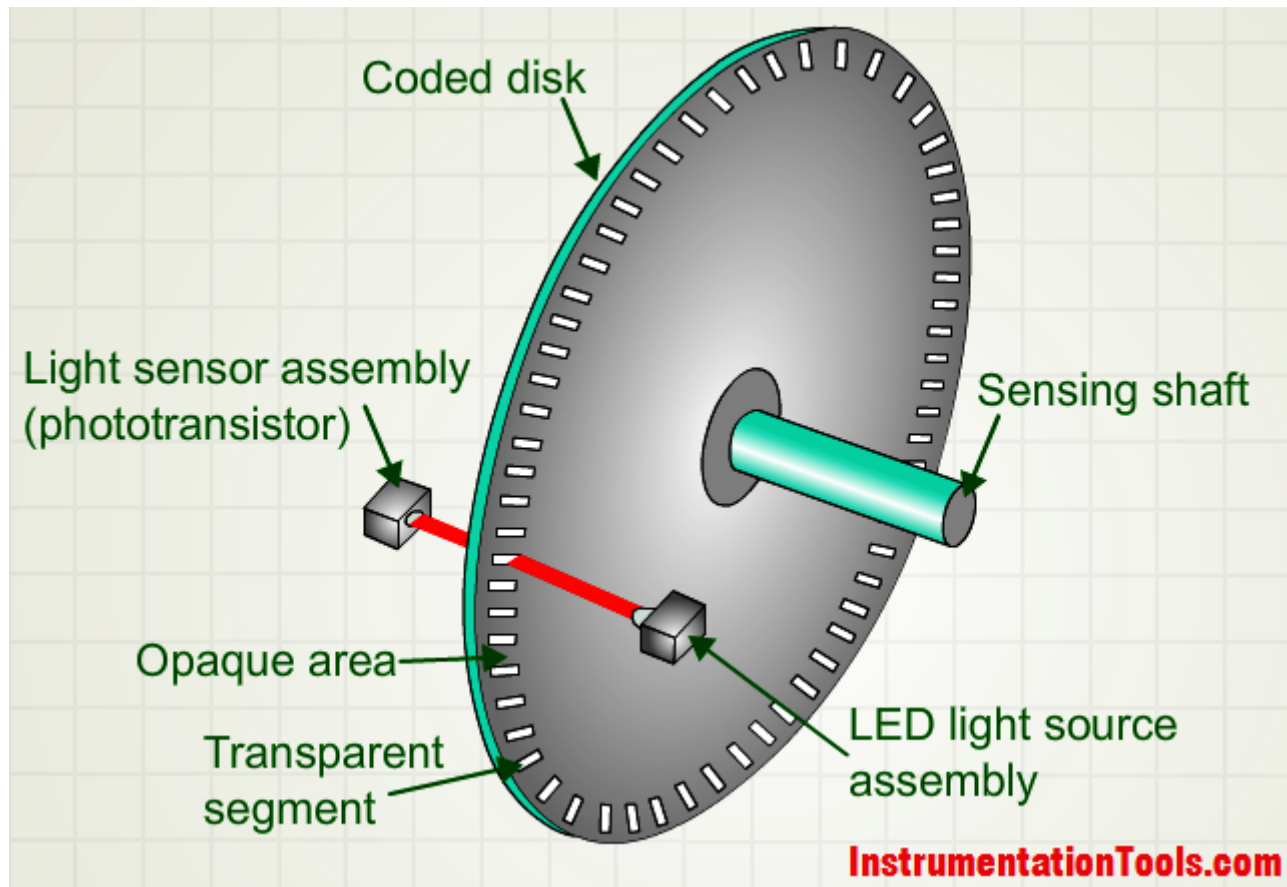
Servo-controlled feed drive system with feedback



Source: Altintas's Mfg. Automation book

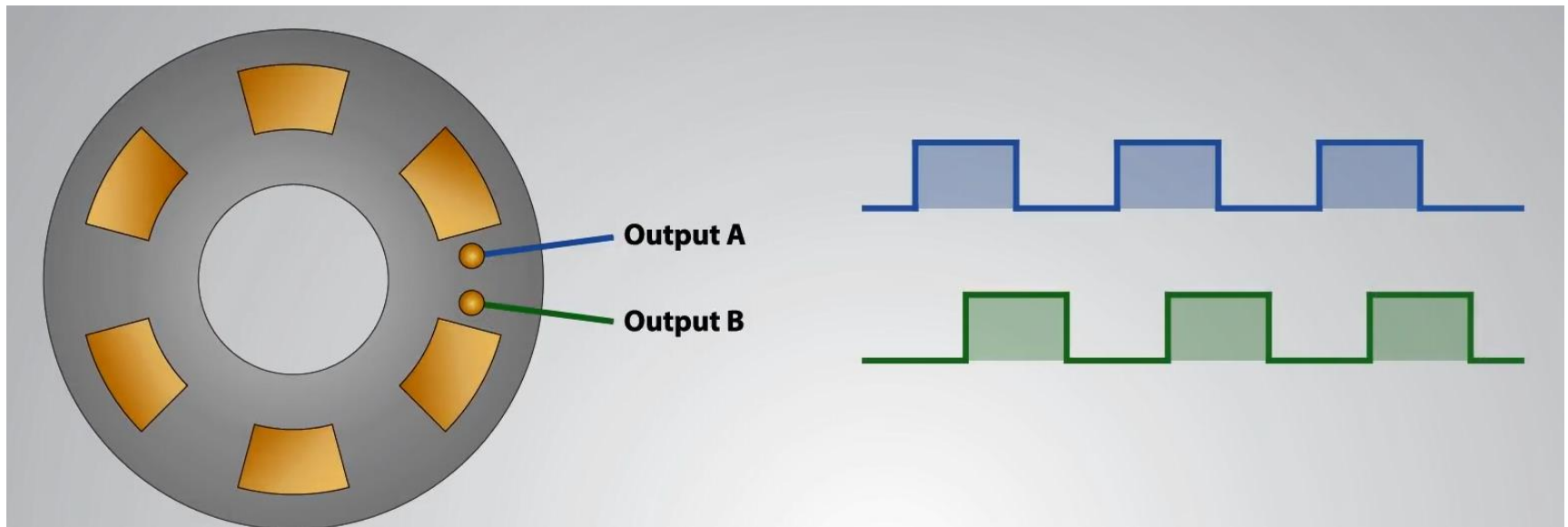


Rotary encoders



How rotary encoders work

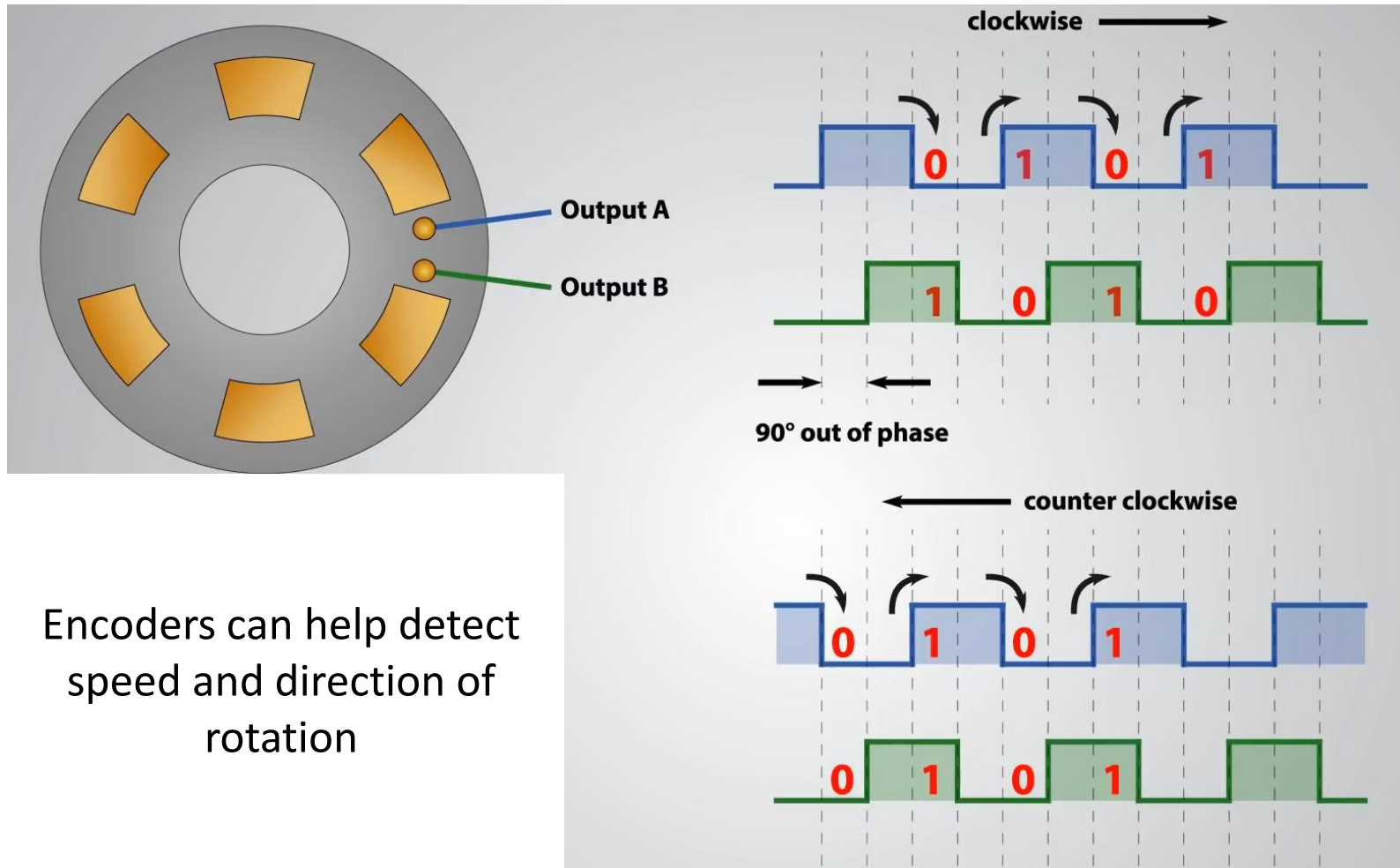
Encoders can help detect speed and direction of rotation



https://www.youtube.com/watch?time_continue=152&v=v4BbSzJ-hz4



How rotary encoders work

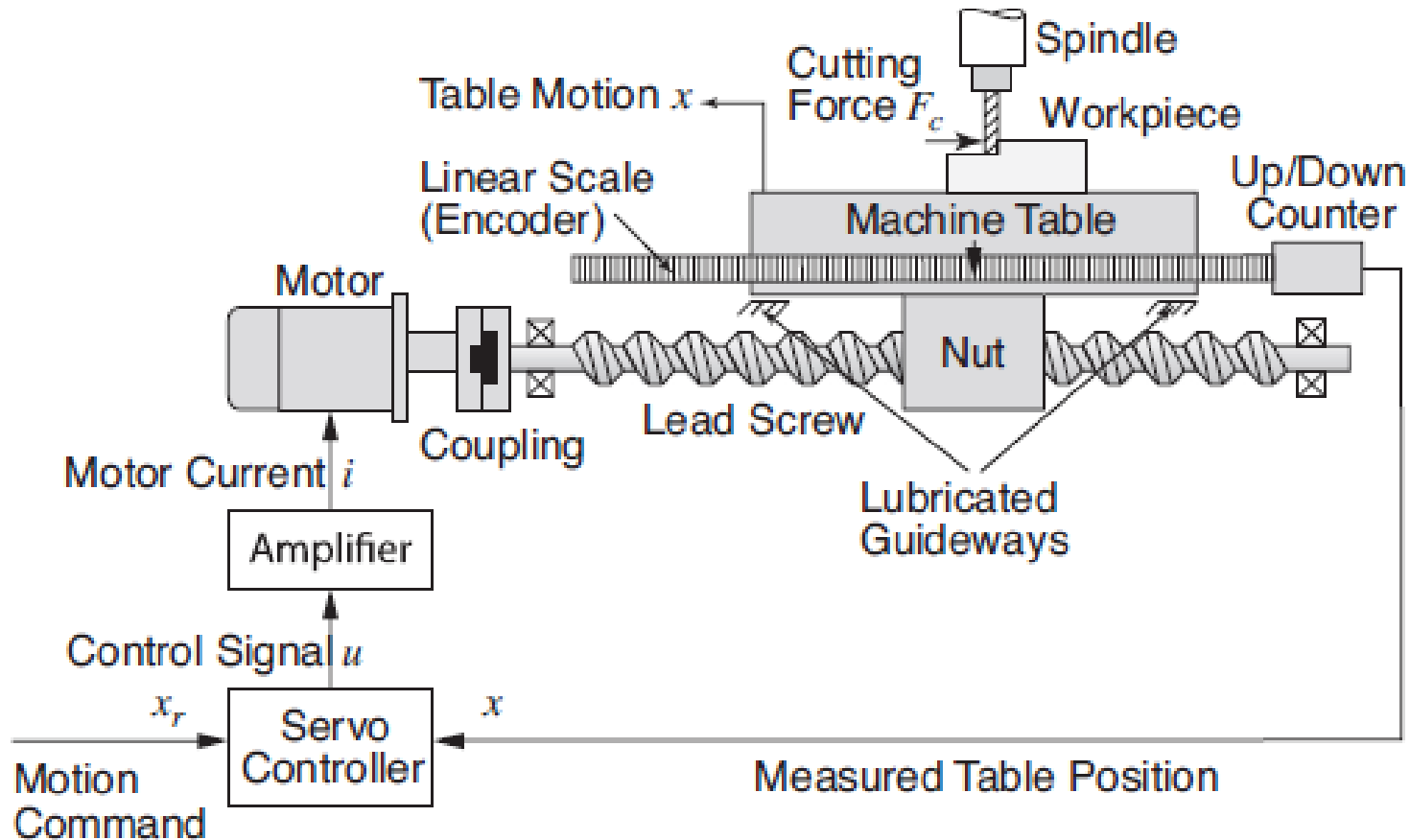


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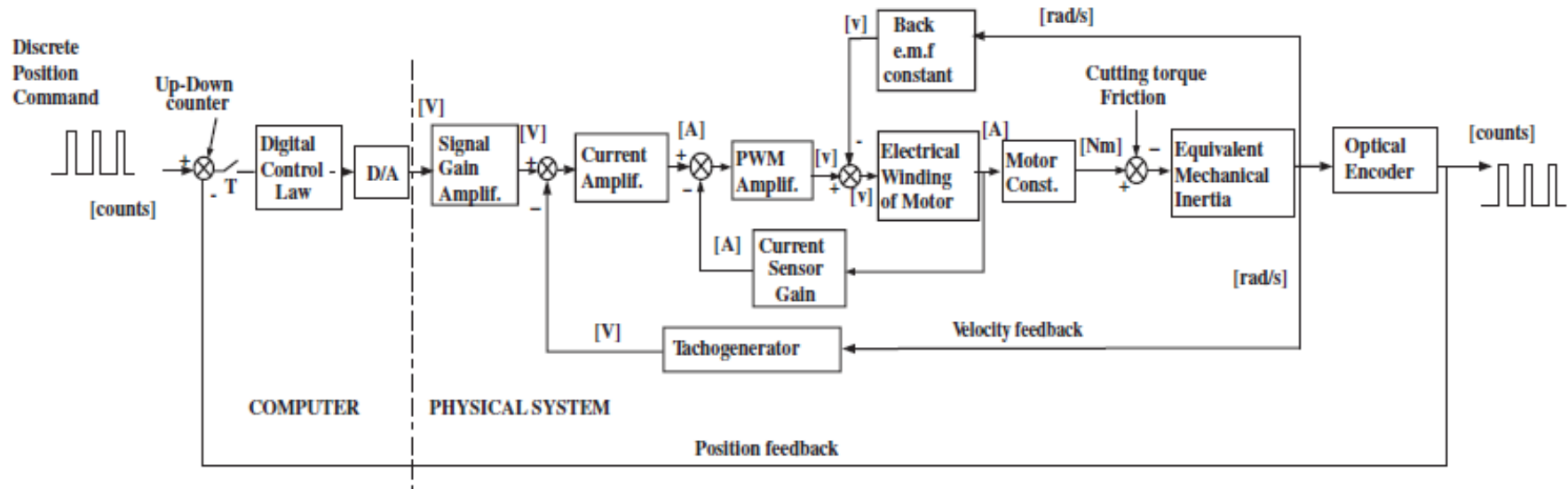
Servo-controlled feed drive system with feedback



Source: Altintas's Mfg. Automation book



Block diagram representation of servo-controlled feed drive system



Source: Altintas's Mfg. Automation book



CNC codes and the CNC executive

- NC programs are written in an internationally recognized standard language, called NC codes.
- The CNC executive is the main system software that decodes the NC codes block by block and sends appropriate commands to physical control, computation, and PLC units of the CNC system.
- For example, a 10-mm distance to be traveled at a 200-mm/s feed velocity command can be translated as follows: The real-time clock is set to generate 10,000 pulses at a rate of 200,000 pulses/s (1 pulse = 0.001mm position). The position pulses (i.e., the discrete velocity commands) are directed to the indicated machine tool axis position control units by converting to their analog voltage equivalent (i.e., typically within ± 10 V range). The analog voltage is amplified by the power unit and fed to the axis drive motors to deliver the desired motion.
- Miscellaneous functions, such as spindle ON and tool change commands, are translated as Boolean logic signals (+5 V or -5 V) for PLC units.

Source: Altintas's Mfg. Automation book



Possibilities on CNC machines



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