

FUNDAMENTAL MANUFACTURING PROCESSES

Milling & Machining Centers

SCENE 1.

ML37A, CGS: Toolchangers & Cutting Tools
white text, centered on background

SCENE 2.

ML38A, **FTD90**, **06:27:16:00-06:27:36:00**
toolchanger, changing tool, machining part
ML38B, **SME4026**, **11:26:05:00-11:26:12:00**
tool change
ML38C, **FTD101**, **11:16:53:00-11:17:03:00**
zoom in, toolchange

NARRATION (VO) :

BY MAKING A VARIETY OF TOOLS AVAILABLE FOR MACHINING, THE TOOLCHANGER DEFINES A MACHINING CENTER'S ABILITY TO PERFORM A VARIETY OF CUTTING OPERATIONS AUTOMATICALLY. THERE ARE MANY TOOLCHANGER DESIGNS. ALL MOVE TOOLS WITHIN SECONDS FROM STORAGE TO THE SPINDLE.

SCENE 3.

ML39A, **SME4026**, **11:58:14:00-11:58:25:00**
tool storage, tools indexing
ML39B, **SME4026**, **11:22:42:00-11:22:58:00**
tilt, multiple tools in storage

NARRATION (VO) :

MOST MACHINING CENTERS HAVE 20 TO 40 TOOLS IN STORAGE. TOOL STORAGE MAGAZINES WITH OVER 200 TOOLS ARE ALSO POSSIBLE. A LARGE TOOL CAPACITY PROVIDES BOTH DIFFERENT TOOLS FOR MULTIPLE OPERATIONS, AS WELL AS REPLACEMENTS FOR WHEN TOOLS WEAR DOWN.

SCENE 4.

ML40A, **SME3339**, **00:27:53:00-00:28:15:00**
zoom out, end milling operation
ML40B, **FTD89**, **05:07:34:00-05:07:56:00**
metal being removed using face mill
ML40C, **FMP006**, **06:36:18:00-06:36:34:00**
face milling
ML40D, **FMP001**, **01:42:41:00-01:42:55:00**
end milling

NARRATION (VO) :

IN GENERAL, A MILLING CUTTER IS A ROTARY TOOL WITH ONE OR MORE CUTTING EDGES, EACH OF WHICH REMOVES A SMALL AMOUNT OF

ML40E, FTD03, 03:19:58:00-03:20:12:00
zoom in, face milling
ML40F, FTD13, 12:07:34:00-12:07:56:00
face milling operation

MATERIAL AS IT CONTACTS THE WORKPIECE.
THE VARIETY OF MILLING CUTTER TYPES IS
IMMENSE. THEY COME IN VARIOUS SHAPES AND
SIZES, MADE FROM SOLID TOOL MATERIALS OR
COMPOSED OF REMOVABLE INSERTS. WE'LL
EXAMINE ONLY SOME OF THE MOST IMPORTANT
CUTTER TYPES, TOGETHER WITH THE BASIC
MILLING OPERATIONS IN WHICH THEY ARE
APPLIED.

--- TOUCH BLACK ---

SCENE 5.

ML41A, CGS: Flat Surfaces & Square
Shoulders
ML41B, FTD07, 06:27:29:00-06:27:47:00
flat surface milling with shoulder

NARRATION (VO) :

GENERATING FLAT SURFACES WITH SQUARE
SHOULDERS IS A BASIC OBJECTIVE OF MANY
MILLING PROCESSES.

SCENE 6.

ML42A, CGS: Face Milling
ML42B, FMP006, 06:30:09:00-06:30:49:00
face milling operation
ML42C, FMP006, 06:06:28:00-06:06:40:00
small face mill, milling
ML42D, FTD03, 03:17:00:00-03:17:13:00
zoom out, face mill, milling
ML42E, FTD07, 06:13:24:00-06:13:56:00
face milling operation replacement

NARRATION (VO) :

FACE MILLING CUTTERS EFFECTIVELY
GENERATE FLAT SURFACES, AT HIGH SPEEDS,
WITH THE SPINDLE AXIS PERPENDICULAR TO
THE WORK SURFACE. FACE MILLS CAN RANGE
FROM A FEW CENTIMETERS TO A HALF-METER
IN DIAMETER.

SCENE 7.

ML43A, SME2666, 04:16:50:00-04:16:59:00
c.u. rotating face mill stops on insert
ML43B, SME2666, 04:17:11:00-04:17:33:00
face milling operation

NARRATION (VO) :

IN FACE MILLING, THE CUTTER BODY HAS
MULTIPLE POCKETS THAT ACCEPT A VARIETY
OF CUTTER INSERTS. METAL IS REMOVED BY
THE PERIPHERAL EDGE OF THE INSERT, WHILE

ITS BOTTOM EDGE CLEANS UP THE WORK
SURFACE AND PRODUCES THE SURFACE FINISH.

--- TOUCH BLACK ---

SCENE 8.

ML44A, CGS: Square Shoulder Milling
ML44B, **FTD19**, **20:03:38:00-20:03:56:00**
square shoulder face milling

NARRATION (VO) :

SQUARE SHOULDER FACE MILLS GENERATE A
FINISH-MILLED SHOULDER THAT IS SQUARE TO
THE FACE THEY MILL.

--- TOUCH BLACK ---

SCENE 9.

ML45A, CGS: Edges, Shoulders, & Grooves
ML45B, **FTD07**, **06:33:46:00-06:34:03:00**
shoulder milling operation

NARRATION (VO) :

MILLING EDGES, SHOULDERS, AND GROOVES,
MAY USE A COMBINATION OF END,
PERIPHERAL, AND, OR FACE MILLING
OPERATIONS.

SCENE 10.

ML46A, CGS: Edges
ML46B, **FTD23**, **03:07:57:00-03:08:08:00**
edging operation
ML46C, CGS: Shoulders
ML46D, **FTD07**, **06:46:02:00-06:46:12:00**
shoulder operation
ML46E, CGS: Grooves
ML46F, **FTD19**, **20:11:25:00-20:11:36:00**
zoom out, grooving operation
ML46G, **FMP006**, **06:34:26:00-06:34:45:00**
slotting cutter operation
ML46H, **FMP015**, **15:40:25:00-15:40:38:00**
edging operation

NARRATION (VO) :

CREATING EDGES, OR 'EDGING,' MAY INVOLVE
THE MILLING OF ONE OR TWO SURFACES...,
SHOULDERS TYPICALLY HAVE TWO
SURFACES....,
AND GROOVES USUALLY HAVE THREE SURFACES.
GROOVES MAY BE CLOSED AT ONE END, OR
OPEN AT BOTH ENDS, AND THEY MAY BE CUT
ON INTERNAL AND EXTERNAL FLAT SURFACES,
AS WELL AS ON ROUND SURFACES.

SCENE 11.

ML47A, CGS: Peripheral Milling
ML47B, **FTD19**, **20:12:29:00-20:13:12:00**
zoom in, peripheral milling operation

NARRATION (VO) :

PERIPHERAL MILLING CUTTERS HAVE CUTTING

EDGES ON THEIR PERIPHERY WHICH ARE PARALLEL WITH THE AXIS OF ROTATION. PERIPHERAL MILLING IS USEFUL FOR CREATING LONG OPEN SLOTS AND FORMS.

SCENE 12.

ML48A, CGS: End Milling
ML48B, **SME3340**, **01:01:27:00-01:01:38:00**
end milling operation
ML48C, **FTD01**, **01:27:13:00-01:27:39:00**
end milling operation
ML48D, **FTD10**, **09:03:20:00-09:04:00:00**
zoom out, end milling operation on graphite

NARRATION (VO) :

END MILLING CUTTERS ARE ROUND-SHANK TOOLS WITH CUTTING EDGES ON THEIR PERIPHERY AND END. THE AXIS OF ROTATION IS PERPENDICULAR TO THE SURFACE PRODUCED BY THE END OF THE TOOL. CUTTER SIZE IS DEFINED BY ITS DIAMETER AND CUTTING DEPTH.

SCENE 13.

ML49A, **SME4025**, **10:03:19:00-10:03:34:00**
end milling of deep pocket
ML49B, **FMP004**, **04:49:47:00-04:50:06:00**
zoom out, long end milling operation

NARRATION (VO) :

SINCE END MILLS CUT MORE WITH THE TEETH ON THEIR PERIPHERY THAN WITH THE TEETH AT THEIR END, THEY ARE SUSCEPTIBLE TO LATERAL FORCES. THIS MAKES THEM SUBJECT TO DEFLECTION, WHICH REDUCES THE ACCURACY OF THE MILLING OPERATION.

SCENE 14.

ML50A, **FTD01**, **01:30:51:00-01:31:24:00**
shallow slot being milled
ML50B, **FTD23**, **03:13:10:00-03:13:25:00**
deep slot milling

NARRATION (VO) :

SHORT, SHALLOW SLOTS ARE OFTEN CREATED WITH END MILLS. DEEP, NARROW SLOTS MAY BE MILLED WITH AN END MILL, A THIN SLITTING CUTTER, OR A GROOVING CUTTER.

SCENE 15.

ML51A, **FMP006**, **06:33:26:00-06:33:48:00**
slotting cutter operation

NARRATION (VO) :

GROOVING OR SLOTTING CUTTERS ARE

GENERALLY MORE EFFICIENT THAN END MILLS FOR CUTTING LONG AND DEEP SLOTS, BECAUSE OF THEIR LARGER DIAMETER AND GREATER NUMBER OF TEETH.

SCENE 16.

ML52A, CGS: Chamfering
ML52B, **FTD92**, **08:18:23:00-08:18:49:00**
zoom out, chamfering using mill
ML52C, **FMP008**, **09:30:22:00-09:30:34:00**
chamfering of workpiece holes
ML52D, **SME2534**, **02:35:13:00-02:35:24:00**
c.u chamfering end mill
ML52E, **SME2534**, **02:35:27:00-02:35:38:00**
c.u chamfering end mill
ML52F, **SME2503**, **02:08:56:00-02:09:05:00**
cutter angled to workpiece surface

NARRATION (VO) :

CHAMFERING ELIMINATES SHARP CORNERS FROM A WORKPIECE, AND IS A GOOD SAFETY MEASURE. CHAMFERS MAY BE PRODUCED WITH THE CHAMFERING END MILL, WHICH BREAKS THE SHARP EDGES OF THE WORKPIECE WITH A 45-DEGREE ANGLE CUT. CHAMFERS CAN ALSO BE GENERATED USING END MILLS, PERIPHERAL MILLING CUTTERS, LONG EDGE CUTTERS, OR FACE MILLS ANGLED 45 DEGREES TO THE WORK SURFACE.

SCENE 17.

ML53A, CGS: Pocket Milling
ML53B, **FMP006**, **06:09:05:00-06:10:11:00**
pocket milling operation
ML53C, **FTD23**, **03:21:28:00-03:22:12:00**
pocket milling operation alternate

NARRATION (VO) :

WITH POCKET MILLING, AN END MILL OR SMALL-DIAMETER FACE MILL DRILLS OR RAMPS DOWN TO A CERTAIN DEPTH AND THEN MILLS OUT AN INTERNAL SHAPE OR POCKET, OFTEN WITH A FLAT BOTTOM.

SCENE 18.

ML54A, CGS: Contour Milling
ML54B, **SME3339**, **00:19:05:00-00:19:26:00**
contour milling operation

NARRATION (VO) :

CONTOUR MILLING SCULPTS INTRICATE CURVED FORMS IN THREE DIMENSIONS AND IS ESSENTIAL FOR DIE AND MOLD MAKING. CONTOUR MILLING IS COMMONLY PERFORMED

USING AN BALLNOSE END MILL.

--- TOUCH BLACK ---

SCENE 19.

ML55A, FTD23, 03:16:48:00-03:17:14:00
zoom in, milling using carbide inserts
ML55B, SME4022, 07:11:24:00-07:11:37:00
high speed machining emphasizing tooling

NARRATION (VO) :

CUTTING TOOLS ARE CHOSEN NOT ONLY FOR THEIR GEOMETRIES; THEY ARE ALSO CHOSEN BY THEIR MATERIALS. MORE THAN EVER, TOUGHER CUTTER MATERIALS ARE AVAILABLE THAT EXTEND TOOL LIFE AND ALLOW FASTER CUTTING OF TOUGHER, HARDER WORKPIECE MATERIALS.

SCENE 20.

ML56A, FTD01, 01:17:52:00-01:18:04:00
zoom out, coated carbide inserts being used for milling
ML56B, SME4022, 07:19:38:00-07:20:00:00
high speed machining emphasizing using cbn
ML56C, SME2666, 04:24:13:00-04:24:23:00
zoom out, pcd insert
ML56D, FTD07, 06:04:28:00-06:04:38:00
pcd insert on mill
ML56E, SME2666, 04:24:49:00-04:25:03:00
pcd insert milling

NARRATION (VO) :

STANDARD CARBIDE, OR COATED CARBIDE TOOLS WORK WELL IN MOST CUTTING SITUATIONS. HOWEVER, CUBIC BORON NITRIDE, OR 'CBN' TOOL INSERTS MAY BE NEEDED FOR CUTTING HARDENED MATERIALS. ADDITIONALLY, TOOLS WITH POLYCRYSTALLINE DIAMOND, OR 'PCD', SURFACES MAY BE NEEDED FOR CUTTING DIFFICULT TO MACHINE NON-FERROUS ALLOYS, SUCH AS NICKEL SUPERALLOYS. THE HIGHER COSTS OF THESE CUTTING TOOLS MUST BE WEIGHED AGAINST THEIR IMPROVEMENTS IN SPEED AND TOOL LIFE.

--- FADE TO BLACK ---