

FUNDAMENTAL MANUFACTURING PROCESSES

Plastics Machining & Assembly

SCENE 1.

CG: Plastics Machining
white text centered on black

SCENE 2.

tape 739, 01:01:38-01:11:32
peter carey narration
tape 724, 11:01:00-11:03:00
GRAPHIC: sme branding logo
tape 728, 15:06:40-15:06:54
c.u. machining of plastic part

NARRATION (VO) :

THE MACHINING OF PLASTICS INVOLVES THE USE OF
CUTTING TOOLS TO CUT AND SHAPE WORKPIECES INTO
COMPLETED PARTS, OR SUB-ASSEMBLY COMPONENTS.

SCENE 3.

tape 719, 05:22:33-05:22:53
zoom out, drilling of injection
molded plastic part
tape 720, 06:25:03-06:25:13
machining of flat plastic sheet
tape 734, 21:10:22-21:10:29
machining of plastic bar/rod
stock

NARRATION (VO) :

MACHINING PROCESSES ARE USED AS SECONDARY
OPERATIONS ON MOLDED AND FORMED PARTS. BUT
MACHINING PROCESSES ARE MOST COMMONLY USED IN THE
FABRICATION OF FLAT PLASTIC SHEET...,
OR ROD AND BAR STOCK INTO FINISHED PRODUCTS.

SCENE 4.

tape 735, 22:17:15-22:17:57
zoom out, machining of plastic
part
CG, SUPER: Thermal Expansion of
Plastics is up to
Ten Times Greater
Than That of Metals
Heat Loss of Plastics
is Much Slower Than
of Metals
Plastics Are More
Elastic & Have Lower
Melting Temperatures
Than Metals

NARRATION (VO) :

THERE ARE SEVERAL KEY DIFFERENCES BETWEEN
MACHINING PLASTICS AND MACHINING METALS,
INCLUDING:
THE THERMAL EXPANSION OF PLASTICS IS UP TO 10
TIMES GREATER THAN THAT OF METALS,
THE HEAT LOSS OF PLASTICS IS MUCH SLOWER THAN OF
METALS,
AND PLASTICS ARE MORE ELASTIC AND HAVE LOWER
MELTING TEMPERATURES THAN METALS.

SCENE 5.

continue previous shot

NARRATION (VO) :

BECAUSE OF THESE DIFFERENCES, CUTTING TOOL SPEEDS

AND FEEDS ARE ADJUSTED TO AVOID PRODUCING MELTED,
TORN, OR OUT-OF-TOLERANCE PARTS.

SCENE 6.

tape 734, 21:14:04-21:14:12
multiple cutting tool materials
used on turned part
tape 728, 15:29:16-15:29:26
zoom out, hss cutting tool
tape 734, 21:08:08-21:08:18
pan down, tungsten carbide and
diamond bit tooling

NARRATION (VO) :

VARIOUS TYPES OF CUTTING TOOL MATERIALS CAN BE
USED TO MACHINE PLASTICS. HIGH-SPEED STEEL CUTTING
TOOLS ARE ACCEPTABLE FOR SHORT-RUN PRODUCTION, BUT
TUNGSTEN CARBIDE AND DIAMOND BIT TOOLS ARE
RECOMMENDED FOR LONG RUNS.

SCENE 7.

tape 735, 22:00:59-22:01:22
zoom in, machining of plastics
CG, SUPER: Soft Plastics
Hard Plastics
Reinforced Plastics

NARRATION (VO) :

BECAUSE THE RANGE OF PLASTIC MATERIALS RESPOND TO
MACHINING DIFFERENTLY, PLASTIC MATERIALS ARE
TYPICALLY DIVIDED INTO THREE MAIN CATEGORIES:
SOFT PLASTICS,
HARD PLASTICS,
AND REINFORCED PLASTICS.

SCENE 8.

CG, SUPER: Soft Plastics
tape 728, 15:15:00-15:15:12
machining of soft plastics with
long curly chips

NARRATION (VO) :

THE MACHINING OF SOFT PLASTICS, SUCH AS
POLYETHYLENE OR POLYPROPYLENE, PRODUCES LONG,
CURLY CHIPS.

SCENE 9.

CG, SUPER: Hard Plastics
tape 725, 12:07:29-12:07:50
zoom out, machining of hard
plastics with short shards

NARRATION (VO) :

MACHINING HARD PLASTICS, SUCH AS ACRYLONITRILE
BUTADIENE STYRENE, OR 'ABS', OR POLYCARBONATE
RESULTS IN THE PRODUCTION OF SHORT SHARDS OF
MATERIAL HAVING A CRYSTALLINE APPEARANCE.

SCENE 10.

CG, SUPER: Reinforced Plastics
tape 696, 12:11:17-12:11:30
zoom in, turning of reinforced
plastics

NARRATION (VO) :

REINFORCED PLASTICS TYPICALLY CONTAIN A LARGE
AMOUNT OF ABRASIVE GLASS FIBERS, AND PRESENT

MACHINING CHALLENGES NOT FOUND WITH THE OTHER
PLASTICS.

SCENE 11.

tape 721, 07:16:02-07:16:44
pan, routing tools

NARRATION (VO) :

BECAUSE EACH TYPE OF PLASTIC MATERIAL EXHIBITS
DIFFERENT CHARACTERISTICS, VARIOUS CUTTING TOOL
GEOMETRIES ARE REQUIRED DEPENDING UPON THE GIVEN
MACHINING APPLICATION.

SCENE 12.

tape 736, 23:17:28-23:17:51
zoom out, plastic part being
machined using coolant

NARRATION (VO) :

SINCE FRICTIONAL HEAT DOES NOT DISSIPATE EASILY
THROUGH A PLASTIC WORKPIECE, THE PART SURFACE
FINISH MAY BE AFFECTED IF IT'S ALLOWED TO REACH
THE SOFTENING POINT. EXCESSIVE HEAT BUILD-UP CAN
ALSO DULL THE CUTTING TOOL. FOR THESE REASONS, THE
USE OF COOLANT MAY BE REQUIRED TO REDUCE
FRICTIONAL HEAT.

SCENE 13.

tape 728, 15:04:26-15:04:41
zoom out, compressed air being
used as coolant
tape 735, 22:04:32-22:04:44
mist spray being used as coolant
for pilot hole drilling
tape 735, 22:25:23-22:25:38
zoom in, liquid coolant used to
machining of plastics

NARRATION (VO) :

TYPICAL COOLANTS USED FOR MACHINING PLASTICS
INCLUDE CLEAN COMPRESSED AIR, WHICH AIDS IN CHIP
REMOVAL AND LIMITS PART CONTAMINATION...,
AND THE USE OF MIST SPRAYS, WATER-SOLUBLE OILS,
LIGHT CUTTING OILS, AND OTHER SOLUTIONS FOR USE IN
HIGH-SPEED AND AUTOMATIC OPERATIONS. COOLANT MUST
BE SELECTED WITH CARE AS SOME MAY REACT WITH
CERTAIN PLASTIC MATERIALS.

SCENE 14.

tape 729, 16:04:18-16:04:28
zoom in, sawing plastics with
cnc saw
CG, SUPER: Sawing
tape 723, 09:21:52-09:22:11

NARRATION (VO) :

THE PRIMARY TYPES OF OPERATIONS USED TO MACHINE
PLASTICS INCLUDE:

milling of plastics
 CG, SUPER: Milling
tape 720, 06:09:03-06:09:09
 drilling of plastics
 CG, SUPER: Drilling
tape 734, 21:15:25-21:15:30
 turning of plastics
 CG, SUPER: Turning
tape 730, 00:00:55-00:01:03
 waterjet cutting of plastics
tape 337, 01:02:50-01:03:20
 audio only for waterjet cutting
 CG, SUPER: Waterjet Cutting
tape 716, 01:09:50-01:09:56
 laser cutting of plastics
 CG, SUPER: Laser Cutting

SAWING...,
 MILLING...,
 DRILLING...,
 TURNING...,
 WATERJET CUTTING...,
 AND LASER CUTTING.

--- TOUCH BLACK ---

SCENE 15.
 CG, SUPER: Sawing
tape 729, 16:03:55-16:04:05
 zoom out, sawing flat plastic
 sheet with table saw
tape 729, 16:06:08-16:06:15
 sawing plastic bar stock with
 miter saw

NARRATION (VO) :

SAWING IS A COMMON OPERATION TYPICALLY USED TO
 REDUCE IN SIZE LENGTHS OF PLASTIC SHEET STOCK...,
 AND BAR AND ROD STOCK FOR SUBSEQUENT MACHINING.

SCENE 16.
tape 721, 07:18:47-07:19:05
 zoom in, sawing plastics with
 cnc saw
tape 729, 16:04:11-16:04:16
 sawing plastics with table saw
tape 729, 16:05:09-16:05:15
 sawing plastics with miter saw

NARRATION (VO) :

THERE ARE NUMEROUS TYPES OF SAWS USED TO CUT
 PLASTICS, INCLUDING:
 COMPUTER NUMERICALLY CONTROLLED, OR CNC, SAWS...,
 TABLE SAWS...,
 AND MITER SAWS.

--- TOUCH BLACK ---

SCENE 17.
 CG, SUPER: Milling
tape 735, 22:18:40-22:19:04
 zoom in, milling of plastic part
tape 728, 15:10:41-15:10:58
 zoom out, milling with ball nose
 end mill

NARRATION (VO) :

MILLING IS A VERSATILE MACHINING PROCESS THAT USES
 THE RELATIVE MOTION BETWEEN A ROTATING, MULTI-EDGE
 CUTTER AND THE WORKPIECE TO CUT FLAT AND CURVED
 SURFACES.

SCENE 18.
 continue previous shot
tape 720, 06:27:55-06:28:08
 routing of plastic part

NARRATION (VO) :

THERE ARE MANY VARIETIES OF MILLING OPERATIONS AND

CG, SUPER: Routing

CUTTERS, BUT THE PRIMARY TYPE USED TO MACHINE PLASTICS IS ROUTING, TYPICALLY WITH AN END-MILL CUTTER.

SCENE 19.

tape 722, 08:10:51-08:11:01

routing of flat sheet stock

tape 716, 01:24:06-01:24:13

routing used to trim excess from plastic part

tape 722, 08:12:35-08:12:50

routing used to create window in part

NARRATION (VO) :

ROUTING IS OFTEN USED TO MACHINE SHAPES OUT OF FLAT PLASTIC SHEET STOCK. ROUTING IS ALSO USED TO TRIM EXCESSIVE WASTE MATERIAL FROM PARTS, AND IN SOME CASES FOR CREATING AN OPENING, SUCH AS A WINDOW, SLOT, OR GROOVE IN A PART.

SCENE 20.

tape 723, 09:06:03-09:06:21

zoom out, routing performed manually

tape 720, 06:17:01-06:17:15

routing using nc machine

NARRATION (VO) :

ROUTING CAN BE PERFORMED MANUALLY....
OR AUTOMATICALLY USING NUMERICALLY CONTROLLED MACHINE TOOLS OR ROUTERS.

--- TOUCH BLACK ---

SCENE 21.

CG, SUPER: Drilling

tape 723, 09:29:21-09:29:53

pan, drilling in plastic part on mill

tape 734, 21:09:40-21:09:56

drilling on lathe

NARRATION (VO) :

THE DRILLING OF CYLINDRICAL HOLES IN PLASTICS IS ACCOMPLISHED BY THE RELATIVE ROTATION OF A HELICALLY FLUTED DRILL AND A WORKPIECE, COMBINED WITH A LINEAR FEED MOVEMENT. TYPICALLY THE DRILL ROTATES INTO A STATIONARY WORKPIECE, BUT THE DRILL MAY BE HELD FIXED WHILE THE WORKPIECE ROTATES, SUCH AS ON A LATHE.

SCENE 22.

tape 728, 15:18:45-15:18:55

zoom out, chips coming out of hole being drilled on lathe

NARRATION (VO) :

MATERIAL IS REMOVED FROM THE HOLE IN THE FORM OF CHIPS CUT BY THE DRILL'S CUTTING LIPS.

SCENE 23.

tape 735, 22:24:00-22:24:24

zoom in, coolant being used in

NARRATION (VO) :

drilling operation
CG, SUPER: Lubricate The Cut
Cool The Drill
Point
Flush Out Chips

SINCE DRILLING TAKES PLACE INSIDE THE WORKPIECE,
THE CHIPS AND HEAT GENERATED BY THE PROCESS ARE
CONFINED. THE GREATER THE DEPTH OF THE HOLE, THE
MORE DIFFICULT IT IS TO CONTROL HEAT BUILDUP AND
REMOVE THE CHIPS. FOR THIS REASON, SUPPLYING
COOLANT TO THE DRILL TIP IS VITAL. THE COOLANT
HELPS LUBRICATE THE CUT, COOL THE DRILL POINT, AND
FLUSH OUT CHIPS.

SCENE 24.

tape 80, 03:17:15-03:17:30
zoom out, helically fluted drill
turning
tape 734, 21:24:51-21:25:09
straight fluted, drill used in
turning

NARRATION (VO) :

DRILLS MAY BE HELICALLY FLUTED...,
OR STRAIGHT FLUTED, AND BE MADE OF CARBIDE OR BE
DIAMOND-TIPPED.

SCENE 25.

tape 735, 22:05:53-22:06:22
c.u., zoom out, drilling
operation with emphasis on drill
flutes

NARRATION (VO) :

DRILL FLUTES ALLOW COOLANT INTO, AND CARRY CHIPS
OUT OF THE HOLE BEING PRODUCED. BOTH FUNCTIONS ARE
ESSENTIAL FOR THE DRILL POINT TO CONTINUE CUTTING
UNDER THE SEVERE CONDITIONS OF ROTATING AT HIGH
SPEED IN AN ENCLOSED SPACE. FOR THIS REASON DRILL
FLUTES SHOULD BE HIGHLY POLISHED.

SCENE 26.

tape 724, 12:00:40-12:00:50
GRAPHIC: blue background with
three drill types
tape 724, 12:01:10-12:01:20
GRAPHIC: blue background with
three drill types, helix angles
highlighted
tape 80, 03:05:07-03:05:15
pan, drill with high helix angle

NARRATION (VO) :

THE HELIX ANGLE OF A DRILL'S FLUTES CAN VARY
DEPENDENT UPON THE MATERIAL TO BE DRILLED.
TYPICALLY A HIGH HELIX OR FAST SPIRAL ANGLE OF 35
TO 40 DEGREES IS USED FOR DRILLING PLASTICS.

SCENE 27.

tape 734, 21:25:53-21:26:17
drilling operation changing over
to tapping operation
CG, SUPER: Tapping

NARRATION (VO) :

ONCE PLASTIC PARTS HAVE BEEN DRILLED THERE ARE

tape 703, 17:11:50-17:11:56
reaming operation
CG, SUPER: Reaming

NUMEROUS HOLE FINISHING OPERATIONS THAT CAN BE PERFORMED, WITH TWO OF THE MOST COMMON BEING: TAPPING..., AND REAMING.

SCENE 28.
CG, SUPER: Tapping
tape 735, 22:09:40-22:10:13
c.u., zoom out, tapping operation
tape 736, 23:23:39-23:23:46
c.u. internal threads

NARRATION (VO) :
TAPPING IS ACCOMPLISHED BY DRIVING A ROTATING TAP WITH SHARP THREAD CUTTING SECTIONS ON IT'S PERIPHERY, INTO A HOLE. THE TAP CUTS A THREAD SHAPE AS IT MOVES AXIALLY, GENERATING INTERNAL THREADS.

SCENE 29.
tape 735, 22:14:49:00
freeze frame, static tap with flutes for plastics, dissolve to next shot
tape 735, 22:14:49-22:15:09
zoom out, tap starting tapping operation

NARRATION (VO) :
TAPS FOR USE WITH PLASTIC MATERIALS TYPICALLY SHOULD HAVE 2 OR 3 FLUTES, AND BE MADE OF CARBIDE, CARBON STEEL OR COATED HIGH-SPEED STEEL.

SCENE 30.
CG, SUPER: Reaming
tape 735, 22:12:15-22:12:35
c.u., zoom out, reaming operation
tape 725, 12:10:00-12:10:10
reaming operation

NARRATION (VO) :
REAMING ENLARGES A CYLINDRICAL HOLE TO ITS FINAL SIZE AND GIVES IT A GOOD FINISH. IT REMOVES ONLY A SMALL AMOUNT OF MATERIAL. REAMERS ARE FLUTED, MULTI-EDGE TOOLS, MADE TO CLOSE DIAMETRAL TOLERANCES. REAMERS ARE TYPICALLY MADE OF CARBIDE TO MINIMIZE WEAR.

SCENE 31.
tape 734, 21:25:15-21:25:26
drilling operation emphasizing hole produced
tape 723, 09:28:32-09:28:48
drilling operation
tape 735, 22:09:20-22:09:35
tapping operation
tape 725, 12:10:49-12:10:58
reaming operation
tape 736, 23:20:07-23:20:20

NARRATION (VO) :
BECAUSE OF THE RESILIENT NATURE OF VARIOUS PLASTICS, THERE IS A TENDENCY FOR THE MATERIAL TO SPRING-BACK ONCE DRILLING AND HOLE FINISHING OPERATIONS ARE PERFORMED. TO COMPENSATE FOR THIS

tapping operation with coolant

SPRING-BACK, DRILLS...,

TAPS...,

REAMERS...,

AND OTHER HOLEMAKING AND HOLE FINISHING TOOLS ARE
OVER-SIZED ACCORDINGLY.

--- TOUCH BLACK ---

SCENE 32.

CG, SUPER: Turning

tape 734, 21:26:18-21:26:34

turning operation on plastic
part

tape 728, 15:21:38-15:21:50

holemaking operation on lathe,
changes to facing operation

NARRATION (VO) :

IN TURNING, A WORKPIECE IS ROTATED ABOUT ITS AXIS
ON A LATHE. SINGLE-POINT CUTTING TOOLS ARE FED
INTO THE WORKPIECE SHEARING OFF UNWANTED MATERIAL
TO CREATE THE DESIRED CYLINDRICAL, AXIALLY
SYMMETRIC SHAPE.

CUTTING IS ALSO PERFORMED ON INTERNAL SURFACES...,
AND THE EXPOSED END.

SCENE 33.

continue previous shot

tape 734, 21:25:29-21:25:38

c.u. single point cutting tool
on lathe entering plastic part

NARRATION (VO) :

SINGLE-POINT CUTTING TOOLS FOR PLASTICS ARE
PRIMARILY TUNGSTEN CARBIDE OR DIAMOND-TIPPED
CARBIDE.

SCENE 34.

tape 728, 15:22:52-15:23:02

plastic workpiece held by chuck

tape 728, 15:23:39-15:23:48

plastic workpiece held by collet

tape 734, 21:28:42-21:28:53

pan, plastic workpiece being
machined between centers

NARRATION (VO) :

WORKPIECES ARE TYPICALLY HELD AT ONE END ON A
LATHE USING A CHUCK...,
OR COLLET..,

THEY MAY ALSO BE HELD AT BOTH ENDS, WHICH IS KNOWN
AS 'BETWEEN CENTERS' TURNING.

--- TOUCH BLACK ---

SCENE 35.

CG, SUPER: Waterjet Cutting

tape 730, 00:08:18-00:08:27

NARRATION (VO) :

waterjet cutting operation
tape 730, 00:08:30-00:08:41
waterjet cutting operation
tape 337, 01:02:50-01:03:20
audio only for waterjet cutting

WATERJET CUTTING EMPLOYS THE FORCE OF A HIGH-PRESSURE STREAM OF WATER, TYPICALLY IN THE RANGE OF 20,000 TO 60,000 PSI, OR POUNDS PER SQUARE INCH, TO CUT A WIDE RANGE OF PLASTIC MATERIALS AND THICKNESSES.

SCENE 36.
continue previous shot
tape 730, 00:03:07-00:03:19
waterjet cutting operation using
abrasive materials

NARRATION (VO) :
WATERJET CUTTING GENERATES NO HEAT OR DUST. ADDITIONALLY, ABRASIVE MATERIAL CAN ALSO BE ADDED TO WATERJET SYSTEMS, ALLOWING CUTTING OF EVEN THE MOST DIFFICULT PLASTICS.

--- TOUCH BLACK ---

SCENE 37.
CG, SUPER: Laser Cutting
tape 716, 01:20:29-01:20:56
zoom out, laser cutting
operation

NARRATION (VO) :
LASER CUTTING IS USED WHEN A FINE POLISHED, ULTRASMooth FINISH IS REQUIRED ON A PLASTIC PART. THE LASER UNIT CUTS BY FOCUSING ITS CONCENTRATED BEAM AT THE EXACT POINT OF THE CUT, CAUSING THE PLASTIC TO MELT, VAPORIZE, AND THEN SOLIDIFY.

SCENE 38.
tape 716, 01:11:52-01:12:11
laser trimming part
CG, SUPER: Carbon Dioxide/CO2
Gas Laser
Neodymium-Doped
Yttrium-Aluminum
Garnet/YAG Solid-
State Laser

NARRATION (VO) :
THE TWO MOST COMMON TYPES OF LASERS INCLUDE: THE CARBON DIOXIDE, OR CO2, GAS LASER, AND THE NEODYMIUM-DOPED YTTRIUM-ALUMINUM GARNET, OR 'YAG', SOLID-STATE LASER.

--- FADE TO BLACK ---