FUNDAMENTAL MANUFACTURING PROCESSES

Plastics Machining & Assembly

SCENE 1. WARNING CG: FBI warning federal law provides severe civil and white text centered on black to blue gradient criminal penalties for the unauthorized reproduction, distribution or exhibition of copyrighted videotapes. Copyright © 2002 by the Society of Manufacturing Engineers

SCENE 2. Always read the operating manual and safety CG: disclaimer information provided by the manufacturer before white text centered on black to operating any plastics machining & blue gradient assembly equipment. Make sure all machine guards are in place, and

SCENE 3. CG: PMMA screen A white text centered on black to blue gradient tape 715, 20:01:10-20:01:50 GRAPHIC: PMMA logo

Engineers. For more information on plastics, please visit our

follow all safety procedures when working with or near plastics machining & assembly equipment.

This program was produced using the technical

resources of the Plastics Molders & Manufacturers

Association of the Society of Manufacturing

continue PMMA logo graphic CG: PMMA screen B white text centered on black to blue gradient

website at: www.sme.org/pmma

SCENE 5. tape 40, 01:00:00-01:00:12 SME logo, with music CG, SUPER: www.sme.org

SCENE 4.

SCENE 6. tape 739, 01:00:00-01:01:35 peter carey narration tape 25, 01:01:00-01:01:45 fundamental series open, with music

MUSIC UP AND UNDER

NARRATION (VO):

THE FUNDAMENTAL MANUFACTURING PROCESSES VIDEO SERIES, EXAMINING THE TOOLS AND TECHNIQUES OF

--- 1 ---

Copyright © 2002 Society of Manufacturing Engineers PRECISION MANUFACTURING.

SCENE 7.
program title:
CG: Plastics Machining &
 Assembly
white text centered on black

SCENE 8. tape 724, 11:01:00-11:03:00 GRAPHIC: sme branding logo tape 421, 15:20:03-15:20:12 part coming out of mold using sprue puller tape 630, 08:07:53-08:07:58 parts being thermoformed tape 402, 08:11:57-08:12:07 parts being blow molded

SCENE 9. tape 415, 10:25:49-10:26:02 mold opening and plastic part falling out tape 641, 19:09:55-19:10:26 part being deflashed, hand trimming tape 640, 18:05:44-18:05:52 parts being cleaned tape 632, 11:07:28-11:07:35 plastic parts being painted tape 728, 15:26:35-15:26:41 part being turned tape 725, 12:15:13-12:15:19 part being assembled

NARRATION (VO): THIS PROGRAM IS AN INTRODUCTION TO PLASTICS

MACHINING AND ASSEMBLY.

NARRATION (VO):

PLASTIC PARTS ARE MOST COMMONLY PRODUCED BY

--- 2 ---

INJECTION MOLDING...,

THERMOFORMING...,

BLOW MOLDING,

AND OTHER PRODUCTION PROCESSES.

NARRATION (VO):

ONCE MOLDED OR FORMED, PARTS MAY REQUIRE

ADDITIONAL PROCESSING, SUCH AS DEFLASHING...,

CLEANING...,

OR DECORATING.

BUT PARTS MAY ALSO BE MACHINED...,

AND/OR ASSEMBLED WITH OTHER PARTS.

NARRATION (VO):

MACHINING AND ASSEMBLY OPERATIONS CAN BE PERFORMED ON PLASTIC PARTS FOR STRUCTURAL, AS WELL AS, APPEARANCE PURPOSES. THESE OPERATIONS ARE USED ON PARTS PRODUCED FROM EITHER THERMOPLASTICS, OR THERMOSETS.

SCENE 11. CG, SUPER: Thermoplastics tape 392, 08:23:50-08:24:00 thermoplastic melted

NARRATION (VO):

THERMOPLASTICS UNDERGO A REVERSIBLE CHANGE FROM SOLID TO LIQUID WHEN HEATED, AND CAN BE Copyright © 2002 Society of Manufacturing Engineers CONTINUOUSLY REUSED.

SCENE 12. CG, SUPER: Thermosets tape 702, 16:14:53-16:15:03 thermoset part pulled from mold NARRATION (VO):

THERMOSETS, ON THE OTHER HAND, UNDERGO A CHEMICAL REACTION BETWEEN TWO REAGENTS WHEN HEATED, AND CANNOT BE RESOFTENED OR REUSED.

SCENE 13. tape 724, 10:07:09-10:07:19 machining of plastic part tape 718, 04:19:34-04:19:48 assembly of thermoplastic parts

NARRATION (VO):

ALTHOUGH MACHINING...,

AND ASSEMBLY PROCESSES CAN BE USED ON BOTH THERMOPLASTIC AND THERMOSET MATERIALS, OUR PRIMARY FOCUS WILL BE ON OPERATIONS PERFORMED ON THERMOPLASTICS.

--- FADE TO BLACK ---

SCENE 14. CG: Plastics Machining white text centered on black

SCENE 15.

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

SCENE 16.

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

SCENE 17. tape 735, 22:17:15-22:17:57 zoom out, 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.

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.

NARRATION (VO):

THERE ARE SEVERAL KEY DIFFERENCES BETWEEN

--- 3 ---

CG, SUPER: Thermal Expansion of MACHINING PLASTICS AND MACHINING METALS,

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

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 18. 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 19.
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 20. 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 21.
CG, SUPER: Soft Plastics
tape 728, 15:15:00-15:15:12
machining of soft plastics with

NARRATION (VO):

THE MACHINING OF SOFT PLASTICS, SUCH AS

--- 4 ---

Copyright © 2002 Society of Manufacturing Engineers --- 5 --long curly chips POLYETHYLENE OR POLYPROPYLENE, PRODUCES LONG,

CURLY CHIPS.

SCENE 22. 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 23. 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 24. 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 25. tape 736, 23:17:28-23:17:51 zoom out, plastic part being machined using coolant

NARRATION (VO):

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 26.

tape 728, 15:04:26-15:04:41
zoom out, compressed air being

used as coolant

TYPICAL COOLANTS USED FOR MACHINING PLASTICS

Copyright © 2002 Society of Manufacturing Engineers ---- 6 ---tape 735, 22:04:32-22:04:44 INCLUDE CLEAN COMPRESSED AIR, WHICH AIDS IN CHIP mist spray being used as coolant for pilot hole drilling REMOVAL AND LIMITS PART CONTAMINATION..., tape 735, 22:25:23-22:25:38 zoom in, liquid coolant used to machining of plastics 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 27.

SCENE 28.

miter saw

CG, SUPER: Sawing

sheet with table saw

tape 729, 16:03:55-16:04:05

tape 729, 16:06:08-16:06:15
sawing plastic bar stock with

zoom out, sawing flat plastic

NARRATION (VO):

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 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

THE PRIMARY TYPES OF OPERATIONS USED TO MACHINE PLASTICS INCLUDE: SAWING..., MILLING..., DRILLING..., TURNING..., WATERJET CUTTING..., AND LASER CUTTING.

--- TOUCH BLACK ---

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 29. 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...,

Copyright © 2002 Society of Manufacturing Engineers TABLE SAWS...,

AND MITER SAWS.

--- TOUCH BLACK ---

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 31.
continue previous shot
tape 720, 06:27:55-06:28:08
routing of plastic part
CG, SUPER: Routing

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

SCENE 30.

end mill

CG, SUPER: Milling

NARRATION (VO):

THERE ARE MANY VARIETIES OF MILLING OPERATIONS AND CUTTERS, BUT THE PRIMARY TYPE USED TO MACHINE PLASTICS IS ROUTING, TYPICALLY WITH AN END-MILL CUTTER.

SCENE 32.
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 33.
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 34. CG, SUPER: Drilling tape 723, 09:29:21-09:29:53 pan, drilling in plastic part on

NARRATION (VO):

tape 723, 09:29:21-09:29:53 THE DRILLING OF CYLINDRICAL HOLES IN PLASTICS IS

--- 7 ---

Copyright © 2002 Society of Manufacturing Engineers --- 8 --mill ACCOMPLISHED BY THE RELATIVE ROTATION OF A tape 734, 21:09:40-21:09:56 drilling on lathe 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 35.

NARRATION (VO):

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

SCENE 36.

tape 728, 15:18:45-15:18:55
zoom out, chips coming out of

hole being drilled on lathe

NARRATION (VO):

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 37.
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

DIAMOND-TIPPED.

SCENE 38.
tape 735, 22:05:53-22:06:22
c.u., zoom out, drilling
operation with emphasis on drill
flutes

NARRATION (VO):

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

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

--- 9 ---

SPEED IN AN ENCLOSED SPACE. FOR THIS REASON DRILL

FLUTES SHOULD BE HIGHLY POLISHED.

SCENE 39. 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 40.

tape 734, 21:25:53-21:26:17
drilling operation changing over
to tapping operation
CG, SUPER: Tapping
tape 703, 17:11:50-17:11:56
reaming operation
CG, SUPER: Reaming

NARRATION (VO):

ONCE PLASTIC PARTS HAVE BEEN DRILLED THERE ARE NUMEROUS HOLE FINISHING OPERATIONS THAT CAN BE PERFORMED, WITH TWO OF THE MOST COMMON BEING: TAPPING...,

AND REAMING.

SCENE 41. 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 42.

SCENE 43.

NARRATION (VO):

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

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.

NARRATION (VO):

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 ENLARGES A CYLINDRICAL HOLE TO ITS FINAL SIZE AND GIVES IT A GOOD FINISH. IT REMOVES ONLY A Copyright © 2002 Society of Manufacturing Engineers --- 10 --reaming operation SMALL AMOUNT OF MATERIAL. REAMERS ARE FLUTED,

> MULTI-EDGE TOOLS, MADE TO CLOSE DIAMETRAL TOLERANCES. REAMERS ARE TYPICALLY MADE OF CARBIDE TO MINIMIZE WEAR.

NARRATION (VO):

tape 734, 21:25:15-21:25:26 drilling operation emphasizing hole produced

SCENE 44.

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
tapping operation with coolant

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 SPRING-BACK, DRILLS...,

TAPS...,

REAMERS...,

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

--- TOUCH BLACK ---

NARRATION (VO):

SCENE 45. 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

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 46. 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 47. 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 LATHE USING A CHUCK ..., 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

OR COLLET..,

THEY MAY ALSO BE HELD AT BOTH ENDS, WHICH IS KNOWN

AS 'BETWEEN CENTERS' TURNING.

--- TOUCH BLACK ---

SCENE 48.

CG, SUPER: Waterjet Cutting tape 730, 00:08:18-00:08:27 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

NARRATION (VO):

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 49. 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 50. 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 51. tape 716, 01:11:52-01:12:11

NARRATION (VO):

--- 11 ---

Copyright © 2002 Society of Manufacturing Engineers --- 12 ---THE TWO MOST COMMON TYPES OF LASERS INCLUDE: laser trimming part CG, SUPER: Carbon Dioxide/CO2 THE CARBON DIOXIDE, OR CO2, GAS LASER, Gas Laser Neodymium-Doped Yttrium-Aluminum AND THE NEODYMIUM-DOPED YTTRIUM-ALUMINUM GARNET, Garnet/YAG Solid-State Laser OR 'YAG', SOLID-STATE LASER.

--- FADE TO BLACK ---

SCENE 52. CG: Plastics Assembly white text centered on black

SCENE 53.

- tape 739, 01:11:33-01:22:14 peter carey narration tape 724, 11:01:00-11:03:00 GRAPHIC: sme branding logo tape 736, 23:13:43-23:13:53 ultrasonic insertion welding of plastic parts tape 735, 22:27:36-22:27:49 bonding of plastic parts CG, SUPER: Part Materials Product Design
 - End Use Conditions of the Finished Product

NARRATION (VO):

THERE ARE MANY METHODS OF ASSEMBLING, OR JOINING, PLASTIC-TO-PLASTIC, AND PLASTIC-TO-METAL PARTS TOGETHER. VARIABLES SUCH AS PART MATERIALS, PRODUCT DESIGN, AND THE END USE CONDITIONS OF THE FINISHED PRODUCT MUST BE CONSIDERED WHEN DESIGNING AN ASSEMBLY METHOD.

NARRATION (VO):

SCENE 54.

tape 722, 08:02:54-08:03:03 manual assembly operation tape 664, 01:00:42-01:00:52 automatic assembly operation

SCENE 55. tape 736, 23:10:20-23:10:29 plastic parts being ultrasonically welded together CG, SUPER: Snap-Fits tape 658, 14:05:18-14:05:24 snap-fit components clipped together CG, SUPER: Hinges tape 721, 07:23:19-07:23:26 c.u. hinge CG, SUPER: Mechanical Fasteners tape 658, 14:01:34-14:01:39 mechanical fastener being tighten on plastic part CG, SUPER: Bonding tape 718, 04:04:32-04:04:40

ASSEMBLY OPERATIONS CAN BE PERFORMED EITHER MANUALLY...,

OR AUTOMATICALLY.

NARRATION (VO):

THE MOST COMMON METHODS OF ASSEMBLING PLASTIC COMPONENTS TOGETHER INCLUDE THE USE OF: SNAP-FITS..., HINGES..., MECHANICAL FASTENERS..., BONDING..., AND WELDING.

--- 13 ---

Copyright © 2002 Society of Manufacturing Engineers adhesive bonding of plastic parts CG, SUPER: Welding tape 726, 13:21:29-13:21:34 ultrasonic welding of plastic parts

SCENE 56. CG, SUPER: Snap-Fits tape 738, 01:20:43-01:20:52 c.u. part with snap fit tape 725, 12:28:35-12:28:45 snap fit part coming out of injection mold tape 738, 01:22:03-01:22:08 side view same part being snap fit into another part tape 738, 01:23:54-01:23:59 c.u. snap fit snapping into place tape 658, 14:05:51-14:05:56 c.u. snap fit operation tape 738, 01:16:33-01:16:41 snap-fit part being disassembled

SCENE 57.

Fits

NARRATION (VO):

SNAP-FITS ARE INTEGRAL FASTENERS MOLDED INTO PLASTIC PARTS, WHICH WHEN ASSEMBLED, LOCK INTO PLACE. SNAP-FITS ARE QUICK AND EASY TO USE IN PERMANENT ASSEMBLY OPERATIONS, AND FOR WHEN DISASSEMBLY IS REQUIRED.

--- TOUCH BLACK ---

NARRATION (VO):

snap fit part being assembled SOME COMMON TYPES OF SNAP-FITS INCLUDE: tape 737, 00:00:54-00:01:00 ANI: cantilever snap fit pushed into place CG, SUPER: Cantilever Arm/Beam AND ANNULAR, OR RING, SNAP FITS.

--- TOUCH BLACK ---

SCENE 58. tape 721, 07:23:38-07:23:55 zoom out, part with hinge CG, SUPER: Hinges tape 727, 14:01:32-14:01:42 zoom in, part with integrated hinge CG, SUPER: One-Piece Integral Hinges tape 738, 01:10:16-01:10:34 zoom out, part with two piece integrated hinge CG, SUPER: Two-Piece Integral Hinges tape 738, 01:15:08-01:15:16 c.u. part with multi-part hinge

NARRATION (VO):

HINGES ARE USED IN ASSEMBLIES REQUIRING REPEATED OPENING AND CLOSING, AND ARE PRIMARILY DIVIDED INTO THREE CATEGORIES: ONE-PIECE INTEGRAL HINGES..., TWO-PIECE INTEGRAL HINGES..., AND MULTI-PART HINGES. Copyright © 2002 Society of Manufacturing Engineers CG, SUPER: Multi-Part Hinges

NARRATION (VO):

ONE-PIECE INTEGRAL HINGES ARE THIN, FLEXIBLE INTEGRAL HINGES CONNECTING PART COMPONENTS TOGETHER. THE LIVING HINGE IS THE MOST COMMON TYPE OF ONE-PIECE INTEGRAL HINGE, AND IS TYPICALLY CREATED BETWEEN THE PART COMPONENTS DURING THE INJECTION MOLDING PROCESS.

SCENE 60.
CG, SUPER: Two-Piece Integral
 Hinges
tape 738, 01:06:00-01:06:19
zoom out, part with two-piece
hinge

CG, SUPER: One-Piece Integral

Hinges tape 727, 14:08:01-14:08:10 part with integrated hinge

CG, SUPER: The Living Hinge tape 727, 14:06:33-14:06:48 part with living hinge

opening and closing

SCENE 59.

NARRATION (VO):

TWO-PIECE INTEGRAL HINGES HAVE ALL THE HINGE COMPONENTS MOLDED INTO THE PLASTIC PARTS, BUT ARE MANUFACTURED AS SEPARATE ELEMENTS AND ASSEMBLED AFTERWARDS.

SCENE 61. CG, SUPER: Multi-Part Hinges tape 738, 01:08:32-01:08:53 pan, multi-part hinge moving

NARRATION (VO):

MULTI-PART HINGES ARE USED IN APPLICATIONS WHERE ONE- AND TWO-PIECE HINGES ARE NOT WELL SUITED, SUCH AS THOSE REQUIRING HEAVY LOADING, AND LOW-PRODUCTION VOLUMES.

SCENE 62.
continue previous shot
tape 738, 01:13:50-01:14:06
multi-part hinge moving

NARRATION (VO):

THE THREE-PIECE LUG-AND-PIN HINGE IS THE MOST COMMON TYPE OF MULTI-PART HINGE. EACH PART HALF CONTAINS A COMPONENT OF THE MOLDED HINGE DESIGN. THE THIRD PIECE IS TYPICALLY A METAL PIN OR RIVET INSERTED THROUGH THE HINGE COMPONENTS.

--- TOUCH BLACK ---

SCENE 63. CG, SUPER: Mechanical Fasteners tape 719, 05:16:21-05:16:36

NARRATION (VO):

Copyright © 2002 Society of Manufacturing Engineers zoom in, mechanical fasteners used to assemble plastic parts together CG, SUPER: Threaded Fasteners tape 658, 14:03:42-14:03:48 c.u. threaded fastener CG, SUPER: Non-Threaded Fasteners tape 738, 01:01:03-01:01:12 zoom in, eyelets on part

tape 738, 01:01:23-01:01:29

plastic parts with rivets

MECHANICAL FASTENERS ARE A FREQUENTLY USED, LOW-COST MEANS OF ASSEMBLING AND HOLDING SIMILAR OR DISSIMILAR PLASTIC PART COMPONENTS TOGETHER. THERE ARE NUMEROUS MECHANICAL FASTENING TYPES, WITH THE MOST COMMON INCLUDING: THREADED FASTENERS...,

--- 15 ---

AND NON-THREADED FASTENERS, SUCH AS EYELETS..., AND RIVETS.

SCENE 64.

CG, SUPER: Threaded Fasteners tape 736, 23:05:21-23:05:40 wide, threaded fasteners used in assembly tape 718, 04:29:03-04:29:19 part being disassembled CG, SUPER: Self-Tapping Screw tape 719, 05:18:35-05:18:42 self-tapping screws used in assembly

SCENE 65. continue previous shot tape 719, 05:13:29-05:13:38 self-tapping screws used in assembly

SCENE 66. tape 736, 23:15:31-23:15:50 zoom in, threaded metal insert being added to part ultrasonically

NARRATION (VO):

THREADED FASTENERS ARE THE MOST FREQUENTLY USED FASTENER TYPE FOR PLASTIC PART ASSEMBLY. THEY COME IN A VARIETY OF STYLES, AND ARE COMMONLY USED WHEN DISASSEMBLY AND REASSEMBLY OF COMPONENTS IS REQUIRED. ONE COMMON TYPE OF THREADED FASTENER IS THE SELF-TAPPING SCREW.

NARRATION (VO):

SELF-TAPPING SCREWS HOLD PLASTIC ASSEMBLIES TOGETHER BY TAPPING, OR CREATING, A THREAD IN THE PLASTIC AS THE SCREW IS INSTALLED.

NARRATION (VO):

IF DIRECT SCREW-TO-PLASTIC CONTACT DOES NOT PROVIDE ENOUGH RETENTION STRENGTH, THEN THE ADDITION OF A THREADED METAL INSERT IN THE PLASTIC PART IS RECOMMENDED.

--- TOUCH BLACK ---

SCENE 67. CG, SUPER: Bonding tape 735, 22:28:15-22:28:32 plastic parts being bonded

NARRATION (VO):

THE USE OF BONDING METHODS IN JOINING TOGETHER

Copyright © 2002 Society of Manufacturing Engineers --- 16 --together PLASTIC COMPONENTS IS WIDE SPREAD IN

> MANUFACTURING. BONDING FORMS PERMANENT JOINTS THAT CANNOT BE DISASSEMBLED WITHOUT DAMAGING OR DESTROYING COMPONENTS.

NARRATION (VO):

continue previous shot tape 719, 05:06:34-05:06:43 zoom out, plastic parts being adhesive bonded together CG, SUPER: Adhesive Bonding tape 721, 07:26:42-07:26:49 plastic parts being solvent bonded together CG, SUPER: Solvent Bonding

SCENE 68.

SCENE 69. CG, SUPER: Adhesive Bonding tape 726, 13:22:00-13:22:08 plastic parts being adhesive bonded together tape 726, 13:25:35-13:25:52 zoom out, adhesive bonded parts coming out of ultraviolet curing

THE BONDING OF PLASTICS CAN BE ARRANGED INTO TWO MAIN CATEGORIES: ADHESIVE BONDING..., AND SOLVENT BONDING.

NARRATION (VO):

ADHESIVE BONDING USES ADHESIVES THAT JOIN COMPONENTS TOGETHER WHILE ADHERING TO THE SURFACE OF THE PLASTIC. ADHESIVE BONDING COMPOUNDS TYPICALLY REQUIRE CURING, OR POLYMERIZATION, TO ACHIEVE THEIR BOND.

NARRATION (VO):

SOLVENT BONDING USES CEMENTS THAT MELT THE SURFACE OF THE PLASTIC COMPONENTS BEING BONDED, CAUSING A MOLECULAR INTERLOCKING WELD BETWEEN THE PARTS UPON EVAPORATION.

SCENE 70. CG, SUPER: Solvent Bonding tape 718, 04:25:57-04:26:01 zoom out, plastic parts being solvent bonded together tape 737, 00:01:28-00:01:34 ANI: solvent bonding, molecular interlocking weld between the part surfaces upon evaporation tape 737, 00:01:46-00:01:55 ANI: c.u. molecular interlocking weld between the part surfaces,

SCENE 71.

tape 735, 22:26:50-22:27:18

GRAPHIC: add red circle cut-out

thermoplastic plastic parts being solvent bonded together CG, SUPER: Cyanacrylate CG, SUPER: Methylethylketone Methylene Chloride Acetone

NARRATION (VO):

BONDING COMPOUNDS FOR THERMOPLASTICS CAN BE EITHER ADHESIVE- OR SOLVENT-BASED. CYANACRYLATE IS THE MOST COMMON BONDING ADHESIVE, AND METHYLENE CHLORIDE,

AND ACETONE ARE THE MOST COMMON BONDING SOLVENTS.

SCENE 72.

SCENE 74.

NARRATION (VO):

tape 698, 02:29:01-02:29:23

zoom in, adhesive being applied to thermoset plastic part CG, SUPER: Epoxies Polyurethanes Silicone Adhesives

BONDING COMPOUNDS FOR THERMOSETS, SINCE THEY CANNOT BE RESOFTENED, ARE ONLY ADHESIVE-BASED. THE MOST COMMON TYPES OF THESE BONDING COMPOUNDS INCLUDE THE EPOXIES, POLYURETHANES,

AND SILICONE ADHESIVES.

SCENE 73. tape 736, 23:08:31-23:08:55 cleaning of plastics before bonding

NARRATION (VO):

SURFACE CLEANLINESS IS CRITICAL FOR OPTIMUM BONDING PERFORMANCE. ALL GREASE, MOLD RELEASE AND OTHER CONTAMINANTS MUST BE REMOVED FROM THE CONTACT SURFACES, OR JOINT REGION, BEFORE BONDING.

tape 718, 04:02:33-04:02:40 zoom out, joint of plastic parts being bonded together tape 737, 00:02:03-00:02:24 ANI: bonded joint being pulled side to side for shear strength, out top and bottom for tensile strength, then in from top and bottom for compressive strength, show arrows too CG, SUPER: Shear Strength CG, SUPER: Tensile Strength CG, SUPER: Compressive Strength

NARRATION (VO):

CAREFUL ATTENTION MUST ALSO BE PAID TO JOINT DESIGN WHEN BONDING TOGETHER PLASTIC COMPONENTS. JOINT SURFACES THAT COMBINE SHEAR STRENGTH..., TENSILE STRENGTH...,

AND COMPRESSIVE STRENGTH ARE PREFERRED.

SCENE 75. tape 737, 00:03:44-00:03:53 ANI: lap joints CG, SUPER: Lap Joints tape 737, 00:02:48-00:02:55 ANI: strap joints CG, SUPER: Strap Joints tape 737, 00:03:01-00:03:08 ANI: butt joints

NARRATION (VO):

TYPICAL JOINT DESIGNS INCLUDE: LAP JOINTS..., STRAP JOINTS...,

--- 17 ---

Copyright © 2002 Society of Manufacturing Engineers CG, SUPER: Butt Joints tape 737, 00:03:14-00:03:22 ANI: tongue-and-groove joints CG, SUPER: Tongue-&-Groove Joints tape 737, 00:03:27-00:03:34 ANI: scarf joints CG, SUPER: Scarf Joints

SCENE 76. CG, SUPER: Welding tape 626, 06:07:22-06:07:43 zoom out, ultrasonically welding plastic parts together

BUTT JOINTS..., TONGUE-AND-GROOVE JOINTS...,

AND SCARF JOINTS.

--- TOUCH BLACK ---

NARRATION (VO):

WELDING IS THE JOINING, OR COALESCENCE, OF THERMOPLASTIC COMPONENTS TOGETHER. WELDING PROVIDES AN EXCEPTIONAL JOINT THAT IS AS STRONG AS THE SURROUNDING PLASTIC.

NARRATION (VO):

continue previous shot tape 729, 17:16:12-17:16:19 hot-gas welding operation tape 733, 20:14:00-20:14:06 vibration welding tape 731, 18:14:50-18:14:53 spin welding operation, freeze last frame CG, SUPER: Spin Welding tape 729, 17:05:42-17:05:49 hot-gas welding operation CG, SUPER: Hot-Gas Welding tape 725, 12:14:30-12:14:38 ultrasonic welding operation CG, SUPER: Ultrasonic Welding tape 731, 18:17:34-18:17:41 vibration welding operation CG, SUPER: Vibration Welding tape 732, 19:07:11-19:07:23 staking operation CG, SUPER: Staking

SCENE 77.

THERE ARE VARIOUS TYPES OF WELDING PROCESSES USED TO ASSEMBLE PLASTIC COMPONENTS TOGETHER, WITH THE PRIMARY TYPES INCLUDING: SPIN WELDING..., HOT-GAS WELDING..., ULTRASONIC WELDING..., VIBRATION WELDING..., AND STAKING.

--- TOUCH BLACK ---

SCENE 78. CG, SUPER: Spin Welding tape 731, 18:15:22-18:15:27 spin welding operation, freeze last frame tape 733, 20:06:04-20:06:38 zoom in, spin welding operation

NARRATION (VO):

SPIN WELDING IS A RAPID METHOD OF WELDING PLASTIC COMPONENTS, TYPICALLY IN BUTT JOINTS, BY FRICTIONAL HEAT. FRICTIONAL HEAT IS GENERATED BY RAPIDLY SPINNING A WORKPIECE AT UP TO 5,000 REVOLUTIONS PER MINUTE AGAINST A STATIONARY

--- 18 ---

Copyright © 2002 Society of Manufacturing Engineers --- 19 ---WORKPIECE. AS THE CONTACT SURFACES HEAT, THEY

MELT, FUSING THE TWO PLASTIC WORKPIECES TOGETHER.

SCENE 79. CG, SUPER: Hot Gas Welding tape 729, 17:17:37-17:18:15 zoom out, hot-gas welding operation

NARRATION (VO):

HOT-GAS WELDING FUSES PLASTIC COMPONENTS TOGETHER USING A WELDING ROD COMPOSED OF THE SAME PLASTIC AS THE MATERIAL TO BE JOINED. HOT GAS IS CREATED BY PASSING EITHER AIR OR INERT GAS OVER HEATING ELEMENTS WITHIN THE WELDING GUN. AS THIS HEAT EXITS THE GUN, IT MELTS THE PLASTIC WELDING ROD, AS WELL AS THE PLASTIC TO BE JOINED, FUSING THE MATERIALS.

SCENE 80. tape 729, 17:06:43-17:07:00 med, hot-gas welding operation

NARRATION (VO):

MATERIALS MOST SUCCESSFULLY JOINED USING HOT-GAS WELDING INCLUDE RIGID POLYVINYL CHLORIDE OR 'PVC', 'ABS', ACRYLICS, POLYETHYLENE, POLYPROPYLENE, POLYSTYRENE, AND POLYCARBONATE.

SCENE 81. CG, SUPER: Ultrasonic Welding tape 726, 13:18:08-13:18:33 zoom in, ultrasonic welding operation

NARRATION (VO):

ULTRASONIC WELDING USES HIGH-FREQUENCY, LONGITUDINAL MECHANICAL VIBRATIONS TO WELD TOGETHER THERMOPLASTIC COMPONENTS, OR PLASTIC-TO-METAL COMPONENTS.

SCENE 82. continue previous shot

NARRATION (VO):

THESE MECHANICAL VIBRATIONS ARE IN THE RANGE OF 15,000 TO 40,000 CYCLES PER SECOND, OR 15 TO 40 KILOHERTZ. THE VIBRATIONS CAUSE INTERMOLECULAR AND SURFACE FRICTIONAL HEAT, THAT QUICKLY MELTS AND FUSES THE COMPONENTS.

SCENE 83. tape 731, 18:03:02-18:03:20 wide, ultrasonic welding operation, zoom in to power supply CG, SUPER: Power Supply tape 731, 18:07:21-18:07:44 tilt down open front of ultrasonic welding machine CG, SUPER: Converter CG, SUPER: Booster CG, SUPER: Horn tape 731, 18:09:04-18:09:22 zoom in horn during ultrasonic welding NARRATION (VO):

THE PRIMARY ELEMENTS OF AN ULTRASONIC WELDING SYSTEM INCLUDE: THE POWER SUPPLY, WHICH RECEIVES ELECTRICAL POWER AND AMPLIFIES IT TO 15 TO 40 KILOHERTZ, THE CONVERTER, WHICH CONVERTS THE 15 TO 40 KILOHERTZ ELECTRICAL INPUT TO 15 TO 40 KILOHERTZ MECHANICAL VIBRATORY OUTPUT...,

THE BOOSTER, WHICH INCREASES OR DECREASES THE AMPLITUDE OF THE MECHANICAL VIBRATION..., AND THE HORN, WHICH CONTACTS THE PARTS AND FOCUSES THE MECHANICAL VIBRATIONS UNDER PRESSURE FOR WELDING.

SCENE 84. tape 725, 12:18:52-12:19:03 ultrasonic welding operation

NARRATION (VO):

ULTRASONIC WELDING IS USED EXTENSIVELY THROUGHOUT THE PLASTICS INDUSTRY.

SCENE 85. CG, SUPER: Vibration Welding tape 733, 20:16:28-20:16:38 c.u. vibration welding

NARRATION (VO):

VIBRATION WELDING USES FRICTIONAL HEAT GENERATED BY VIBRATING A PART COMPONENT AGAINST A STATIONARY MATING COMPONENT IN EITHER A LINEAR OR ORBITAL MOTION TO WELD THEM TOGETHER.

SCENE 86. tape 731, 18:24:16-18:24:32 med, part set up and vibration welded

NARRATION (VO):

THE FREQUENCY OF VIBRATION IS MUCH LOWER THAN WITH ULTRASONIC WELDING, TYPICALLY 120 OR 240 HERTZ.

SCENE 87.
tape 733, 20:11:14-20:11:21
wide, part placed in machine,
vibration welding beginning, cut
to next shot

tape 733, 20:15:56-20:16:05

NARRATION (VO):

AS THE PARTS ARE VIBRATED AGAINST EACH OTHER, A MELT FILM IS FORMED. ONCE VIBRATION STOPS THE

Copyright © 2002 Society of Manufacturing Engineers --- 21 --c.u. vibration welding in PARTS ARE QUICKLY POSITIONED UNDER PRESSURE. THE progress, stopping MELT FILM IS THEN ALLOWED TO SOLIDIFY, CREATING

THE WELD.

SCENE 88.

SCENE 90.

NARRATION (VO):

CG, SUPER: Staking

tape 732, 19:09:32-19:09:48
c.u. plastic to plastic staking
operation
tape 732, 19:06:14-19:06:26

zoom out, heat staking operation

STAKING IS A METHOD OF APPLYING ENERGY AGAINST A THERMOPLASTIC PROTRUSION THAT IS PASSED THROUGH A TO-BE-ASSEMBLED COMPONENT. THE ENERGY HEATS AND SOFTENS THE PROTRUSION, WHICH IS THEN REFORMED INTO A HEAD, MECHANICALLY RETAINING THE COMPONENT. STAKING IS USED TO ASSEMBLE THERMOPLASTIC COMPONENTS TO OTHER PLASTIC, METAL OR COMPOSITE MATERIALS.

NARRATION (VO):

SCENE 89.
tape 732, 19:07:48-19:07:57
zoom in, heat staking operation
CG, SUPER: Heat Staking
tape 733, 20:18:06-20:18:08
ultrasonic staking operation,
freeze last frame
CG, SUPER: Ultrasonic Staking

CG, SUPER: Heat Staking tape 732, 19:10:23-19:10:34

heat staking operation

STAKING IS PERFORMED USING TWO PRIMARY METHODS: HEAT STAKING..., AND ULTRASONIC STAKING.

NARRATION (VO):

WITH HEAT STAKING THE ENERGY IS APPLIED USING A HEATED TOOL CALLED A 'PROBE' THAT IMPACTS AND MELTS THE PROTRUSION, FORMING THE HEAD AND ASSEMBLING THE COMPONENTS.

SCENE 91. CG, SUPER: Ultrasonic Staking tape 733, 20:18:13-20:18:30 zoom out, plastic to plastic ultrasonic staking operation

NARRATION (VO):

WITH ULTRASONIC STAKING, THE ENERGY IS APPLIED USING AN ULTRASONIC TOOL OR HORN, WHICH CAUSES FRICTION AND RESULTANT MELTING OF THE PROTRUSION FOR ASSEMBLY.

SCENE 92. CG: Review white text centered on black tape 739, 01:22:17-01:25:06 peter carey narration tape 63, 12:00:15-12:03:49 review music

SCENE 93. 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

SCENE 94.

SCENE 95.

SCENE 96.

continue previous shot

MUSIC UP AND UNDER

NARRATION (VO):

LET'S REVIEW THE MATERIAL CONTAINED IN THIS VIDEOTAPE.

--- FADE TO BLACK ---

NARRATION (VO):

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

NARRATION (VO):

tape 719, 05:22:33-05:22:53 zoom out, drilling of injection MACHINING PROCESSES ARE USED AS SECONDARY 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

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.

NARRATION (VO):

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 is Much Slower Than of Metals Plastics Are More Elastic & Have Lower Melting Temperatures Than Metals

THERE ARE SEVERAL KEY DIFFERENCES BETWEEN

MACHINING PLASTICS AND MACHINING METALS,

INCLUDING:

Heat Loss of Plastics 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.

NARRATION (VO):

--- 22 ---

BECAUSE OF THESE DIFFERENCES, CUTTING TOOL SPEEDS

AND FEEDS ARE ADJUSTED TO MACHINE PLASTIC PARTS.

SCENE 97. tape 736, 23:17:28-23:17:51 zoom out, plastic part being machined using coolant

THE USE OF COOLANT MAY BE REQUIRED TO REDUCE THE FRICTIONAL HEAT THAT BUILDS IN PLASTIC PARTS WHILE BEING MACHINED.

NARRATION (VO):

NARRATION (VO):

SCENE 98.
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

SCENE 99. continue previous shot tape 729, 16:03:55-16:04:05 sawing plastics CG, SUPER: Sawing tape 723, 09:21:57-09:22:11 zoom in, milling of plastics CG, SUPER: Milling tape 720, 06:27:55-06:28:08 routing of plastic part CG, SUPER: Routing tape 728, 15:21:38-15:21:50 turning of plastics CG, SUPER: Turning tape 730, 00:00:55-00:01:03 waterjet cutting of plastics CG, SUPER: Waterjet Cutting tape 716, 01:09:50-01:09:56 laser cutting of plastics CG, SUPER: Laser Cutting tape 734, 21:25:50-21:25:59 drilling then tapping of plastics CG, SUPER: Drilling CG, SUPER: Tapping tape 735, 22:12:15-22:12:35 c.u., zoom out, reaming operation CG, SUPER: Reaming

TYPICAL COOLANTS USED FOR MACHINING PLASTICS INCLUDE CLEAN COMPRESSED AIR..., AND THE USE OF MIST SPRAYS, WATER-SOLUBLE OILS, LIGHT CUTTING OILS, AND OTHER SOLUTIONS.

NARRATION (VO):

THE PRIMARY TYPES OF OPERATIONS USED TO MACHINE PLASTICS INCLUDE: SAWING..., MILLING..., ROUTING..., TURNING..., WATERJET CUTTING..., LASER CUTTING..., DRILLING..., AND SECONDARY HOLE FINISHING OPERATIONS, SUCH AS TAPPING..., AND REAMING. ---- TOUCH BLACK ----

SCENE 100. tape 736, 23:13:43-23:13:53 NARRATION (VO):

Copyright © 2002 Society of Manufacturing Engineers --- 24 --ultrasonic insertion welding of THERE ARE MANY METHODS OF ASSEMBLING, OR JOINING, plastic parts tape 735, 22:27:36-22:27:49 PLASTIC-TO-PLASTIC, AND PLASTIC-TO-METAL PARTS bonding of plastic parts CG, SUPER: Part Materials TOGETHER. VARIABLES SUCH AS PART MATERIALS, Product Design End Use Conditions of PRODUCT DESIGN, AND END USE CONDITIONS OF THE the Finished Product FINISHED PRODUCT MUST BE CONSIDERED WHEN DESIGNING AN ASSEMBLY METHOD. SCENE 101. NARRATION (VO): tape 719, 05:16:21-05:16:36 plastic parts being THE MOST COMMON METHODS OF ASSEMBLING PLASTIC ultrasonically welded together CG, SUPER: Snap-Fits COMPONENTS TOGETHER INCLUDE THE USE OF: tape 658, 14:05:18-14:05:24 snap-fit components clipped SNAP-FITS..., together CG, SUPER: Hinges HINGES..., tape 721, 07:23:19-07:23:26 c.u. hinge MECHANICAL FASTENERS..., CG, SUPER: Mechanical Fasteners ADHESIVE BONDING..., tape 658, 14:01:34-14:01:39 mechanical fastener being tighten on plastic part SOLVENT BONDING..., CG, SUPER: Adhesive Bonding tape 719, 05:06:34-05:06:43 AND THE VARIOUS WELDING PROCESSES, INCLUDING: adhesive bonding of plastic parts SPIN WELDING..., CG, SUPER: Solvent Bonding tape 718, 04:25:57-04:26:04 HOT-GAS WELDING..., solvent bonding of plastic parts CG, SUPER: Welding ULTRASONIC WELDING..., tape 626, 06:07:22-06:07:43 zoom out, ultrasonically welding VIBRATION WELDING..., plastic parts together CG, SUPER: Spin Welding HEAT STAKING..., tape 733, 20:06:04-20:06:38 zoom in, spin welding operation AND ULTRASONIC STAKING. CG, SUPER: Hot-Gas Welding tape 729, 17:05:42-17:05:49 --- FADE TO BLACK --hot-gas welding operation CG, SUPER: Ultrasonic Welding tape 725, 12:14:30-12:14:38 ultrasonic welding operation CG, SUPER: Vibration Welding tape 733, 20:16:28-20:16:38 vibration welding operation CG, SUPER: Heat Staking tape 732, 19:10:23-19:10:34 heat staking operation CG, SUPER: Ultrasonic Staking tape 733, 20:18:13-20:18:30 zoom out, plastic to plastic ultrasonic staking operation

SCENE 102.
CG, ROLL: credits
white text on black, fade up
mid-screen
tape 715, 20:01:10-20:01:50
GRAPHIC: PMMA logo

Produced By: the Society of Manufacturing Engineers

Executive Producer: Steven R. Bollinger

Producer/Director/Cameraman: Jerome T. Cook

Written By: Douglas Bryce, Texas Plastic Technologies

> Graphics By: Dennis Summers, Quantum Dance Works Jerome T. Cook

Equipment Access Provided By: Alro Plastics ATEK Thermoforming, Inc. Branson Ultrasonics Corporation Eastern Plastics, Inc. Exotic Rubber & Plastics Corp. Kreuter Manufacturing Co., Inc. Plastic Assembly Systems Sonitek Stellar Plastics Total Plastics Inc. Triple S Plastics, Inc.

Additional Materials Provided By: Flow International Corporation

--- 25 ---

Copyright $\ensuremath{\mathbb{C}2002}$ Society of Manufacturing Engineers

--- 26 ---

Technical & Editorial Consulting: Richard J. Klein Steven J. Sabol

Production Assistance Provided By: Dennis Dittel

> Aimee Longato George Odell Dave Wason

Video Editing: Communicore

SCENE 103. CG: disclaimer white text centered on black Always read the safety information provided in the manufacturers' manual before machine operation.

SCENE 104. **tape 40, 01:00:00-01:00:12** SME logo, with music CG, SUPER: www.sme.org