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FUNDAMENTAL MANUFACTURING PROCESSES

Rapid Prototyping

SCENE 1.
RP01A, CG: FBI warning
white text centered on black to blue gradient

WARNING

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SCENE 2.
RP02A, CG: disclaimer
white text centered on black to blue gradient

Always read the operating manual and safety information provided by the manufacturer before operating any rapid prototyping equipment. Make sure all machine guards are in place, and follow all safety procedures when working with or near rapid prototyping equipment.

SCENE 3.
RP03A, CG: RPA screen A
white text centered on black to blue gradient
GRAPHIC: RPA logo

This program was produced using the technical resources of The Rapid Prototyping Association of The Society of Manufacturing Engineers.

SCENE 4.
continue RPA logo graphic
RP04A, CG: RPA screen B
white text centered on black to blue gradient

For more information on rapid prototyping, please visit our website at:

www.sme.org/rpa

SCENE 5.
RP05A, tape 40, 01:00:00-01:00:12
SME logo, with music
CG, SUPER: www.sme.org

SCENE 6.
RP06A, tape 25, 01:01:00-01:01:45
fundamental series open, with music
RP06B, peter carey narration

MUSIC UP AND UNDER

NARRATION (VO):

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

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SCENE 7.
program title:
RP07A, CG: Rapid Prototyping
white text centered on black

NARRATION (VO):

THIS PROGRAM EXPLORES THE FUNDAMENTALS OF RAPID PROTOTYPING.

SCENE 8.
RP08A, tape 827, 03:05:45-03:06:00
zoom out, rapid prototyping of part
RP08B, tape 839, 16:17:45-16:18:03
rapid prototyping of part
RP08C, tape 835, 12:25:49-12:26:03
laying foil in ultrasonic consolidation operation
RP08D, tape 835, 12:28:12-12:28:20
milling of foil in ultrasonic consolidation operation
RP08E, tape 828, 06:05:40-06:05:53
rtv operation, pulling mold halves apart

NARRATION (VO):

RAPID PROTOTYPING IS A GENERAL TERM ENCOMPASSING A VARIETY OF SYSTEMS USED TO CREATE THREE-DIMENSIONAL PHYSICAL MODELS DIRECTLY FROM ELECTRONIC DATA. THESE RAPID PROTOTYPING SYSTEMS PRIMARILY CREATE MODELS USING A LAYER-BY-LAYER, OR ADDITIVE, MEANS OF CONSTRUCTION. MORE RECENTLY THOUGH, SYSTEMS USING A COMBINATION OF

ADDITIVE...,

AND SUBTRACTIVE LAYERING...,

AND PATTERN-BASED RAPID PROTOTYPING PROCESSES HAVE DEVELOPED.

SCENE 9.
RP09A, tape 844, 21:08:05-21:08:30
early rapid prototyping footage

NARRATION (VO):

THE RAPID PROTOTYPING INDUSTRY BEGAN WITH THE DEVELOPMENT OF THE FIRST RAPID PROTOTYPING TECHNOLOGY IN THE MID-1980’S.

SCENE 10.
RP10A, tape 830, 08:05:01-08:05:15
zoom in, rapid prototyping computer screen
RP10B, tape 670, 02:12:42-02:13:09
solid model representation of part

NARRATION (VO):

RAPID PROTOTYPING TECHNOLOGIES ARE BASED ON THE SOLID MODELING PORTION OF COMPUTER-AIDED DESIGN, OR 'CAD'. SOLID MODELING INVOLVES USING 'CAD' MODEL DATA TO FULLY DESCRIBE A PART'S SHAPE, INCLUDING IT'S INTERIOR VOLUME AND OUTSIDE SURFACES.

SCENE 11.
RP11A, tape 840, 17:39:05-17:39:37

NARRATION (VO):

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complex shaped rapid prototyped part being built
RP11B, tape 840, 17:55:00-17:55:12
complex shaped rapid prototyped part coming out of process

RAPID PROTOTYPING SYSTEMS USE THIS SOLID MODELING DATA TO BUILD FABRICATIONS LAYER-BY-LAYER IN EXTREMELY THIN CROSS-SECTIONS. THESE CROSS-SECTIONS, OR SLICES, ARE STACKED ONE ATOP ANOTHER IN SUCCESSION UNTIL THE SHAPE IS COMPLETE. THIS PERMITS MANUFACTURE OF INTRICATE AND COMPLEX SHAPES AND SURFACES MUCH MORE SIMPLY THAN BY CONVENTIONAL METHODS.

SCENE 12.
RP12A, tape 833, 11:21:50-11:22:00
zoom out, cast fan blade
RP12B, tape 833, 11:22:44-11:22:53
zoom out, fan blade on computer screen

NARRATION (VO):

RAPID PROTOTYPING TECHNOLOGIES CAN ALSO PRODUCE MODELS USING SCAN DATA GENERATED FROM THE 3-DIMENSIONAL DIGITIZING OF EXISTING PARTS, AND MEDICAL IMAGING DEVICES.

SCENE 13.
RP13A, tape 825, 01:16:04-01:16:23
liquid based rapid prototyping system producing part
RP13B, tape 840, 17:45:50-17:45:58
powder based rapid prototyping system producing part
RP13C, tape 831, 09:25:19-09:25:34
zoom in, filament based rapid prototyping system producing part
RP13D, tape 834, 11:14:50-11:15:04
foil based rapid prototyping system producing part

NARRATION (VO):

THE MATERIALS USED FOR PRODUCING PROTOTYPES RAPIDLY ARE BROADLY CLASSIFIED AS EITHER

LIQUID...,

POWDER...,

FILAMENT...,

OR FOIL.

SCENE 14.
RP14A, tape 833, 11:19:07-11:19:16
wide, unattended rapid prototyping operation
RP14B, tape 833, 11:07:02-11:07:24
support removal from rapid prototyped part

NARRATION (VO):

TYPICALLY, RAPID PROTOTYPING SYSTEMS OPERATE UNTENDED...,

UPON COMPLETION, SOME POST PROCESSING, SUCH AS SURFACE FINISHING OR SUPPORT REMOVAL CAN BE REQUIRED. THE NET RESULT OF RAPID PROTOTYPING THOUGH IS A MARKED REDUCTION IN FABRICATION TIME

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AND COST OF MODELS.

SCENE 15.
RP15A, tape 839, 16:24:08-16:24:44
part being extracted from rapid prototyping operation
RP15B, tape 828, 06:09:02-06:09:21
rtv tooling being poured operation
RP15C, tape 829, 07:18:27-07:18:36
low volume part produced from rapid prototyped mold
RP15D, tape 459, 04:27:41-04:27:55
zoom in, investment casting operation
RP15E, still, functional prototype sprinkler in use

NARRATION (VO):

ALTHOUGH RAPID PROTOTYPING TECHNOLOGIES WERE INITIALLY DEVELOPED TO CREATE PHYSICAL MODELS FOR DESIGN APPROVAL AND PART VERIFICATION, MANY OTHER TECHNOLOGICAL APPLICATIONS HAVE EMERGED, SUCH AS:

THE CREATION OF RAPID TOOLING FOR MOLDING PROCESSES...,

LOW VOLUME PARTS PRODUCTION...,

THE MANUFACTURE OF PATTERNS FOR CASTING...,

THE PRODUCTION OF FUNCTIONAL PROTOTYPES,

AND MORE.

SCENE 16.
RP16A, tape 826, 02:16:27-02:16:37
wide, sls modeler
RP16B, tape 831, 09:09:09-09:09:24
zoom in, fdm rapid prototyping system producing part
RP16C, tape 827, 03:07:22-03:07:32
stereolithography rapid prototyping operation
CG, SUPER: Stereolithography
RP16D, tape 826, 02:10:25-02:10:32
zoom in, selective laser sintering rapid prototyping operation
CG, SUPER: Selective Laser Sintering
RP16E, tape 833, 11:04:13-11:04:21
fused deposition modeling rapid prototyping operation
CG, SUPER: Fused Deposition Modeling
RP16F, tape 834, 11:10:32-11:10:46
ultrasonic consolidation operation
CG, SUPER: Ultrasonic Consolidation
RP16G, tape 841, 00:02:11-00:02:21
pro metal system rapid prototyping operation
CG, SUPER: Pro Metal System
RP16H, tape 833, 11:18:22-11:18:32
zoom, thermojet modeler producing model
CG, SUPER: ThermoJet Modeler

NARRATION (VO):

RAPID PROTOTYPING SYSTEMS RANGE FROM LARGE MODELERS SUITABLE FOR SHOP-FLOOR AND LABORATORY ENVIRONMENTS, TO SMALLER 'DESKTOP' MODELERS.

WITHIN THIS RANGE THERE ARE NUMEROUS RAPID PROTOTYPING TECHNOLOGIES AND SYSTEMS, WITH THE PRIMARY TYPES INCLUDING:

STEREOLITHOGRAPHY...,

SELECTIVE LASER SINTERING...,

FUSED DEPOSITION MODELING...,

ULTRASONIC CONSOLIDATION...,

THE PRO METAL SYSTEM...,

THE THERMOJET MODELER...,

THE 612 MODELER...,

THE Z810 MODELER...,

THE EDEN 330 MODELER...,

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RP16I, tape 843, 12:04:48-12:04:56
612 modeler producing model
CG, SUPER: 612 Modeler
RP16J, tape 836, 13:41:53-13:42:03
Z810 modeler producing model
CG, SUPER: Z810 Modeler
RP16K, tape 830, 08:22:22-08:22:29
eden 330 modeler producing model
CG, SUPER: Eden 330 Modeler
RP16L, tape 828, 06:22:38-06:22:48
pouring of room temperature vulcanized tooling
CG, SUPER: Room Temperature Vulcanized Tooling

AND ROOM TEMPERATURE VULCANIZED TOOLING.

--- TOUCH BLACK ---

SCENE 17.
CG, SUPER: Stereolithography
RP17A, tape 827, 03:02:00-03:02:32
zoom out, stereolithography rapid prototyping operation

NARRATION (VO):

STEREOLITHOGRAPHY, FIRST OF THE RAPID PROTOTYPING TECHNOLOGIES, IS A LIQUID-BASED PROCESS FOR MAKING MODELS. THE MODELS ARE BUILT IN LAYERS WITHIN A RESERVOIR OF A LIQUID, THERMOSETTING, EPOXY-BASED, PHOTOSENSITIVE POLYMER BY SELECTIVE CURING WITH THE ULTRAVIOLET LIGHT FROM A FOCUSED LOW-POWER LASER BEAM.

SCENE 18.
RP18A, tape 825, 01:20:04-01:20:11
laser tracing part during stereolithography operation
RP18B, tape 825, 01:20:21-01:20:28
laser tracing part during stereolithography operation
RP18C, tape 825, 01:20:32-01:20:41
stereolithography platform lowering
RP18D, tape 825, 01:20:45-01:20:58
wiper dispensing polymer over model
RP18E, tape 825, 01:19:45-01:19:55
lasering of next layer beginning

NARRATION (VO):

THE LASER BEAM CONTINUOUSLY TRACES AND SELECTIVELY HARDENS THE THIN LAYER OF POLYMER ACCORDING TO THE 'CAD' FILE. ONCE TRACING OF THE LAYER IS COMPLETE, THE PLATFORM THAT THE MODEL IS BUILT ON MOVES DOWN PRECISELY ONE LAYER..., LIQUID RESIN IS THEN DISPENSED OVER THE MODEL..., AND TRACING OF THE NEXT LAYER BEGINS.

SCENE 19.
RP19A, tape 825, 01:03:36-01:03:51
stereolithography operation

NARRATION (VO):

MINIMUM LAYER, OR SLICE, THICKNESS RANGES FROM ONE THOUSANDTH OF AN INCH TO TWELVE THOUSANDTHS OF AN INCH.

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SCENE 20.
RP20A, tape 825, 01:13:38-01:13:52
stereolithography operation with supports

NARRATION (VO):

SUPPORTING RIBS, FOR OVERHANGS AND UNDERCUTS, ARE BUILT-UP ALONG WITH THE MODEL, AND LATER REMOVED BY SECONDARY OPERATIONS.

SCENE 21.
RP21A, tape 825, 01:25:39-01:26:15
completed model rising from reservoir
RP21B, tape 826, 02:02:15-02:02:25
support removal from stereolithography part
RP21C, tape 826, 02:08:21-02:08:32
additional curing of stereolithography part
RP21D, tape 826, 02:26:37-02:26:44
surface finishing of stereolithography part

NARRATION (VO):

WHEN THE MODEL IS COMPLETE, THE PLATFORM RISES OUT OF THE POLYMER RESERVOIR...,

ONCE THE EXCESS POLYMER DRAINS AWAY, THE MODEL IS REMOVED FOR POST PROCESSING, SUCH AS REMOVAL OF SUPPORTS...,

ADDITIONAL CURING...,

AND SURFACE FINISHING.

SCENE 22.
RP22A, tape 827, 03:01:07-03:01:33
zoom in, stereolithography system producing multiple parts

NARRATION (VO):

STEREOLITHOGRAPHY MACHINES CAN PRODUCE MODELS AS LARGE AS FORTY BY THIRTY TWO BY TWENTY THREE INCHES. ADDITIONALLY, MULTIPLE SMALLER MODELS OR MODEL COMPONENTS CAN BE NESTED TOGETHER FOR SIMULTANEOUS BUILDING.

SCENE 23.
RP23A, tape 825, 01:18:14-01:18:28
zoom in, stereolithography model being built
RP23B, tape 826, 02:04:35-02:04:52
post processing of stereolithography model

NARRATION (VO):

MODELS MADE BY STEREOLITHOGRAPHY CAN BE EXTREMELY PRECISE, WITH THIN AND SHARP FEATURES AND SMOOTH FINISHES. SUBSTANTIAL POST PROCESSING MAY BE REQUIRED HOWEVER TO SEPARATE THE MODEL FROM ITS SUPPORTS. ADDITIONALLY, POLYMER COST IS HIGH.

--- TOUCH BLACK ---

SCENE 24.
CG, SUPER: Selective Laser Sintering

NARRATION (VO):

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RP24A, tape 826, 02:12:18-02:12:36
selective laser sintering operation

SELECTIVE LASER SINTERING, IS SOMEWHAT SIMILAR TO STEREOLITHOGRAPHY EXCEPT THAT THE MATERIALS USED TO FORM MODELS ARE IN POWDER FORM, AND THE LASER IS A MORE POWERFUL CARBON-DIOXIDE UNIT.

SCENE 25.
RP25A, tape 826, 02:12:38-02:12:48
selective laser sintering operation, powder spread by roller
RP25B, tape 826, 02:12:59-02:13:12
selective laser sintering operation

NARRATION (VO):

A LAYER OF POWDER IS DEPOSITED OVER THE MACHINE BUILD AREA AND SPREAD EVENLY BY A ROLLER. POWDER LAYER THICKNESS RANGES FROM THREE THOUSANDTHS OF AN INCH TO TWELVE THOUSANDTHS OF AN INCH.

SCENE 26.
RP26A, tape 826, 02:14:39-02:14:53
selective laser sintering operation, laser fusing powder together
RP26B, tape 826, 02:15:02-02:15:06
selective laser sintering operation, powder spread by roller
RP26C, tape 826, 02:15:21-02:15:31
selective laser sintering operation, laser fusing powder together

NARRATION (VO):

THE LASER BEAM SCANS THE MODEL DESIGN ACCORDING TO THE 'CAD' FILE AND SELECTIVELY SINTERS, OR FUSES, THE POWDER PARTICLES TOGETHER. THE MODEL PLATFORM LOWERS INCREMENTALLY AS EACH SUCCESSIVE LAYER OF POWDER IS SIMILARLY FUSED.

SCENE 27.
RP27A, tape 826, 02:20:00-02:20:14
cake pulled from machine
RP27B, tape 826, 02:20:45-02:20:56
completed model pulled from cake of powder
RP27C, tape 826, 02:24:43-02:24:57
model finished using secondary operation

NARRATION (VO):

ONCE COMPLETE, THE MODEL, OR MODELS, ARE MOVED FROM THE MACHINE IN A CAKE OF UNSINTERED POWDER...,

THEY ARE THEN MANUALLY REMOVED FROM THE POWDER CAKE...,

AND FINISHED USING SECONDARY OPERATIONS.

TYPICALLY THE EXCESS POWDER IS RECYCLED FOR REUSE.

SCENE 28.
RP28A, tape 826, 02:08:59-02:09:34
zoom out, selective laser sintering of polycarbonate
CG, SUPER: Polycarbonate

NARRATION (VO):

THE PRINCIPAL ADVANTAGE OF THE SELECTIVE LASER

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Acrylic-Styrene
Nylon
Thermoplastic Elastomer
Investment-Casting Wax
Silica
Zirconium Silicate
Polymer-Coated Carbon Steel

SINTERING PROCESS IS THE WIDE RANGE OF MATERIALS FROM WHICH MODELS CAN BE CREATED. AMONG THE ASSORTMENT OF SUITABLE MATERIALS ARE POLYCARBONATE, ACRYLIC-STYRENE, NYLON, THERMOPLASTIC ELASTOMER, INVESTMENT-CASTING WAX, SILICA AND ZIRCONIUM-SILICATE FOUNDRY SANDS, AND EVEN POLYMER-COATED CARBON STEEL. HOWEVER MAINTENANCE AND OPERATING COSTS ARE HIGH.

SCENE 29.
RP29A, tape 827, 03:11:12-03:11:25
selective laser sintering operation

NARRATION (VO):

SELECTIVE LASER SINTERING MACHINES CAN PRODUCE MODEL DESIGNS AS LARGE AS FOURTEEN AND A HALF BY TWELVE AND A HALF BY SEVENTEEN AND A HALF INCHES.

--- TOUCH BLACK ---

SCENE 30.
CG, SUPER: Fused Deposition Modeling
RP30A, tape 831, 09:21:31-09:21:57
zoom in, fused deposition modeling operation

NARRATION (VO):

FUSED DEPOSITION MODELING INVOLVES FEEDING A THERMOPLASTIC FILAMENT INTO A HEATED EXTRUSION HEAD THAT MOVES IN THE 'X' AND 'Y' AXES. THE HEATED EXTRUSION HEAD MELTS AND DEPOSITS THE THERMOPLASTIC MATERIAL ON A TABLE THAT MOVES IN THE 'Z' AXIS, BUILDING THE MODEL.

SCENE 31.
RP31A, tape 831, 09:13:12-09:14:00
extrusion tip, extruding out plastic

NARRATION (VO):

THE MOLTEN THERMOPLASTIC IS CHANNELED THROUGH AN EXTRUSION TIP WHICH REDUCES IT TO A FINE BEAD FOR DEPOSITION ONTO A SUBSTRATE MATERIAL. AFTER DEPOSITING EACH BEAD, THE TIP FLATTENS IT IN PREPARATION FOR SUBSEQUENT LAYERS, AND THE MODEL IS BUILT UP LAYER BY LAYER. LAYER THICKNESS IS

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TYPICALLY BETWEEN FIVE THOUSANDTHS OF AN INCH TO THIRTEEN THOUSANDTHS OF AN INCH.

SCENE 32.
RP32A, tape 831, 09:09:13-09:09:34
c.u. extrusion tip, extruding out plastic

NARRATION (VO):

AS IT IS DEPOSITED, THE MOLTEN THERMOPLASTIC MATERIAL IS JUST SLIGHTLY ABOVE ITS MELTING POINT. SOLIDIFICATION OCCURS IMMEDIATELY AFTER EXTRUSION AS THE MATERIAL COLD WELDS TO PREVIOUS LAYERS.

SCENE 33.
RP33A, tape 831, 09:24:00-09:24:20
wide, fused deposition modeling operation, zoom in to plastic part
RP33B, tape 832, 10:04:43-10:05:00
fused deposition modeling operation
CG, SUPER: Investment-Casting Wax
Elastomer
Polycarbonate
Polyphenylsulfone

NARRATION (VO):

THE MOST COMMON MATERIAL USED FOR FUSED DEPOSITION MODELING IS ACRYLO-NITRILE BUTADIENE STYRENE OR 'ABS' THERMOPLASTIC IN VARIOUS COLORS. 'ABS' PROVIDES TENSILE STRENGTHS OF UP TO FIFTY FOUR HUNDRED POUNDS PER SQUARE INCH. OTHER MATERIALS USED INCLUDE INVESTMENT-CASTING WAX, ELASTOMER, POLYCARBONATE AND POLYPHENYLSULFONE.

SCENE 34.
RP34A, tape 833, 11:04:09-11:04:26
zoom out, fused deposition modeling operation

NARRATION (VO):

DEPENDING ON THE MACHINE, MAXIMUM PART SIZE CAN RANGE FROM EIGHT BY EIGHT BY TWELVE INCHES ON THE SMALLEST MACHINE TO TWENTY FOUR BY TWENTY BY TWENTY FOUR INCHES ON THE LARGEST MACHINE.

SCENE 35.
RP35A, tape 832, 10:06:14-10:06:24
part coming out of machine
RP35B, tape 832, 10:06:52-10:07:00
part with support material going into removal process
RP35C, tape 832, 10:07:31-10:07:44
part coming out of support removal process

NARRATION (VO):

FUSED DEPOSITION MODELING IS MODERATE TO FAST IN BUILDING SPEED...,
ADDITIONALLY, MOST SYSTEMS INCORPORATE A WATER-SOLUBLE SUPPORT MATERIAL...,
WHICH AIDS IN SUPPORT REMOVAL.

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SCENE 36.
RP36A, tape 832, 10:08:03-10:08:09
fdm manifold part
RP36B, tape 832, 10:13:15-10:13:20
fdm pump casing part
RP36C, tape 832, 10:09:10-10:09:16
fdm spring part
RP36D, tape 832, 10:13:34-10:13:39
fdm clear part
RP36E, tape 832, 10:08:59-10:09:05
fdm multi-color part

NARRATION (VO):

THE STRENGTH AND HEAT RESISTANCE OF MODELS ARE ALSO ADVANTAGEOUS AND THE VARIETY OF COLORS AVAILABLE ARE USEFUL IN ACCENTUATING PART FEATURES.

--- TOUCH BLACK ---

SCENE 37.
CG, SUPER: Ultrasonic Consolidation
RP37A, tape 834, 11:03:48-11:04:36
zoom in, ultrasonic consolidation operation

NARRATION (VO):

ULTRASONIC CONSOLIDATION PRODUCES DIRECT METAL PARTS FROM 'CAD' DATA BY ULTRASONICALLY WELDING LAYERS OF COILED ALUMINUM FOIL STRIPS TO A PREPARED METAL SUBSTRATE.

SCENE 38.
RP38A, tape 834, 11:07:23-11:08:00
foil strips being ultrasonically welded to substrate
CG, SUPER: Sonotrode
RP38B, tape 835, 12:24:51-12:25:13
foil strips being ultrasonically welded to substrate

NARRATION (VO):

AS THE FOIL STRIPS ARE PLACED ON THE SUBSTRATE, A TOOL CALLED THE 'SONOTRODE' USES HIGH-FREQUENCY VIBRATORY ENERGY AND MODERATE FORCE TO DISRUPT THE INTERFACE SURFACES, INDUCING INTERATOMIC ATTRACTION AND METALLURGICAL BONDING BETWEEN THE FOIL AND THE SUBSTRATE SURFACES.

SCENE 39.
RP39A, tape 835, 12:28:09-12:28:36
ultrasonically consolidated layer being milled

NARRATION (VO):

ONCE ULTRASONICALLY WELDED, THE LAYER IS THEN MILLED TO THE CROSS-SECTIONAL SHAPE DEFINED BY THE 'CAD' DATA.

SCENE 40.
RP40A, tape 835, 12:34:06-12:34:26
layer of aluminum tape added to substrate
RP40B, tape 835, 12:37:14-12:37:36
milling of excess layer material

NARRATION (VO):

THIS PROCESS OF ADDING MATERIAL TO A PREVIOUS LAYER...,

AND THEN REMOVING THE EXCESS CONTINUES UNTIL THE

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PART IS COMPLETE.

SCENE 41.
RP41A, tape 835, 12:49:59-12:50:18
zoom out, ultrasonically consolidated mold with complex details

NARRATION (VO):

LIKE OTHER RAPID PROTOTYPING PROCESSES, ULTRASONIC CONSOLIDATION ALSO ALLOWS FOR THE BUILD-UP OF COMPLEX GEOMETRIES, OVERHANGS AND ENCLOSURES WITHIN A PART.

SCENE 42.
RP42A, tape 835, 13:01:56-13:02:12
zoom out, ultrasonic consolidation operation

NARRATION (VO):

ULTRASONIC CONSOLIDATION CAN BE USED TO BOND A VARIETY OF SIMILAR AND DISSIMILAR METALS, AS WELL AS CERTAIN CERAMIC-METAL COMBINATIONS.

--- TOUCH BLACK ---

SCENE 43.
CG, SUPER: Pro Metal System
RP43A, tape 841, 00:31:03-00:31:40
pro metal system producing metal model

NARRATION (VO):

THE PRO METAL SYSTEM MODELERS ARE ALSO USED FOR CREATING METAL MODELS. THIS SYSTEM INVOLVES USING INKJETS TO APPLY A LIQUID POLYMERIC BINDER ONTO POWDER MEDIA TO PRODUCE MODELS.

SCENE 44.
RP44A, tape 841, 00:39:17-00:39:30
pro metal system producing metal model

NARRATION (VO):

THE MODELS, ARE BUILT FROM STEEL-BASED POWDER FROM THE BOTTOM UP.

SCENE 45.
RP45A, tape 841, 00:51:11-00:52:04
model coming out of prometal modeler

NARRATION (VO):

UPON COMPLETION, MODELS ARE SINTERED TO REMOVE THE BINDER AND BOND THE POWDER PARTICLES, AND THEN INFILTRATED WITH BRONZE TO SUBSTANTIALLY REDUCE OR ELIMINATE POROSITY.

SCENE 46.
RP46A, tape 841, 00:31:45-00:32:30
pro metal system producing metal model

NARRATION (VO):

BESIDES THE CAPABILITY OF MAKING HIGH-STRENGTH,

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DURABLE MODELS, NO SUPPORT STRUCTURES ARE REQUIRED. TOOLING FOR PLASTIC MOLDING PROCESSES ARE A COMMON APPLICATION.

--- TOUCH BLACK ---

SCENE 47.
RP47A, tape 833, 11:11:57-11:12:06
thermojet modeler producing model
RP47B, tape 843, 12:00:47-12:00:53
612 producing model
RP47C, tape 836, 13:45:40-13:45:46
Z810 modeler producing model
RP47D, tape 830, 08:08:08-08:08:19
eden 330 modeler producing model

NARRATION (VO):

OF THE SMALLER RAPID PROTOTYPING SYSTEMS, THE THERMOJET...,

612...,

Z810...,

AND EDEN 330 MODELERS ARE ALL INK-JET BASED.

--- TOUCH BLACK ---

SCENE 48.
CG, SUPER: ThermoJet Modeler
RP48A, tape 833, 11:09:54-11:10:14
c.u., zoom out, thermojet modeler producing model

NARRATION (VO):

THE THERMOJET MODELER IS A MULTI-JET MODELING SYSTEM THAT USES AN ARRAY OF OVER 300 JETS TO PRODUCE WAX MODELS AS LARGE AS TEN BY SEVEN AND A HALF BY EIGHT INCHES.

SCENE 49.
RP49A, tape 833, 11:19:33-11:19:41
wide, thermojet modeler unit
RP49B, tape 833, 11:20:43-11:20:55
loading of modeling material into thermojet machine
RP49C, tape 833, 11:07:27-11:07:57
post processing of thermojet produced part

NARRATION (VO):

THE THERMOJET MODELER IS A SELF-CONTAINED, COMPACT UNIT, WHICH IS EQUIPPED WITH A CARTRIDGE SYSTEM FOR EASY LOADING OF THE MODELING MATERIAL...,

POST PROCESSING OF THERMOJET PRODUCED MODELS IS MINIMAL.

--- TOUCH BLACK ---

SCENE 50.
CG, SUPER: 612 Modeler
RP50A, tape 843, 12:11:48-12:12:14
wide, 612 building-up model

NARRATION (VO):

THE 612 MODELER USES TWO PRINT-HEADS, ONE TO

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RP50B, tape 843, 12:17:18-12:17:29
supports being dissolved in solvents

BUILD-UP MODELS USING A PROPRIETARY THERMOPLASTIC, AND THE OTHER TO BUILD-UP SUPPORTS USING A PROPRIETARY WAX. THESE SUPPORTS ARE DESIGNED TO DISSOLVE IN SOLVENTS WITHOUT DAMAGING THE MODEL MATERIAL.

SCENE 51.
RP51A, tape 843, 12:06:25-12:06:41
med, 612 modeler building model

NARRATION (VO):

THE 612 CAN PRODUCE MODELS UP TO TWELVE BY SIX BY SIX INCHES. LAYER THICKNESS CAN BE AS THIN AS FIVE TEN-THOUSANDTHS OF AN INCH.

SCENE 52.
RP52A, tape 843, 12:09:04-12:09:14
milling operation of model layer

NARRATION (VO):

TO ENSURE PRECISE LAYER THICKNESS, A MILLING OPERATION IS PERFORMED BETWEEN LAYER BUILD-UP. THIS IS CARRIED-OUT UNTIL MODEL COMPLETION.

SCENE 53.
RP53A, tape 843, 12:09:18-12:09:40
612 modeler finishing highly detailed model

NARRATION (VO):

THE 612 SYSTEM PRIMARILY PRODUCES SMALL, HIGHLY ACCURATE, DETAILED PATTERNS IN THE RANGE OF PLUS OR MINUS ONE THOUSANDTH OF AN INCH.

SCENE 54.
continue previous shot
RP54A, still, medical part
RP54B, still, ring

NARRATION (VO):

THE SYSTEM IS COMMONLY USED TO PROVIDE MODELS FOR THE MEDICAL,

AND JEWELRY INDUSTRIES.

--- TOUCH BLACK ---

SCENE 55.
CG, SUPER: Z810 Modeler
RP55A, tape 836, 13:36:27-13:37:42
Z810 modeler building-up part layer, leveling next layer of powder, building up layer

NARRATION (VO):

THE Z810 MODELER IS AMONG THE FASTEST RAPID PROTOTYPING SYSTEMS, HAVING A BUILDING SPEED OF ONE TO TWO INCHES PER HOUR.

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SCENE 56.
continue previous shot

NARRATION (VO):

THE Z810 MODELER USES ONE OF TWO POWDER-MATERIAL TYPES TO BUILD MODELS. THE FIRST COMBINES STARCH AND CELLULOSE AND THE SECOND IS PLASTER-BASED. BOTH MATERIALS CAN BE SUBSEQUENTLY INFILTRATED WITH WAX OR PARTICULAR RESINS TO ENHANCE CERTAIN QUALITIES.

SCENE 57.
RP57A, tape 836, 13:18:08-13:18:14
wiper blade smoothing powder
RP57B, tape 836, 13:22:16-13:22:52
printer head infiltrating powder with binder, layer finished
RP57C, tape 836, 13:25:45-13:26:06
finished layer covered with powder powder leveled
RP57D, tape 836, 13:26:24-13:26:40
printing resuming on new layer

NARRATION (VO):

THE Z810 MODELER HAS A WIPER BLADE THAT SMOOTHES THE POWDER IN THE BUILD AREA UNTIL IT IS LEVEL. ONCE LEVEL, THE POWDER IS INFILTRATED WITH A BINDER FROM THE PRINTER HEAD. THE BINDER IS DISPENSED ONLY IN THE AREAS DICTATED BY THE 'CAD' FILE. ONCE A LAYER IS PRINTED, THE PLATFORM LOWERS AND THE EXISTING LAYER IS LEVELED OVER WITH POWDER...,

AND PRINTING RESUMES...,

THIS PROCESS IS REPEATED UNTIL THE MODEL IS COMPLETE.

SCENE 58.
RP58A, tape 836, 13:57:18-13:57:33
finished model being lifted from Z810 modeler as building material is reclaimed

NARRATION (VO):

THE Z810 MODELER CAN BUILD MODELS UP TO TWENTY BY TWENTY FOUR BY SIXTEEN INCHES.

SCENE 59.
RP59A, tape 836, 13:57:50-13:58:09
c.u. building material reclaimed from finished model

NARRATION (VO):

MODELS PRODUCED TEND TO HAVE ROUGH SURFACE FINISHES, BUT LOW COST, LOW POWER USAGE, INEXPENSIVE MATERIALS, AND REUSE OF UNUSED BUILDING MATERIAL ARE KEY ADVANTAGES.

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--- TOUCH BLACK ---

SCENE 60.
CG, SUPER: Eden 330 Modeler
RP60A, tape 830, 08:10:28-08:10:56
eden 330 system, zoom in to inkjet nozzles

NARRATION (VO):

THE EDEN 330 MODELING SYSTEM FEATURES EIGHT HEADS THAT CONTAIN A TOTAL OF 1,536 NOZZLES. HALF OF THESE NOZZLES JET FINE DROPLETS OF A PROPRIETARY PHOTOPOLYMER MODEL MATERIAL AND THE OTHER HALF DROPLETS OF A PROPRIETARY PHOTOPOLYMER SUPPORT MATERIAL.

SCENE 61.
RP61A, tape 830, 08:21:22-08:21:48
zoom out, eden 330 system model being produced

NARRATION (VO):

THIS SYSTEM PRODUCES EXTREMELY THIN LAYERS OF SIX-TEN THOUSANDTHS OF AN INCH. PRODUCING SUCH THIN LAYERS INCREASES DETAIL, ACCURACY AND FINISH SMOOTHNESS OF THE MODELS.

SCENE 62.
RP62A, tape 830, 08:22:45-08:22:58
eden 330 system model layer exposed to ultraviolet light

NARRATION (VO):

EACH MODEL LAYER IS CURED IMMEDIATELY BY EXPOSURE TO ULTRAVIOLET LIGHT. THEN THE BUILD PLATFORM DESCENDS AND THE INKJET UNIT DEPOSITS THE MATERIAL FOR THE NEXT LAYER.

SCENE 63.
RP63A, tape 830, 08:28:55-08:29:05
support material pulled from finished model

NARRATION (VO):

UPON MODEL COMPLETION, THE GEL-LIKE PROPRIETARY SUPPORT MATERIAL IS EASILY REMOVED.

--- TOUCH BLACK ---

SCENE 64.
CG, SUPER: Room Temperature Vulcanized Tooling
RP64A, tape 828, 06:11:17-06:11:56
pouring of rtv material into mold
RP64B, tape 829, 07:03:35-07:03:49
mold being pulled apart after curing

NARRATION (VO):

A RAPID MEANS OF PRODUCING SOFT TOOLING FOR LOW-PRESSURE MOLDING INVOLVES THE USE OF ROOM TEMPERATURE VULCANIZED, OR 'RTV', SILICONE

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MATERIALS. THESE 'RTV' SILICONES ARE THE PREFERRED MATERIALS SINCE THEY DO NOT REQUIRE SPECIAL EQUIPMENT FOR CURING.

SCENE 65.
RP65A, tape 842, 12:03:43-12:03:52
prepared rapid prototyped pattern
RP65B, tape 842, 12:06:20-12:06:32
pattern secured in clay, parting line defined
RP65C, tape 842, 12:08:35-12:08:50
frame built around pattern

NARRATION (VO):

IN GENERAL, 'RTV' TOOLING PRODUCTION BEGINS BY USING A PREPARED RAPID PROTOTYPED MODEL AS A PATTERN. DEVELOPMENT OF THE FIRST MOLD HALF BEGINS BY SECURING THE PATTERN IN OIL-BASED CLAY OR OTHER BUILDING MATERIALS AND CONSTRUCTING THE PARTING LINE...,

ONCE DONE, THE PATTERN IS THEN SECURED IN A BOX OR FRAME.

SCENE 66.
RP66A, tape 842, 12:23:51-12:24:16
rtv molding material pour around pattern half

NARRATION (VO):

SILICONE 'RTV' MOLDING MATERIAL IS THEN POURED AROUND THE PATTERN AND ALLOWED TO CURE. TYPICALLY, IT IS NECESSARY TO APPLY A VACUUM TO EITHER THE 'RTV' MOLDING MATERIAL BEFORE POURING, OR THE TOOLING ASSEMBLY AFTER POURING TO REMOVE AIR BUBBLES FROM THE MOLDING MATERIAL DURING CURING.

SCENE 67.
RP67A, tape 842, 12:10:39-12:10:52
box removed from first mold half
RP67B, tape 842, 12:14:26-12:14:37
sealing ring cut
RP67C, tape 842, 12:15:37-12:15:43
building box around first mold half
RP67D, tape 842, 12:17:09-12:17:16
release sprayed on pattern box
RP67E, tape 842, 12:18:28-12:18:44
vent poles added to pattern box

NARRATION (VO):

ONCE THE SILICONE HAS CURED, THE BOX IS REMOVED...,

AND THE MOLD HALF AND PATTERN ARE PREPARED FOR THE POURING OF THE SECOND MOLD HALF...,

THIS PREPARATION CAN INCLUDE A RELEASE AGENT COATING TO ENSURE SEPARATION OF THE MOLD HALVES.

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AND THE INCLUSION OF A GATE FOR INJECTION, AND VENTING TO ALLOW AIR IN THE MOLD TO ESCAPE DURING THE INJECTION.

SCENE 68.
RP68A, tape 842, 12:23:07-12:23:38
zoom in, second mold half poured
RP68B, tape 842, 12:21:29-12:21:37
mold halves separated
RP68C, tape 842, 12:21:46-12:21:51
pattern removed from mold
RP68D, tape 842, 12:22:01-12:22:30
mold halves prepared for injection

NARRATION (VO):

ONCE PREPARED, THE SECOND MOLD HALF IS POURED, AND ALLOWED TO CURE...,

ONCE ENTIRELY CURED, THE MOLD HALVES ARE SEPARATED ALONG THE PARTING LINE...,

THE PATTERN IS REMOVED...,

AND THE MOLD IS PREPARED FOR USE.

SCENE 69.
RP69A, tape 829, 07:06:14-07:06:24
molding of parts using rtv mold

NARRATION (VO):

'RTV' TOOLING CAN BE USED TO MOLD SMALL TO MEDIUM QUANTITIES OF PARTS OUT OF A LARGE VARIETY OF URETHANE, EPOXY OR OTHER POLYMER MATERIALS.

SCENE 70.
RP70A, tape 829, 07:08:17-07:08:27
mold put together
RP70B, tape 829, 07:12:21-07:13:12
molding of parts using rtv mold

NARRATION (VO):

'RTV' TOOLING CAN TYPICALLY BE USED TO MOLD SEVERAL PARTS BEFORE REPLACEMENT BECOMES NECESSARY. THE NUMBER OF PARTS PRODUCED DEPENDS ON ACCURACY AND FINISH REQUIREMENTS AND THE COMPLEXITY OF THE PART GEOMETRY.

SCENE 71.
RP71A, tape 828, 06:16:51-06:17:01
simple mold halves put together
RP71B, tape 829, 07:23:54-07:24:05
complex mold halves put together
RP71C, tape 829, 07:26:18-07:26:56
molding material injected into mold

NARRATION (VO):

DOZENS OF SIMPLE PARTS CAN BE PRODUCED FROM A SINGLE SILICONE RUBBER MOLD, BUT TEN TO TWENTY IS TYPICAL IF THE PARTS ARE MORE COMPLEX. WEAR OF THE MOLD OCCURS DUE TO THE EXOTHERMIC AND REACTIVE NATURE OF THE MOLDING MATERIALS, AND BECAUSE OF THE NECESSITY TO MECHANICALLY DEFORM

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THE MOLD TO REMOVE PARTS.

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SCENE 72.
RP72A, CG: Review
white text on black
RP72B, peter carey narration
RP72C, tape 63, 12:00:15-12:03:49
review music

MUSIC UP AND UNDER

NARRATION (VO):

LET'S REVIEW THE MATERIAL CONTAINED IN THIS PROGRAM.

SCENE 73.
RP73A, tape 827, 03:05:45-03:06:00
zoom out, rapid prototyping of part
RP73B, tape 839, 16:17:45-16:18:03
rapid prototyping of part
RP73C, tape 835, 12:25:49-12:26:03
laying foil in ultrasonic consolidation operation
RP73D, tape 835, 12:28:12-12:28:20
milling of foil in ultrasonic consolidation operation
RP73E, tape 828, 06:05:40-06:05:53
rtv operation, pulling mold halves apart

NARRATION (VO):

RAPID PROTOTYPING IS A GENERAL TERM ENCOMPASSING A VARIETY OF SYSTEMS USED TO CREATE THREE-DIMENSIONAL PHYSICAL MODELS DIRECTLY FROM ELECTRONIC DATA. THESE RAPID PROTOTYPING SYSTEMS PRIMARILY CREATE MODELS USING A LAYER-BY-LAYER, OR ADDITIVE, MEANS OF CONSTRUCTION. MORE RECENTLY THOUGH, SYSTEMS USING A COMBINATION OF

ADDITIVE...,

AND SUBTRACTIVE LAYERING...,

AND PATTERN-BASED RAPID PROTOTYPING PROCESSES HAVE DEVELOPED.

SCENE 74.
RP74A, tape 670, 02:12:42-02:13:09
solid model representation of part

NARRATION (VO):

RAPID PROTOTYPING TECHNOLOGIES ARE BASED ON THE SOLID MODELING PORTION OF COMPUTER-AIDED DESIGN, OR 'CAD'.

SCENE 75.
RP75A, tape 840, 17:39:05-17:39:37
complex shaped rapid prototyped part being built
RP75B, tape 840, 17:55:00-17:55:12
complex shaped rapid prototyped part coming out of process

NARRATION (VO):

RAPID PROTOTYPING SYSTEMS USE SOLID MODELING DATA TO BUILD FABRICATIONS LAYER-BY-LAYER IN EXTREMELY THIN CROSS-SECTIONS. THESE CROSS-SECTIONS, OR SLICES, ARE STACKED ONE ATOP ANOTHER IN

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SUCCESSION UNTIL THE SHAPE IS COMPLETE. THIS PERMITS MANUFACTURE OF INTRICATE AND COMPLEX SHAPES AND SURFACES MUCH MORE SIMPLY THAN BY CONVENTIONAL METHODS.

SCENE 76.
RP76A, tape 833, 11:21:50-11:22:00
zoom out, cast fan blade
RP76B, tape 833, 11:22:44-11:22:53
zoom out, fan blade on computer screen

NARRATION (VO):

RAPID PROTOTYPING TECHNOLOGIES CAN ALSO PRODUCE MODELS USING SCAN DATA GENERATED FROM THE 3-DIMENSIONAL DIGITIZING OF EXISTING PARTS, AND MEDICAL IMAGING DEVICES.

SCENE 77.
RP77A, tape 825, 01:16:04-01:16:23
liquid based rapid prototyping system producing part
RP77B, tape 840, 17:45:50-17:45:58
powder based rapid prototyping system producing part
RP77C, tape 831, 09:25:19-09:25:34
zoom in, filament based rapid prototyping system producing part
RP77D, tape 834, 11:14:50-11:15:04
foil based rapid prototyping system producing part

NARRATION (VO):

THE MATERIALS USED FOR PRODUCING PROTOTYPES RAPIDLY ARE BROADLY CLASSIFIED AS EITHER

LIQUID...,

POWDER...,

FILAMENT...,

OR FOIL.

SCENE 78.
RP78A, tape 839, 16:24:08-16:24:44
part being extracted from rapid prototyping operation
RP78B, tape 828, 06:09:02-06:09:21
rtv tooling being poured operation
RP78C, tape 829, 07:18:27-07:18:36
low volume part produced from rapid prototyped mold
RP78D, tape 459, 04:27:41-04:27:55
zoom in, investment casting operation
RP78E, still, functional prototype sprinkler in use

NARRATION (VO):

ALTHOUGH RAPID PROTOTYPING TECHNOLOGIES WERE INITIALLY DEVELOPED TO CREATE PHYSICAL MODELS FOR DESIGN APPROVAL AND PART VERIFICATION, MANY OTHER TECHNOLOGICAL APPLICATIONS HAVE EMERGED, SUCH AS:

THE CREATION OF RAPID TOOLING FOR MOLDING PROCESSES...,

LOW VOLUME PARTS PRODUCTION...,

THE MANUFACTURE OF PATTERNS FOR CASTING...,

THE PRODUCTION OF FUNCTIONAL PROTOTYPES,

AND MORE.

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SCENE 79.
RP79A, tape 826, 02:16:27-02:16:37
wide, sls modeler
RP79B, tape 831, 09:09:09-09:09:24
zoom in, fdm rapid prototyping system producing part
RP79C, tape 825, 01:20:04-01:20:11
laser tracing part during stereolithography operation
CG, SUPER: Stereolithography
RP79D, tape 826, 02:14:39-02:14:53
selective laser sintering operation, laser fusing powder together
CG, SUPER: Selective Laser Sintering
RP79E, tape 831, 09:24:00-09:24:20
wide, fused deposition modeling operation, zoom in to plastic part
CG, SUPER: Fused Deposition Modeling
RP79F, tape 834, 11:07:23-11:08:00
foil strips being ultrasonically welded to substrate
CG, SUPER: Ultrasonic Consolidation
RP79G, tape 841, 00:02:11-00:02:21
pro metal system rapid prototyping operation
CG, SUPER: Pro Metal System
RP79H, tape 833, 11:09:54-11:10:14
c.u., zoom out, thermojet modeler producing model
CG, SUPER: ThermoJet Modeler
RP79I, tape 843, 12:04:48-12:04:56
612 modeler producing model
CG, SUPER: 612 Modeler
RP79J, tape 836, 13:36:27-13:37:42
Z810 modeler building-up part layer
CG, SUPER: Z810 Modeler
RP79K, tape 830, 08:21:22-08:21:48
zoom out, eden 330 system model being produced
CG, SUPER: Eden 330 Modeler
RP79L, tape 829, 07:06:14-07:06:24
molding of parts using rtv mold
CG, SUPER: Room Temperature Vulcanized Tooling

NARRATION (VO):

RAPID PROTOTYPING SYSTEMS RANGE FROM LARGE MODELERS SUITABLE FOR SHOP-FLOOR AND LABORATORY ENVIRONMENTS, TO SMALLER 'DESKTOP' MODELERS. WITHIN THIS RANGE THERE ARE NUMEROUS RAPID PROTOTYPING TECHNOLOGIES AND SYSTEMS, WITH THE PRIMARY TYPES INCLUDING:

STEREOLITHOGRAPHY...,

SELECTIVE LASER SINTERING...,

FUSED DEPOSITION MODELING...,

ULTRASONIC CONSOLIDATION...,

THE PRO METAL SYSTEM...,

THE THERMOJET MODELER...,

THE 612 MODELER...,

THE Z810 MODELER...,

THE EDEN 330 MODELER...,

AND ROOM TEMPERATURE VULCANIZED TOOLING.

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SCENE 80.
CG, ROLL: credits
white text on black, fade up mid-screen
RP80A, GRAPHIC: RPA logo

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Executive Producer:
Steven R. Bollinger

Producer/Director/Cameraman:
Jerome T. Cook

Written By:
John A. Vaccari

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Lance Rosol

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SCENE 81.
CG: disclaimer
white text centered on black

Some machinery in this program had safety equipment removed to allow better recording of certain processes.

Always read the safety information provided in the manufacturers' manual before machine operation.

SCENE 82.
RP82A, tape 40, 01:00:00-01:00:12
SME logo, with music
CG, SUPER: www.sme.org