FUNDAMENTALS OF TOOL DESIGN

Rapid Tooling Design

SCENE 1.
FTD01A, CGS: FBI warning
white text centered on black to transparent gradient
FTD01B, motion background

WARNING

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SCENE 2.
continue motion background
FTD02A, CGS: disclaimer
white text centered on black to transparent gradient

Always read the operating manual and safety information provided by the manufacturer before operating any manufacturing equipment.

Make sure all machine guards are in place, and follow all safety procedures when working with or near manufacturing equipment.

SCENE 3.
FTD03A, SME logo open, with music

SCENE 4.
FTD04A, FTD open, with music
RT04B, edited peter carey narration
RT04C, peter carey narration inserts

MUSIC UP AND UNDER

NARRATION (VO):

THE FUNDAMENTALS OF TOOL DESIGN VIDEO SERIES, EXAMINING THE DIVERSE FIELD OF TOOL DESIGN MATERIALS AND TECHNOLOGIES.

SCENE 5.
continue FTD open
RT05A, CGS: Rapid Tooling Design
white text, centered on background
FTD05B, blue background
FTD05C, sound slug

NARRATION (VO):

THIS PROGRAM IS AN INTRODUCTION TO RAPID TOOLING DESIGN CONCEPTS AND PRACTICES.

SCENE 6.
RT06A, FTD56, 07:22:27:00-07:22:53:00
injection molding using rapid tooled mold
RT06B, CGS: Cost Reduction
Efficiency Improvement

NARRATION (VO):

AS THE NAME STATES, THE KEY ADVANTAGE OF

Labor Reduction

RAPID TOOLING IS A REDUCTION IN THE TIME TO PRODUCE A MOLD FOR PARTS PRODUCTION. OTHER ADVANTAGES, SUCH AS COST REDUCTION, EFFICIENCY IMPROVEMENT AND LABOR REDUCTION MAY ALSO BE ACHIEVED.

SCENE 7.
RT07A, FTD60, 12:02:05:00-12:02:30:00
rapid tooling being produced
RT07B, FTD10, 09:20:50:00-09:20:59:00
zoom out, high speed machining of mold
RT07C, FMP828, 06:07:21:00-06:07:32:00
pulling part from rtv process
RT07D, FMP916, 11:04:04:00-11:04:17:00
injection molding operation
RT07E, FMP454, 22:09:59:00-22:10:22:00
investment casting operation
RT07F, FTD29, 09:17:58:00-09:18:12:00
zoom out, progressive stamping operation

NARRATION (VO):

RAPID TOOLING HAS COME TO DESCRIBE ANY MOLD MAKING PROCESS THAT IS PERFORMED QUICKLY. IT INCLUDES TOOL MAKING APPROACHES THAT APPLY ADDITIVE...,
SUBTRACTIVE...,
AND PATTERN-BASED PROCESSES--ALONE OR IN COMBINATION--FOR A VARIETY OF APPLICATIONS RANGING FROM INJECTION MOLDING...,
TO CASTING OPERATIONS...,
AND SHEET METAL STAMPING.

SCENE 8.
RT08A, FTD68, 01:03:23:00-01:03:47:00
zoom in, rtv molding
RT08B, FTD56, 07:41:05:00-07:41:21:00
zoom out, dmls process
RT08C, FTD56, 07:20:33:00-07:20:45:00
injection mold, part ejected
RT08D, FTD60, 12:15:42:00-12:16:12:00
dmls process

NARRATION (VO):

IN THIS BROAD CONTEXT, RAPID TOOLING IS FAR TOO EXTENSIVE TO EXPLORE ADEQUATELY. FOR THAT REASON, THIS PROGRAM WILL FOCUS ON MOLD MAKING THAT EMPLOYS ADDITIVE RAPID PROTOTYPING PROCESSES TO PRODUCE PLASTIC PARTS THAT ARE DESIGNED FOR INJECTION MOLDING.

--- TOUCH BLACK ---

SCENE 9.
RT09A, FMP829, 07:06:10:00-07:06:38:00

NARRATION (VO):

molding of parts using rtv mold
RT09B, CGS: Indirect Tooling
Direct Tooling

RAPID TOOLING CAN BE DEPLOYED IN TWO FORMS:

INDIRECT TOOLING,

AND DIRECT TOOLING.

SCENE 10.
RT10A, FTD69, 03:12:10:00-03:12:25:00
zoom in, pattern pulled from rtv mold
RT10B, CGS: Indirect Tooling

NARRATION (VO):

INDIRECT TOOLING INCORPORATES PATTERN-BASED METHODS WHERE A TOOL IS CAST FROM A RAPID PROTOTYPE THAT DEPICTS THE PART TO BE MOLDED.

SCENE 11.
RT11A, FTD64, 16:01:42:00-16:01:59:00
zoom out, mold having direct tooling elements
RT11B, FTD63, 15:06:02:00-15:06:17:00
zoom in, dmls process
RT11C, CGS: Direct Tooling
RT11D, FTD60, 12:08:50:00-12:09:20:00
dmls process

NARRATION (VO):

DIRECT TOOLING IS A METHOD WHERE THE MOLD, INSERTS OR COMPONENTS ARE MADE DIRECTLY FROM A RAPID PROTOTYPING MACHINE.

SCENE 12.
continue previous shot
RT12A, FTD68, 01:52:13:00-01:52:22:00
wiper action in stereolithography operation, dissolve to next image
RT12B, FTD68, 01:52:29:00-01:53:05:00
zoom out, stereolithography operation

NARRATION (VO):

TO UNDERSTAND RAPID TOOLING AND LEVERAGE ITS ADVANTAGES, THERE MUST BE AN APPRECIATION FOR THE UNDERLYING TECHNOLOGY, RAPID PROTOTYPING. ALSO CALLED ADDITIVE FABRICATION, ADDITIVE MANUFACTURING, AND FREEFORM FABRICATION, RAPID PROTOTYPING GROWS PHYSICAL OBJECTS—DIRECT FROM ‘3D’ CAD DATA—BY BONDING LAYERS OF MATERIAL.

SCENE 13.
RT13A, FTD60, 12:01:04:00-12:01:29:00
zoom in, laser sintering operation
RT13B, FMP826, 02:11:18:00-02:11:34:00
zoom in, laser sintering operation
RT13C, FTD59, 11:29:29:00-11:30:11:00

NARRATION (VO):

THE ADDITIVE NATURE OF THE PROCESS ALLOWS INTRICATE DETAILS AND COMPLEX

laser sintering operation

SHAPES TO BE MANUFACTURED WITH LITTLE EFFORT AND NO IMPACT ON TIME OR COST. ALSO, MUCH OF THE PROCESS IS COMPLETED WITHOUT DIRECT LABOR OR A MACHINE OPERATOR IN ATTENDANCE.

SCENE 14.
RT14A, FTD59, 11:23:49:00-11:24:10:00
laser sintering operation
RT14B, FTD59, 11:50:21:00-11:50:33:00
zoom out, laser sintered part

NARRATION (VO):

THIS DISTINCTION FROM TRADITIONAL MACHINING AND MANUFACTURING PROCESSES PROMOTES THE USE OF RAPID PROTOTYPING-BASED TOOLING WHEN ELEMENTS OF A MOLD ARE INTRICATE AND HIGHLY DETAILED.

SCENE 15.
RT15A, FMP825, 01:21:15:00-01:21:50:00
zoom out, 3d systems stereolithography operation
RT15B, FTD56, 07:55:16:00-07:55:29:00
zoom in, eos laser-sintering
RT15C, FMP831, 09:11:39:00-09:11:52:00
stratasys fused deposition modeling
RT15D, FMP830, 08:12:08:00-08:12:25:00
zoom out, objet geometries ‘3d’ printing
RT15E, FMP843, 12:09:22:00-12:09:38:00
solidscape ‘3d’ printing
RT15F, FMP840, 17:43:49:00-17:44:28:00
z corporation ‘3d’ printing

NARRATION (VO):

THERE ARE NUMEROUS MANUFACTURERS OF RAPID PROTOTYPING MACHINES, WITH THE MOST POPULAR TECHNOLOGIES INCLUDING:
STEREOLITHOGRAPHY, FROM 3D SYSTEMS...,
LASER-SINTERING, FROM EOS AND 3D SYSTEMS...,
FUSED DEPOSITION MODELING, FROM STRATASYS...,
AND THE VARIOUS ‘3D’ PRINTING PROCESSES FROM:
OBJET GEOMETRIES...,
SOLIDSCAPE...,
AND Z CORPORATION.

SCENE 16.
RT16A, FMP825, 01:05:36:00-01:05:53:00
zoom in, stereolithography operation
RT16B, FTD63, 15:10:29:00-15:10:59:00
zoom in, laser sintering operation

NARRATION (VO):

WHILE SIMILAR IN THE FUNDAMENTAL

RT16C, FMP831, 09:23:25:00-09:23:39:00
fused deposition modeling
RT16D, FMP830, 08:08:13:00-08:08:25:00
objet geometries '3d' printing
RT16E, FMP836, 13:28:31:00-13:29:13:00
z corporation '3d' printing

APPROACH OF CONSTRUCTING PARTS ON A LAYER-BY-LAYER BASIS, EACH RAPID PROTOTYPING TECHNOLOGY OFFERS DISTINCT DIFFERENCES IN PROCESSES, MATERIALS AND ADVANTAGES. IT IS THESE DIFFERENCES THAT CAN MAKE ONE TECHNOLOGY MORE SUITABLE FOR RAPID TOOLING OVER ANOTHER.

SCENE 17.
RT17A, FTD61, 13:31:23:00-13:31:41:00
rtv mold being opened
RT17B, FTD56, 07:52:29:00-07:53:08:00
zoom out, dmls operation
RT17C, FTD61, 13:34:33:00-13:35:24:00
nanotool material being fused
RT17D, FTD61, 13:06:51:00-13:07:20:00
nanotool coming out of tank
RT17E, FTD64, 16:16:31:00-16:16:46:00
dmls operation

NARRATION (VO):

ALTHOUGH MOST RAPID PROTOTYPING TECHNOLOGIES CAN BE USED FOR INDIRECT, PATTERN-BASED, RAPID TOOLING, THE BULK OF THE DIRECT TOOLING WORK USES A METAL-BASED TECHNOLOGY SUCH AS DIRECT METAL LASER-SINTERING, SELECTIVE LASER MELTING OR LASER CUSING. YET, SOME COMPANIES HAVE HAD SUCCESS IN BUILDING MOLDS OF COMPOSITE-PLASTIC FROM STEREOLITHOGRAPHY. WHILE NOT AS DURABLE AS A METAL MOLD, THESE PROVE TO BE VIABLE FOR EARLY PROTOTYPE MOLDS AND OPERATIONS REQUIRING LOW QUANTITIES OF PARTS

--- TOUCH BLACK ---

SCENE 18.
RT18A, FTD59, 11:32:52:00-11:33:15:00
zoom in, tooling file being processed from cad data
RT18B, FTD59, 11:17:50:00-11:18:14:00
dmls tooling being built up
RT18C, FTD59, 11:55:23:00-11:55:40:00
zoom out, post processing of dmls tooling
RT18D, FTD60, 12:17:11:00-12:17:30:00

NARRATION (VO):

THE RAPID PROTOTYPING WORKFLOW CONSISTS OF THREE STEPS:

DATA PREPARATION..., WHICH INCLUDES THE

scrolling through stl file

CREATION OF AN STL FILE FROM A 3D CAD MODEL AND THE APPLICATION OF BUILD-SPECIFIC CONSTRUCTION PARAMETERS. PART BUILDING..., WHICH IS THE ACTUAL RAPID PROTOTYPING CONSTRUCTION PROCESS. AND POSTPROCESSING..., WHICH INCLUDES SECONDARY OPERATIONS PERFORMED ON THE PART ONCE IT IS REMOVED FROM THE RAPID PROTOTYPING MACHINE.

SCENE 19.
RT19A, FTD56, 08:03:57:00-08:04:40:00
zoom out, dmls process unattended

NARRATION (VO):

COMMONLY, THESE THREE STEPS OF THE RAPID PROTOTYPING PROCESS ARE COMPLETED IN LESS THAN ONE DAY. FOR THE TOOL MAKER, ANOTHER IMPORTANT DISTINCTION IS THAT THE FIRST TWO STEPS ARE VIRTUALLY LABOR-LESS. THIS ALLOWS PATTERNS AND INSERTS TO BE CONSTRUCTED WITHOUT OPERATOR OVERSIGHT, ALLOWING TOOL MAKING STAFF TO WORK ON OTHER MOLD PRODUCTION ACTIVITIES.

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SCENE 20.
RT20A, CGS: Indirect Rapid Tooling Processes
white text, centered on background

SCENE 21.
RT21A, FMP829, 07:03:32:00-07:03:52:00
mold being pulled apart after curing
RT21B, CGS: Room Temperature Vulcanized Rubber Molding

NARRATION (VO):

INDIRECT RAPID TOOLING PROCESSES PRODUCE MOLDS BY FORMING THEM FROM A PATTERN. A

COMMON EXAMPLE OF THIS TECHNIQUE IS 'RTV', OR ROOM TEMPERATURE VULCANIZED RUBBER MOLDING.

SCENE 22.
RT22A, FMP828, 06:11:17:00-06:11:56:00
pouring of rtv material into mold

NARRATION (VO):

'RTV' TOOLING, WHICH IS USED FOR GRAVITY CASTING OR LOW-PRESSURE MOLDING OF THERMOSET PLASTICS, INVOLVES THE USE OF 'RTV' SILICONE MATERIALS TO PRODUCE THE MOLDS.

SCENE 23.
continue previous shot
RT23A, FTD69, 02:29:48:00-02:30:06:00
zoom in, rapid prototyping pattern being made for rtv process

NARRATION (VO):

TYPICALLY, THE PATTERN USED TO PRODUCE THIS TYPE OF INDIRECT RAPID TOOLING IS CONSTRUCTED USING A RAPID PROTOTYPING MACHINE.

SCENE 24.
RT24A, cad image of glove box showing draft angle of side walls
RT24B, FTD70, 04:09:55:00-04:10:12:00
zoom in, cad part being looked at

NARRATION (VO):

TO AID IN PART REMOVAL, DRAFT MAY BE ADDED TO THE PATTERN'S SIDE WALLS. TO COMPENSATE FOR THE NET SHRINKAGE OF THE MOLD MATERIAL AND THE PLASTIC FOR THE PART, THE PATTERN'S SIZE MAY BE ADJUSTED.

SCENE 25.
RT25A, FTD70, 04:11:01:00-04:11:51:00
cad pattern file converted to stl file

NARRATION (VO):

FOLLOWING PATTERN DESIGN, AN 'STL' FILE IS EXPORTED FROM THE 'CAD' SOFTWARE PROGRAM, PREPARED FOR RAPID PROTOTYPING, AND THEN DOWNLOADED TO THE MACHINE.

SCENE 26.
RT26A, FMP830, 08:10:27:00-08:10:50:00

NARRATION (VO):

zoom in, rapid prototyping of pattern

UNLIKE MACHINING AND FABRICATION PROCESSES, THE BUILD TIME FOR THE PATTERN IS DEPENDENT ON ITS SIZE AND MASS, NOT THE LEVEL OF DETAIL AND NUMBER OF FEATURES.

SCENE 27.
RT27A, FMP830, 08:28:56:00-08:29:09:00
pattern being post processed
RT27B, FTD70, 04:01:34:00-04:01:57:00
zoom out, pattern being post processed
RT27C, FTD70, 04:04:34:00-04:04:53:00
pattern being sealed

NARRATION (VO):

FOLLOWING THE PATTERN'S CONSTRUCTION, IT IS POSTPROCESSED TO PREPARE IT FOR MOLD CREATION. THIS OFTEN ENTAILS FILLING OF BUILD LINES, FINE FINISH SANDING, AND APPLICATION OF A PATTERN SEALER.

SCENE 28.
RT28A, FMP842, 12:03:43:00-12:03:58:00
prepared rapid prototyped pattern
RT28B, FMP842, 12:06:19:00-12:06:31:00
pattern secured in clay, parting line defined
RT28C, FMP842, 12:08:35:00-12:08:50:00
frame built around pattern

NARRATION (VO):

ONCE POST PROCESSED, DEVELOPMENT OF THE FIRST MOLD HALF TYPICALLY BEGINS BY SECURING THE PATTERN IN OIL-BASED CLAY, OR OTHER BUILDING MATERIALS, AND CONSTRUCTING THE PARTING LINE..., THEN, THE PATTERN IS SECURED IN A BOX OR FRAME.

SCENE 29.
RT29A, FMP842, 12:23:51:00-12:24:16:00
rtv molding material pour around pattern half
RT29B, FTD68, 01:44:07:00-01:44:25:00
rtv tooling in vacuum

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.

SCENE 30.
RT30A, FMP842, 12:10:39:00-12:10:52:00
box removed from first mold half
RT30B, FMP842, 12:14:26:00-12:14:37:00
sealing ring cut
RT30C, FMP842, 12:15:37:00-12:15:43:00
building box around first mold half
RT30D, FMP842, 12:17:09:00-12:17:16:00
release sprayed on pattern box
RT30E, FMP842, 12:18:28:00-12:18:44:00
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.
IT MAY ALSO INCLUDE ADDING A GATE FOR INJECTION, AND VENTING TO ALLOW AIR IN THE MOLD TO ESCAPE.

SCENE 31.
RT31A, FMP842, 12:23:07:00-12:23:38:00
zoom in, second mold half poured
RT31B, FMP842, 12:21:29:00-12:21:37:00
mold halves separated
RT31C, FMP842, 12:21:46:00-12:21:51:00
pattern removed from mold
RT31D, FMP842, 12:22:01:00-12:22:30:00
mold halves prepared for injection

NARRATION (VO):

ONCE PREPARED, THE SECOND MOLD HALF IS POURED, AND ALLOWED TO CURE...,
AFTER CURING, THE MOLD HALVES ARE SEPARATED ALONG THE PARTING LINE...,
THE PATTERN IS REMOVED...,
AND THE MOLD IS PREPARED FOR USE.

SCENE 32.
RT32A, FTD70, 04:14:51:00-04:15:10:00
zoom out, part pulled from 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 33.
RT33A, FMP829, 07:08:16:00-07:08:32:00
mold put together
RT33B, FMP829, 07:12:21:00-07:13:12:00
molding of parts using rtv mold
RT33C, CGS: Casting Material

NARRATION (VO):

'RTV' TOOLING CAN TYPICALLY BE USED TO MOLD MANY PARTS BEFORE REPLACEMENT

Accuracy & Finish Requirements
Complexity of the Part Geometry

TOOLING BECOMES NECESSARY. THE TOOL LIFE DEPENDS ON THE CASTING MATERIAL, ACCURACY AND FINISH REQUIREMENTS, AND THE COMPLEXITY OF THE PART GEOMETRY.

SCENE 34.
RT34A, FMP828, 06:16:51:00-06:17:10:00
simple mold halves put together
RT34B, FMP829, 07:23:54:00-07:24:05:00
complex mold halves put together
RT34C, FMP829, 07:26:18:00-07:26:56:00
molding material injected into mold
RT34D, FTD68, 01:30:32:00-01:30:48:00
zoom out, part pulled from 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 THERMOSET MATERIALS, AND BECAUSE OF THE NECESSITY TO MECHANICALLY DEFORM THE MOLD TO REMOVE PARTS.

--- FADE TO BLACK ---

SCENE 35.
RT35A, CGS: Direct Rapid Tooling Processes
white text, centered on background

SCENE 36.
RT36A, FTD65, 17:13:10:00-17:13:37:00
zoom in, dmls process

NARRATION (VO):

CONTRARY TO INDIRECT RAPID TOOLING PROCESSES THAT ARE WELL-ESTABLISHED AND WIDELY USED, DIRECT RAPID TOOLING PROCESSES ARE STILL EMERGING AND DEVELOPING AS THE TECHNOLOGIES, MATERIALS AND PROCESSES EVOLVE.

SCENE 37.
RT37A, zoom out, still, mold with dmls inserts
RT37B, FTD57, 08:06:22:00-08:06:33:00
injection mold process using dmls inserts, add vignette to image to mask edges

NARRATION (VO):

YET, RAPID TOOLING HAS BEEN SUCCESSFULLY DEPLOYED FOR PROTOTYPE, BRIDGE, SHORT-

RT37C, FTD57, 08:17:42:00-08:17:58:00
injection mold process using dmls inserts

RUN AND HIGH VOLUME INJECTION MOLDING OPERATIONS USING MATERIALS RANGING FROM COMMODITY PLASTICS TO HIGHLY-ENGINEERED RESINS.

SCENE 38.
RT38A, FTD71, 05:20:45:00-05:21:07:00
mold insert being benched
RT38B, FTD71, 05:18:11:00-05:18:28:00
zoom out, mold base being assembled with dmls inserts

NARRATION (VO):

THE AIM OF DIRECT RAPID TOOLING IS TO DRAMATICALLY DECREASE THE TIME FOR MOLD CONSTRUCTION. WHEN APPLIED PROPERLY, MOLD MAKERS CITE LEAD TIMES OF THREE TO FOURTEEN DAYS FOR STANDARD TOOLS. IN CASES WHERE EXTENSIVE AMOUNTS OF EDM WORK ARE ELIMINATED, MOLD MAKERS REPORT TIME, AND COST, SAVINGS UPWARDS OF SIXTY-SIX PERCENT.

SCENE 39.
RT39A, FTD58, 10:24:54:00-10:25:20:00
cad design of cavity
RT39B, zoom in, still, mold with complete dmls core and cavity
RT39C, zoom out, still, mold using dmls only for complex region
RT39D, FTD63, 15:18:50:00-15:19:09:00
zoom in, mold with dmls slides

NARRATION (VO):

TO ACHIEVE THESE IMPRESSIVE RESULTS, TOOL MAKERS ARE APPROACHING TOOL DESIGN AND CONSTRUCTION WITH AN EMPHASIS ON USING THE RIGHT PROCESS FOR DISCRETE ELEMENTS OF THE TOOL. THEY MAY APPLY RAPID TOOLING TO THE CONSTRUCTION OF COMPLETE CORES AND CAVITIES; A COMPLEX REGION OF A CORE OR CAVITY; OR INDIVIDUAL COMPONENTS SUCH AS GATES, SLIDES AND LIFTERS.

SCENE 40.
RT40A, FTD63, 15:49:23:00-15:50:28:00
injection mold process using dmls inserts

NARRATION (VO):

ALTHOUGH FEASIBLE, IT IS UNCOMMON FOR AN

ENTIRE INJECTION MOLD TO BE RAPID TOOLED. THOSE THAT HAVE BEEN SUCCESSFUL WITH RAPID TOOLING TAKE A DIFFERENT APPROACH - THEY EVALUATE EACH ELEMENT OF THE TOOL TO DETERMINE WHAT WOULD BE THE FASTEST CONSTRUCTION PROCESS. THE RESULT IS A HYBRID TOOL THAT IS PIECED TOGETHER FROM COMPONENTS THAT ARE INVENTORIED, MACHINED OR RAPID TOOLED.

SCENE 41.
RT41A, FTD64, 16:19:36:00-16:20:01:00
zoom in, dmls process
RT41B, FTD65, 17:20:15:00-17:20:30:00
zoom out, mold with dmls inserts

NARRATION (VO):

IN THIS CONTEXT, RAPID TOOLING BECOMES AN ALTERNATIVE FOR EACH ELEMENT, OR PIECE, OF THE INJECTION MOLD RATHER THAN A SUBSTITUTION FOR CONVENTIONAL MANUFACTURING METHODS. PIECES THAT ARE RAPID TOOLED ARE COMBINED WITH MACHINED METAL CAVITIES AND PURCHASED MOLD BASES.

SCENE 42.
RT42A, FTD65, 18:05:16:00-18:05:40:00
zoom out, powder cleaned from around dmls inserts

NARRATION (VO):

THE ADDITIVE FABRICATION TECHNOLOGIES THAT ARE USED GENERALLY PRODUCE NET SHAPE, FULLY DENSE METAL COMPONENTS WITH SURFACE FINISH AND ACCURACIES SUITABLE FOR MANY INJECTION MOLDING APPLICATIONS.

SCENE 43.
RT43A, FTD65, 17:07:56:00-17:08:36:00
zoom in, dmls process
RT43B, CGS: Stainless Steel
Cobalt Chromium
Maraging Steel
Titanium
Alloy Blends

NARRATION (VO):

WHILE THERE ARE SEVERAL TECHNOLOGIES THAT MEET THESE CRITERIA, THE MOST PREVALENT ARE DIRECT METAL LASER-

SINTERING, OR 'DMLS', AND SELECTIVE LASER MELTING, OR 'SLM'. THESE ADDITIVE TECHNOLOGIES PRODUCE PARTS IN MATERIALS THAT INCLUDE STAINLESS STEEL, COBALT CHROMIUM, MARAGING STEEL, TITANIUM AND ALLOY BLENDS.

SCENE 44.
RT44A, FTD61, 13:45:31:00-13:46:07:00
zoom in, rapid prototyping with nanotool material
RT44B, CGS: Acrylonitrile Butadiene Styrene
Acetal
Polycarbonate

NARRATION (VO):

ADDITIONALLY, USING RESINS, SUCH AS THE CERAMIC-FILLED 'NANOTOOL', THE STEREOLITHOGRAPHY PROCESS HAS BEEN APPLIED TO MOLD CONSTRUCTION FOR SMALL QUANTITIES OF PARTS INJECTION MOLDED IN A WIDE RANGE OF THE THERMOPLASTICS, INCLUDING:
ACRYLONITRILE BUTADIENE STYRENE, OR ABS,
ACETAL,
AND POLYCARBONATE.

SCENE 45.
RT45A, FTD63, 15:56:12:00-15:56:42:00
injection molded part removed
RT45B, FTD58, 10:17:26:00-10:17:42:00
dmls inserts in cad program
RT45C, FTD56, 07:53:35:00-07:53:50:00
zoom out, dmls process
RT45D, FTD66, 19:21:00:00-19:21:22:00
mold insert being ground
RT45E, FTD57, 08:12:00:00-08:12:13:00
zoom in, injection mold using dmls inserts

NARRATION (VO):

WHETHER USING METAL OR PLASTIC INSERTS, THE KEY TO SUCCESSFUL RAPID TOOLING DEPLOYMENT IS TO EVALUATE THE PROJECT THROUGH THE EYES OF THE PRODUCT DESIGNER, TOOL DESIGNER, MACHINIST, TOOL MAKER AND MOLDER. THIS COMPREHENSIVE VIEW PROVIDES AN APPRECIATION FOR THE CHALLENGES IN EACH STEP OF THE PROCESS, THE GOALS OF EACH OPERATION AND THE OPPORTUNITIES FOR IMPROVEMENT.

SCENE 46.
RT46A, FTD71, 05:28:59:00-05:29:12:00
zoom out, dmls inserts in cad program
RT46B, FTD64, 16:15:43:00-16:16:20:00
dmls process
RT46C, FTD66, 19:32:39:00-19:32:59:00
tilt, mold base being assembled with dmls inserts

NARRATION (VO):

IN THIS CONTEXT, THE INJECTION MOLD IS THEN ASSESSED COMPONENT-BY-COMPONENT AND ZONE-BY-ZONE WITH THE GOAL OF DETERMINING WHAT IS THE FASTEST METHOD TO MANUFACTURE EACH AREA OR ELEMENT OF THE MOLD WHILE MEETING THE PRODUCTION DEMANDS. WITH FEW EXCEPTIONS, THIS RESULTS IN A HYBRID TOOL CONSTRUCTED FROM BOTH ADDITIVE AND SUBTRACTIVE PROCESSES.

SCENE 47.
RT47A, FTD65, 18:10:05:00-18:10:20:00
zoom out, detailed dmls insert
RT47B, FMP253, 08:22:30:00-08:22:42:00
edming of mold
RT47C, FTD65, 17:05:16:00-17:05:34:00
dmls process

NARRATION (VO):

RAPID TOOLING IS MOST EFFECTIVE WHEN USED TO PRODUCE FINE, INTRICATE DETAILS. IF A TOOL'S DESIGN SHOWS AN AREA, OR COMPONENT, THAT REQUIRES EXTENSIVE EDM WORK OR FINE MACHINING, THIS SIGNALS AN OPPORTUNITY TO ACCELERATE THE MOLD MAKING PROCESS THROUGH RAPID TOOLING TECHNOLOGIES.

SCENE 48.
RT48A, FTD64, 16:20:15:00-16:20:49:00
dmls process
RT48B, FTD71, 05:13:49:00-05:14:21:00
zoom out, machining of mold base

NARRATION (VO):

IN ESSENCE, RAPID TOOLING REPLACES THE MACHINING OPERATIONS FOR ONLY THE AREAS, OR ELEMENTS, OF THE TOOL THAT WOULD BE TIME CONSUMING AND LABOR INTENSIVE. IT ALSO ENABLES A CONCURRENT, DUAL-PATH WORKFLOW THAT EXPEDITES DELIVERY AND

IMPROVES PRODUCTIVITY.

SCENE 49.
RT49A, FTD60, 12:07:03:00-12:07:26:00
dmls operation
RT49B, CGS: Tool Design
RT49C, FTD71, 05:35:24:00-05:35:31:00
cad design of dmls inserts, dissolve to next image
RT49D, FTD71, 05:35:33:00-05:35:39:00
cad design of dmls inserts
RT49E, CGS: Component Building
RT49F, FTD64, 16:14:43:00-16:15:00:00
zoom in, dmls process
RT49G, CGS: Tool Assembly
RT49H, FTD66, 19:40:54:00-19:41:08:00
assembly of dmls tool
RT49I, CGS: Injection Molding
RT49J, FTD67, 21:10:23:00-21:10:37:00
injection molding using dmls inserts

NARRATION (VO):

THE BASIC, FOUR-STEP PROCESS FOR CONSTRUCTING INJECTION MOLDS WITH RAPID TOOLING TECHNIQUES IS THE SAME AS THAT WHEN MACHINING A MOLD:

TOOL DESIGN...,

COMPONENT BUILDING...,

TOOL ASSEMBLY...,

AND INJECTION MOLDING.

---TOUCH BLACK---

SCENE 50.
RT50A, CGS: Tool Design
RT50B, FTD71, 05:25:59:00-05:26:20:00
zoom out, dmls inserts in cad program

NARRATION (VO):

AFTER REVIEWING THE COMPONENTS OF THE TOOL AND IDENTIFYING WHAT IS TO BE RAPID TOOLED AND WHAT IS TO BE MACHINED, THE NEXT STEP IS TO DESIGN THE INSERTS.

SCENE 51.
continue previous shot
RT51A, FTD65, 17:02:24:00-17:03:02:00
zoom out, dmls process
RT51C, FMP908, 03:26:27:00-03:26:44:00
zoom in, machining process

NARRATION (VO):

THE INSERTS ARE DESIGNED SUCH THAT SIZE AND MASS ARE MINIMIZED. IT IS IMPORTANT TO RECOGNIZE THAT EFFICIENT RAPID TOOLING IS ACHIEVED WHEN THE VOLUME OF MATERIAL TO BE ADDITIVELY FABRICATED IS MINIMIZED, WHICH IS IN STARK CONTRAST TO EFFICIENT MACHINING THAT MINIMIZES THE VOLUME OF MATERIAL TO BE REMOVED AND NUMBER OF TOOL OR CLAMPING CHANGES.

SCENE 52.
RT52A, FTD65, 17:15:20:00-17:15:26:00

NARRATION (VO):

core with empty pocket, dissolve into next image
RT52B, FTD65, 17:15:30:00-17:15:36:00
insert placed into core pocket

HAVING DESIGNED THE INSERTS, CREATE A POCKET IN THE CORE, CAVITY OR MOLD BASE INTO WHICH EACH WILL SEAT.

SCENE 53.
RT53A, FTD66, 19:25:35:00-19:26:02:00
zoom out, inserts being machined for precision fit into mold base
RT53B, FTD57, 09:07:20:00-09:07:38:00
zoom out, dmls mold with flat parting surface

NARRATION (VO):

OPTIONALLY, THE INSERTS MAY BE ADJUSTED TO ALLOW MACHINING STOCK FOR A PRECISE FIT IN THE MACHINED POCKETS. A SMALL AMOUNT OF STOCK IS ADDED TO THE BACK FACE AND SIDE WALLS OF THE INSERT. WHEN THE PARTING SURFACE IS FLAT OR RELATIVELY SIMPLY, SOME STOCK MAY ALSO BE ADDED TO THIS FACE.

SCENE 54.
RT54A, FTD57, 09:27:50:00-09:28:04:00
zoom out, through holes in dmls insert mold
RT54B, tilt, still dmls insert with multiple holes

NARRATION (VO):

ADDITIONALLY, STOCK MAY BE ADDED TO THROUGH HOLES, SUCH AS THOSE FOR THE EJECTOR PINS. TO MINIMIZE THE SECONDARY MACHINING, STOCK ALLOWANCES TYPICALLY RANGE FROM TEN THOUSANDTHS OF INCH TO TWENTY-FIVE THOUSANDTHS OF INCH.

SCENE 55.
RT55A, FTD57, 09:19:27:00-09:19:40:00
pan, cavity and core side of mold having dmls insert
RT55B, FTD57, 09:12:46:00-09:13:03:00
zoom out, gate of dmls insert

NARRATION (VO):

FOR DIRECT METAL INSERTS, IT IS ADVISABLE TO ADHERE TO RECOMMENDED ALLOWANCES FOR DRAFT ANGLES. WHEN PRACTICAL, GATES ARE ALSO DESIGNED INTO THE INSERT OR PRODUCED INDEPENDENTLY WITH THE DIRECT METAL TECHNOLOGY.

SCENE 56.
RT56A, FTD61, 13:41:01:00-13:41:17:00

NARRATION (VO):

stereolithography process using nanotool material
RT56B, FTD62, 14:02:55:00-14:03:14:00
part removed from mold using nanotool insert

WHEN USING STEREOLITHOGRAPHY INSERTS MADE FROM 'NANOTOOL', THERE ARE ADDITIONAL DESIGN REQUIREMENTS THAT ARISE BECAUSE OF THE MATERIAL'S PROPERTIES. SINCE THE INSERT IS A COMPOSITE PLASTIC, IT IS IMPORTANT TO DESIGN THE COMPONENTS TO AVOID DAMAGE THAT MAY RESULT DURING PLASTIC INJECTION AND PART EJECTION.

SCENE 57.
RT57A, FTD61, 13:08:53:00-13:09:04:00
small nanotool inserts draining
RT57B, zoom in, mold with small nanotool inserts

NARRATION (VO):

'NANOTOOL' INSERTS ARE GENERALLY LESS THAN FOUR INCHES FROM SIDE TO SIDE. ANYTHING LARGER REQUIRES AN INJECTION PRESSURE AND SHOT SIZE THAT WILL MOST LIKELY DAMAGE THE TOOL.

SCENE 58.
RT58A, still, nanotool insert in mold
RT58B, c.u., nanotool insert cavity
RT58C, c.u., gate of nanotool mold
RT58D, relocated gate of nanotool mold, dissolve into next shot
RT58E, relocated gate of nanotool mold
RT58F, c.u., nanotool mold with large standing ribs

NARRATION (VO):

ADDITIONAL DESIGN RULES FOR THE 'NANOTOOL' INSERTS INCLUDE:
DRAFT ANGLES OF TWO TO FOUR DEGREES OR MORE...,
OVERSIZED GATES THAT ARE TWO TO THREE TIMES THE STANDARD SIZE...,
RELOCATED GATES TO DECREASE INJECTION PRESSURES...,
STANDING RIBS GREATER THAN A SIXTEENTH OF AN INCH THICK WITH A HEIGHT TO WIDTH RATIO NO MORE THAN 3 TO 1.

SCENE 59.
RT59A, FTD61, 13:09:16:00-13:09:28:00
zoom out, nanotool insert draining
RT59B, FTD62, 14:20:23:00-14:20:44:00
injection molding operation using nanotool insert, parts manually pulled from mold

NARRATION (VO):

A FINAL DESIGN CONSIDERATION FOR A RAPID TOOL USING 'NANOTOOL' INSERTS IS TO SIMPLIFY THE TOOL'S OPERATION. SINCE THE TOOL WILL ONLY BE EXPECTED TO MOLD A SMALL NUMBER OF PARTS, TYPICALLY BETWEEN 20 AND 1,000, IT'S BEST TO DESIGN IT FOR MANUAL PART EJECTION THAT INCORPORATES HAND-LOADED INSERTS RATHER THAN SLIDES OR LIFTERS.

SCENE 60.
RT60A, CGS: Component Building
RT60B, FTD61, 13:39:42:00-13:40:08:00
zoom in, stereolithography process using nanotool material

NARRATION (VO):

ONCE THE TOOL DESIGN IS COMPLETE, THE RAPID PROTOTYPING BUILD CAN PROCEED.

SCENE 61.
continue previous shot
RT61A, FTD64, 16:06:51:00-16:07:41:00
zoom out, dmls process
RT61B, CGS: Layer Thickness
Build Orientation

NARRATION (VO):

THE RAPID PROTOTYPED INSERTS AND TOOLING COMPONENTS REQUIRE NO PROCESS MODIFICATION. HOWEVER, CONSIDERATION SHOULD BE GIVEN TO CONSTRUCTION CHARACTERISTICS THAT MAY CONTRIBUTE TO NET SHAPE PRODUCTION, WHICH ELIMINATES OR MINIMIZES SECONDARY MACHINING AND SIMPLIFIES POSTPROCESSING. THESE CONSIDERATIONS INCLUDE LAYER THICKNESS AND BUILD ORIENTATION.

SCENE 62.
RT62A, FMP908, 03:27:02:00-03:27:14:00
zoom out, machining of mold components
RT62B, FMP913, 08:21:31:00-08:21:45:00
grinding of pin

NARRATION (VO):

WHILE BUILDING THE RAPID TOOLED COMPONENTS, THE SIMULTANEOUS MACHINING

OF ALL OTHER INJECTION MOLD ELEMENTS, SUCH AS CORES, CAVITIES, GATES, SLIDES, AND EJECTION SYSTEM CAN OCCUR.

SCENE 63.
RT63A, peter carey narration replacement
RT63B, FTD61, 13:18:40:00-13:18:50:00
nanotool being wiped
RT63C, FTD61, 13:27:05:00-13:27:29:00
nanotool going into uv oven
RT63D, CGS: Parts Washing
Support Removal
Ultraviolet Curing
RT63E, FTD66, 19:17:24:00-19:17:45:00
dmls inserts being post processed
RT63F, FTD66, 19:06:39:00-19:06:58:00
dmls inserts cut from platform
RT63G, FTD59, 11:49:50:00-11:50:02:00
dmls insert attached to build platform, pulled from machine

NARRATION (VO):

ONCE RAPID PROTOTYPING IS COMPLETE, THE INSERTS ARE POSTPROCESSED. FOR 'NANOTOOL' INSERTS, THIS INCLUDES PARTS WASHING, SUPPORT REMOVAL AND ULTRAVIOLET, OR UV CURING. FOR THE 'DMLS' AND 'SLM' PROCESSES, THIS INCLUDES REMOVAL OF SUPPORTS AND ANY EXCESS METAL POWDER. WHILE THE BUILD PLATFORM MAY BE CUT AWAY FROM THE METAL INSERT, IT IS OFTEN INCLUDED AS AN INTEGRAL MOLD ELEMENT.

SCENE 64.
RT64A, FTD59, 11:51:51:00-11:52:11:00
zoom out, shot peening on dmls insert

NARRATION (VO):

SHOT PEENING IS OFTEN USED TO IMPROVE THE SURFACE FINISH AND COMPACT THE OUTER SKIN OF THE DIRECT METAL INSERT FOR ENHANCED DURABILITY.

SCENE 65.
RT65A, peter carey narration replacement
RT65B, FTD66, 19:28:24:00-19:28:42:00
zoom out, dmls insert being machined

NARRATION (VO):

IT IS CRITICAL TO AVOID EXCESSIVE SECONDARY OPERATIONS FOR THE PURPOSE OF HOLDING DESIRED TOLERANCES AND IMPROVING SURFACE FINISH.

SCENE 66.
RT66A, peter carey narration replacement
RT66B, FTD02, 02:42:15:00-02:42:48:00
zoom in, edming of injection mold

NARRATION (VO):

IF A SIGNIFICANT AMOUNT OF MACHINING IS

RT66C, CM47, 19:19:39:00-19:20:00:00
zoom out, edming of injection mold

REQUIRED TO DELIVER THE SURFACE FINISH AND ACCURACY NEEDED FOR THE INJECTION MOLD, THE TIME FOR MACHINE SET UP AND OPERATION WILL NEGATE THE TIME ADVANTAGE THAT RAPID TOOLING OFFERS. THIS IS ESPECIALLY TRUE WHEN USING EDM AS A SECONDARY OPERATION.

SCENE 67.
RT67A, zoom in, still, gate with stair stepping
RT67B, pan, still, stair stepping on dmls insert

NARRATION (VO):

ADDITIONALLY, STAIR STEPPING, WHICH NATURALLY RESULTS FROM SOME RAPID PROTOTYPING LAYERING PROCESSES, OCCURS ON INSERT SURFACES THAT ARE NOT VERTICAL OR HORIZONTAL. IF MACHINING OR POLISHING ISN'T A PRACTICAL SOLUTION TO REMOVE THESE STAIR STEPS, THEY MAY CAUSE SOME DIFFICULTY WHEN EJECTING THE MOLDED PART, OR AFFECT THE PARTS COSMETIC APPEAL.

SCENE 68.
RT68A, peter carey narration replacement
RT68B, FTD66, 19:33:35:00-19:34:11:00
zoom out, dmls insert being ground for placement in mold base
RT68C, FTD66, 19:45:52:00-19:46:21:00
dmls insert being ground for placement in mold base
RT68D, zoom out, still, dmls mold insert with holes

NARRATION (VO):

IF STOCK WAS ADDED TO AN INSERT'S DESIGN, THE SIDE WALLS, BACK FACE AND PARTING SURFACE MUST BE FINISHED TO SIZE BEFORE ASSEMBLY. DEPENDING ON THE TYPE OF INSERT AND THE MATERIAL FROM WHICH IT IS MADE, THE MATERIAL MAY BE REMOVED BY GRINDING, MILLING OR WIRE EDM. HOLES THAT WERE INTENTIONALLY UNDERSIZED ARE REAMED TO SIZE.

SCENE 69.
RT69A, CGS: Tool assembly
RT69B, FTD66, 20:00:21:00-20:00:35:00
zoom in, dmls inserts mounted into mold base
RT69C, FTD66, 19:44:15:00-19:44:24:00
insert placed into empty pocket
RT69D, FTD66, 19:39:05:00-19:39:15:00
insert placed into empty pocket

NARRATION (VO):

FINALLY, THE INSERTS ARE MOUNTED INTO THE POCKETS THAT HAVE BEEN MACHINED TO ACCEPT THEM, AND ALL OTHER COMPONENTS ARE ADDED TO COMPLETE THE INJECTION MOLD.

SCENE 70.
RT70A, CGS: Injection Molding
RT70B, FTD67, 21:03:33:00-21:03:41:00
dmls mold mounted to injection molding machine

NARRATION (VO):

THE MOLD IS THEN MOUNTED IN THE MACHINE FOR INJECTION MOLDING.

SCENE 71.
RT71A, still, zoom in, damaged nanotool inserts
RT71B, FTD62, 14:23:18:00-14:23:38:00
injection molding using nanotool inserts

NARRATION (VO):

'NANOTOOL' INSERTS DO NOT HAVE THE MECHANICAL PROPERTIES OF A METAL TOOL, SO EXCESSIVE PRESSURE AND FORCEFUL PACKING OF THE CAVITY WILL RESULT IN INSERT DAMAGE. FOR THIS REASON, EASING INTO THE PRESSURE AND SHOT SIZE UNTIL THE CAVITY IS COMPLETELY FILLED AND GOOD PARTS ARE MOLDED IS ADVISABLE.

SCENE 72.
RT72A, FTD62, 14:28:48:00-14:29:00:00
zoom out, nanotool insert in mold
RT72B, FTD62, 14:09:44:00-14:10:00:00
injection molding using nanotool inserts
RT72C, still, deformed, failed nanotool insert and part

NARRATION (VO):

ADDITIONALLY, THE COMPOSITE PLASTIC 'NANOTOOL' MATERIAL ACTS AS AN INSULATOR. EVEN WITH OVERSIZED COOLING CHANNELS, THE TEMPERATURE OF THE INSERT WILL CONTINUE TO RISE WITH EACH INJECTION CYCLE. IF ALLOWED TO GET TOO HOT, THE PLASTIC PARTS MAY BEGIN TO STICK TO THE INSERT, THE INSERT MAY

DEFORM OR THE INSERT MAY FAIL.

SCENE 73.
RT73A, FTD62, 14:25:57:00-14:26:16:00
wide, injection molding using nanotool inserts, parts removed manually

NARRATION (VO):

TO COUNTERACT ANY HEAT RETENTION, THE CYCLE TIME MUST BE INCREASED. FOR MOST THERMOPLASTICS, AN INCREASE OF 30 TO 60 SECONDS IS SUFFICIENT.

SCENE 74.
RT74A, FTD62, 14:13:52:00-14:14:08:00
zoom in, injection molding using nanotool inserts, parts removed manually

NARRATION (VO):

IF THE TOOL IS OPERATED MANUALLY THE DELAY BETWEEN INJECTION MOLDING SHOTS SHOULD BE SUFFICIENT TO ALLOW THE TOOL TO COOL.

SCENE 75.
RT75A, FTD62, 14:24:33:00-14:25:03:00
zoom in, injection molding using nanotool inserts, parts ejected

NARRATION (VO):

IN SOME CASES, THE THERMAL PROPERTIES OF THE ‘NANOTOOL’ INSERT ARE BENEFICIAL. THE ELEVATED TEMPERATURE OF THE TOOL MAY AVOID SHORT SHOTS BY PREVENTING FREEZING OFF OF THE PLASTIC IN THE CAVITY.

SCENE 76.
RT76A, FTD63, 15:43:33:00-15:44:13:00
zoom in, injection molding using dmls inserts

NARRATION (VO):

‘DMLS’ AND ‘SLM’ METAL INSERTS DON’T REQUIRE ANY SPECIAL CHANGES TO THE INJECTION MOLDING MACHINE. THE STRENGTH OF THE METAL INSERTS ELIMINATES THE NEED TO EASE INTO SHOT SIZE AND PRESSURE, AND ITS COOLING RATE IS SIMILAR TO THAT OF THE OTHER MOLD COMPONENTS, ALLOWING CONSISTENT COOLING.

SCENE 77.
RT77A, FTD57, 08:08:08:00-08:08:24:00

NARRATION (VO):

zoom in, injection molding using conformal cooling lines
RT77A, FTD57, 08:10:42:00-08:10:58:00
injection molding using conformal cooling lines

WHEN USED IN HIGH-VOLUME PRODUCTION MOLDS, RAPID TOOLING OFFERS A UNIQUE OPPORTUNITY FOR DECREASING CYCLE TIMES SIGNIFICANTLY BY USING CONFORMAL COOLING LINES.

SCENE 78.
RT78A, FTD59, 11:18:30:00-11:18:49:00
zoom out, dmls process
RT78B, FTD59, 11:34:59:00-11:35:08:00
cad image of insert cut away with conformal cooling lines
RT78C, FTD59, 11:35:33:00-11:35:42:00
cad image of insert with conformal cooling lines
RT78D, FTD57, 08:12:26:00-08:12:42:00
zoom in, injection molding using conformal cooling lines

NARRATION (VO):

SINCE COMPLEXITY IS NOT A CONCERN WHEN ADDITIVELY CONSTRUCTING A MOLD AND ITS INSERTS, RAPID TOOLING CAN ACCOMMODATE COOLING CHANNELS THAT TWIST, BEND AND CONTORT TO FOLLOW THE CONTOURS OF THE MOLD'S CAVITY. THIS CIRCULATES COOLANT ACROSS THE ENTIRE MOLD CAVITY OR IN THE HOTTEST SPOTS OF THE MOLD.

SCENE 79.
RT79A, FTD59, 11:36:44:00-11:36:56:00
pan, cad image of conformal cooling lines
RT79B, FMP415, 10:25:49:00-10:26:02:00
mold with cooling lines, opening expelling part

NARRATION (VO):

THE CONFORMAL COOLING CHANNELS, WHEN DESIGNED EFFECTIVELY, HAVE BEEN REPORTED TO DECREASE CYCLE TIMES BY AS MUCH AS 40 PERCENT WHEN COMPARE TO THE STRAIGHT LINE, GUN DRILLED CHANNELS OF CONVENTIONALLY MADE INJECTION MOLDS.

--- TOUCH BLACK ---

SCENE 80.
RT80A, FTD61, 13:13:23:00-13:13:47:00
opening rtv mold
RT80B, FTD57, 08:10:44:00-08:10:57:00
dmls mold opening, dropping parts, closing

NARRATION (VO):

CONTRARY TO THE INDUSTRY PERCEPTIONS, RAPID TOOLING IS NOT LIMITED TO PROTOTYPING OR PRODUCTION OF SMALL PARTS IN SMALL QUANTITIES FROM A LIMITED

NUMBER OF PLASTICS. WHEN COMBINED WITH MACHINED COMPONENTS, RAPID TOOLING CAN PRODUCE LARGE NUMBERS OF LARGE PARTS IN MOST, IF NOT ALL, THERMOPLASTICS.

SCENE 81.
RT81A, FTD56, 07:45:41:00-07:45:56:00
dmls process, dissolve to next image
RT81B, FTD56, 07:47:41:00-07:47:56:00
dmls process later
RT81C, FTD57, 09:08:40:00-09:08:56:00
zoom out, dmls mold
RT81D, FTD59, 11:11:59:00-11:12:23:00
dmls process
FTD CXM, credit music

NARRATION (VO):

THEY KEY TO SUCCESS IS TO APPLY RAPID TOOLING TO THE COMPONENTS OR REGIONS OF THE TOOL THAT CAN LEVERAGE ITS STRENGTHS IN RAPIDLY CONSTRUCTING COMPLEX, INTRICATE AND DETAILED MOLD FEATURES. WITH THIS HYBRID APPROACH, RAPID TOOLING BECOMES AN ALTERNATIVE TO MACHINING CORES, CAVITIES AND COMPONENTS THAT WOULD PROVE TO BE DIFFICULT, TIME CONSUMING AND COSTLY TO MANUFACTURE USING CONVENTIONAL METHODS.

--- FADE TO BLACK ---

SCENE 82.
continue music, up and under
CD CRX 02, CGS, ROLL: credits
white text, fade up mid-screen
FTD EXM, extended motion background

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SCENE 83.
continue motion background
FTD DIS, CGS: disclaimer
white text, centered on background

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 84.
FTD03A, SME logo open, with music