COMPOSITES MANUFACTURING

Automated Composite Layup & Spray Up

SCENE 1.
AL01A, GRAPHIC: FBI warning
white text centered on black to blue gradient

WARNING

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SCENE 2.
AL02A, GRAPHIC: disclaimer
white text centered on black to blue gradient

Always read the operating manual and safety information provided by the manufacturer before operating any automated layup & spray up composite equipment.

Make sure all machine guards are in place, and follow all safety procedures when working with or near automated layup & spray up composite equipment.

SCENE 3.
AL03A, GRAPHIC: EMA/SME screen
white text centered on black to blue gradient

This program was produced using the technical resources of the Engineering Materials Applications Community of SME.

For more information on composites and automated layup & spray up, please visit our website at:

www.sme.org

SCENE 4.
AL04A, SME logo open, with music

SCENE 5.
AL05A, composites manufacturing open, with music
AL05B, peter carey narration

MUSIC UP AND UNDER

NARRATION (VO):

THE COMPOSITES MANUFACTURING SERIES, EXAMINING THE MATERIALS, TOOLS AND TECHNIQUES USED FOR COMPOSITES FABRICATION.

SCENE 6.
AL06A, GRAPHIC: Automated Composite Layup & Spray Up
white text centered on black

NARRATION (VO):

THIS PROGRAM IS AN INTRODUCTION TO AUTOMATED COMPOSITE LAYUP AND SPRAY-UP.

SCENE 7.
AL07A, tape 15, 15:01:25-15:01:42
manual layup operation
AL07B, tape 21, 21:03:23-21:03:40
manual spray up operation

NARRATION (VO):

TRANSFORMING PLASTIC-MATRIX COMPOSITES INTO USEFUL PRODUCTS BY MANUAL LAYUP...,
AND SPRAY-UP IS A FAIRLY LABORIOUS PROCESS CONSIDERING ALL THE PRODUCTION VARIABLES.

SCENE 8.
AL08A, tape 19, 19:18:36-19:18:46
manual layup operation
AL08B, tape 03, 03:07:31-03:07:59
zoom out, robotic spray up

NARRATION (VO):

FOR SHORT RUNS OF SMALL OR LARGE PARTS, MANUAL LAYUP OR SPRAY-UP CAN BE COST-EFFECTIVE, BUT AS PARTS PRODUCTION INCREASES, USE OF AUTOMATION BECOMES INCREASINGLY ECONOMICAL.

SCENE 9.
continue previous shot
AL09A, tape 01, 01:17:56-01:18:03
automated ply cutting
AL09B, tape 23, 20:23:00-20:23:06
tape layup machine
AL09C, tape 705, 20:24:53-20:25:00
fiber placement machine

NARRATION (VO):

THUS SEVERAL TECHNOLOGIES HAVE BEEN DEVELOPED TO AUTOMATE COMPOSITES MANUFACTURING, THEREBY INCREASING PRODUCTIVITY AND QUALITY IMPROVEMENT WHILE, MORE OFTEN THAN NOT, REDUCING PRODUCT COST.

--- TOUCH BLACK ---

SCENE 10.
AL10A, tape 23, 20:04:57-20:05:11
zoom out, prepreg tape being laid up
AL10B, tape 705, 20:34:39-20:34:48
prepreg tow rolled off creel by hand, slow down clip if necessary

NARRATION (VO):

MUCH OF THE AUTOMATION REGARDING LAYUP PERTAINS TO THE USE OF PREPREG, OR PREIMPREGNATED, MATERIAL. PREPREG COMBINES PARTIALLY CURED RESIN WITH TYPICALLY CONTINUOUS OR SHORT UNIDIRECTIONAL FIBERS IN

THIN SHEET, TAPE OR TOW FORM.

SCENE 11.
AL11A, tape 705, 20:28:31-20:28:49
zoom out, fiber placement machine placing prepreg on mold
AL11B, CGS: Glass
Carbon/Graphite
Aramid
Boron

NARRATION (VO):

THE PRIMARY REINFORCEMENT FIBERS USED ARE

GLASS,

CARBON OR GRAPHITE,

ARAMID,

AND IN SOME CASES, BORON.

SCENE 12.
AL12A, tape 27, 03:19:41-03:19:55
prepreg tape being laid
AL12B, tape 705, 20:01:09-20:01:16
c.u. prepreg fibers coming out of fiber placement machine
AL12C, CGS: Epoxy
Bismaleimide

NARRATION (VO):

ALTHOUGH THE MATRIX FOR PREPREG CAN BE A

THERMOSET OR THERMOPLASTIC RESIN, THERMOSETS

DOMINATE, WITH THE EPOXY AND BISMALEIMIDE

MATRIX MATERIALS BEING PRIMARILY USED.

--- TOUCH BLACK ---

SCENE 13.
AL13A, tape 23, 20:18:46-20:19:09
wide, prepreg tape being laid up

NARRATION (VO):

THE DIRECTION OR ORIENTATION OF THE FIBERS,

THE PRINCIPAL LOAD-BEARING ELEMENTS, CAN VARY

PLY TO PLY AND BETWEEN SERIES OF PLIES. AND

THAT ORIENTATION IS CRITICAL TO PART

PERFORMANCE.

SCENE 14.
AL14A, tape 01, 01:18:18-01:18:36
wide, ply cutting operation, plies being cut and marked
AL14B, CGS: Ply Cutting

NARRATION (VO):

THIS IS ONE OF THE MANY REASONS WHY PLY

CUTTING WAS THE FIRST OPERATION TO BE

AUTOMATED WITH THE USE OF PREPREG.

SCENE 15.
AL15A, tape 01, 01:20:23-01:20:31
ply cutting operation
AL15B, tape 01, 01:21:46-01:21:58
zoom in, nesting software
AL15C, tape 01, 01:22:42-01:22:58
pan of cut prepreg plies

NARRATION (VO):

PLY CUTTING OPERATIONS HAVE BEEN CLOSELY

INTEGRATED WITH AUTOMATED NESTING

TECHNOLOGIES. ONCE A COMPOSITE DESIGN IS FINALIZED, IT'S LOADED INTO NESTING SOFTWARE. THIS SOFTWARE MINIMIZES WASTE BY NESTING THE SHAPES TO BE CUT IN THE MOST ECONOMICAL PATTERN AND GOVERNS THE CUTTING OPERATION.

SCENE 16.
AL16A, tape 01, 01:22:25-01:22:39
c.u. ply cutting operation
AL16B, tape 01, 01:20:45-01:21:06
zoom out, ply cutting operation

NARRATION (VO):

CUTTING INVOLVES THE USE OF EITHER RECIPROCATING-KNIFE, ROTARY-KNIFE, MECHANICAL, ULTRASONIC, LASER OR WATER JET CUTTERS, OPERATING FROM A GANTRY. THE GANTRY TRAVERSES A LARGE TABLE SUPPORTING THE PREPREG, SOMETIMES MULTIPLE LAYERS AT A TIME. CUTTING IS RAPID AND ACCURATE.

SCENE 17.
AL17A, tape 01, 01:18:37-01:18:49
ply cutting operation, plies being cut and marked
AL17B, tape 01, 01:01:47-01:02:06
plies being collated into kits
AL17C, tape 01, 01:11:27-01:11:38
manual layup operation using prepreg

NARRATION (VO):

SHEETS AND PLIES CAN BE MARKED FOR IDENTIFICATION DURING CUTTING, FOR LATER COLLATION INTO BAGS CALLED KITS, FOR LAYUP. THESE KITS ARE EITHER USED IMMEDIATELY FOR LAYUP OR PLACED IN REFRIGERATED STORAGE FOR FUTURE USE.

--- TOUCH BLACK ---

SCENE 18.
AL18A, tape 25, 10:25:49-10:26:11
tape lamination machine running
AL18B, CGS: Tape Lamination Machines
AL18C, tape 705, 20:24:20-20:24:30
wide, fiber placement machine running
AL18D, CGS: Fiber Placement Machines

NARRATION (VO):

THE AUTOMATED LAYUP OF PREPREG MATERIAL IS USED PRIMARILY IN THE AEROSPACE INDUSTRY, AND IS ACCOMPLISHED USING TAPE LAMINATION MACHINES, CALLED TAPE LAYERS...,
AND FIBER PLACEMENT MACHINES.

SCENE 19.
AL19A, tape 23, 20:06:00-20:06:14
zoom out, tape laying operation
AL19B, CGS: Tape Lamination Machines

NARRATION (VO):

FOR FLAT AND VERY MILDLY CONTOURED PARTS, PLY DEPOSITION USING TAPE LAMINATION MACHINES HAS MARKEDLY DECREASED LAYUP TIME OVER MANUAL METHODS.

SCENE 20.
AL20A, tape 28, 04:38:09-04:38:34
tape laying operation
AL20B, tape 28, 04:36:45-04:37:24
wide, tape laying showing multiple axes
AL20C, CGS: Y Axis
AL20D, GRAPHIC: arrow showing y-axis
AL20E, CGS: X Axis
AL20F, GRAPHIC: arrow showing x-axis

NARRATION (VO):

TAPE LAMINATION MACHINES ARE FULLY PROGRAMMABLE GANTRY-STYLE COMPUTER-NUMERICALLY-CONTROLLED MACHINES. TYPICALLY THESE MACHINES HAVE A 'Y-AXIS' CROSS MEMBER...,

THAT SLIDES ON 'X-AXIS' WAYS...,

AND SUPPORTS A MULTIAXIS TAPE-LAYING HEAD.

SCENE 21.
AL21A, tape 24, 22:26:29-22:26:49
wide, head with spool of tape, zoom in, tape laying, cutting of tape

NARRATION (VO):

THE HEAD CONTAINS A SPOOL OF PAPER-BACKED UNIDIRECTIONALLY REINFORCED TAPE THAT IS UP TO TWELVE-INCHES OR 305-MILLIMETERS WIDE...,

AND DUAL-AXIS CUTTERS.

SCENE 22.
AL22A, tape 24, 22:03:46-22:04:02
first course of tape being laid

NARRATION (VO):

IN OPERATION, A COURSE OF TAPE IS AUTOMATICALLY DEPOSITED AT A DESIRED FIBER ORIENTATION, AND COMPACTED AT 40 POUNDS PER SQUARE INCH OR 275 KILOPASCALS.

SCENE 23.
AL23A, tape 24, 22:34:31-22:34:39
dual-axis cutter, cutting tape
AL23B, tape 25, 10:05:15-10:05:28
spool taking up paper

NARRATION (VO):

THE DUAL-AXIS CUTTERS CUT THE TAPE WITHOUT CUTTING THE PAPER...,

WHICH IS SIMULTANEOUSLY TAKEN UP ON ANOTHER

SPOOL.

SCENE 24.
AL24A, tape 24, 22:04:02-22:04:23
second course of tape being laid
AL24B, tape 24, 22:08:50-22:09:07
later tape courses being laid

NARRATION (VO):

ONCE THE COURSE OF TAPE IS LAID, THE HEAD ROTATES AND BEGINS DEPOSITION OF THE NEXT COURSE IN THE OPPOSITE DIRECTION, EDGE TO EDGE WITH THE PREVIOUS COURSE. TAPE COURSES ARE DEPOSITED IN THIS FASHION UNTIL A FULL PLY HAS BEEN LAID.

SCENE 25.
AL25A, tape 24, 22:27:40-22:27:49
c.u. tape course being laid, dissolve to next shot
AL25B, tape 24, 22:27:53-22:28:08
c.u. tape course being laid over previous course

NARRATION (VO):

ALL SUBSEQUENT PLIES ARE DEPOSITED IN LIKE MANNER...,
USUALLY WITH THE FIBERS IN EACH COURSE CROSSING ANGULARLY OVER THOSE OF THE FORMER ONE, UNTIL REQUIRED PART THICKNESS IS ACHIEVED.

SCENE 26.
AL26A, tape 25, 10:36:31-10:36:59
c.u. laying of tape
AL26B, tape 24, 22:14:52-22:15:09
tape layer computer

NARRATION (VO):

SOME TAPE-LAYER HEADS CAN APPLY HEAT TO THE PREPREG BEING APPLIED. THIS CAN INCREASE DEPOSITION RATES OR PROVIDE TACKINESS TO TAPE THAT IS INSUFFICIENTLY TACKY AT ROOM TEMPERATURE. TAPE TEMPERATURE AND OTHER PROCESS PARAMETERS CAN BE SET AUTOMATICALLY AND ARE CONTINUOUSLY MONITORED BY COMPUTER.

SCENE 27.
AL27A, tape 24, 22:02:50-22:03:24
wide, tape laying operation

NARRATION (VO):

THERE IS ESSENTIALLY NO LIMIT TO THE SIZE OF WORKPIECES THAT CAN BE PRODUCED USING A TAPE LAMINATION MACHINE, BUT TYPICALLY THE SHAPE OF

THE WORKPIECE HAS TO BE RELATIVELY FLAT DUE TO THE LIMITED COMPLIANCE OF THE PREPREG TAPE TO CURVATURE.

--- TOUCH BLACK ---

SCENE 28.
AL28A, tape 705, 20:09:01-20:09:16
wide, fiber placement machine moving into position on slides
AL28B, CGS: Fiber Placement Machines
AL28C, tape 705, 20:15:50-20:16:18
wide, fiber placement machine placing prepreg on mold

NARRATION (VO):

TO OVERCOME THE LIMITATIONS OF TAPE LAMINATION MACHINES, AUTOMATIC, MULTIAXIS, FIBER-PLACEMENT MACHINES WERE INTRODUCED. THESE MACHINES AUTOMATICALLY CONTROL DISPENSING NUMEROUS INDIVIDUAL UNIDIRECTIONAL PREPREG TOWS OR SLIT TAPE, WHICH ARE COLLIMATED AS THEY ARE LAID ON A MOLDS SURFACE.

SCENE 29.
AL29A, tape 705, 20:32:08-20:32:17
tows running off creels
AL29B, tape 705, 20:02:01-20:02:19
head open, cutting device running
AL29C, tape 705, 20:26:37-20:26:49
head individually cutting tows

NARRATION (VO):

THE TOW IS MOUNTED ON CREELS AND PULLED THROUGH COMBS. THE HEAD ON THE FIBER-PLACEMENT MACHINE HAS A CLAMPING, CUTTING AND RETHREADING DEVICE THAT ALLOWS IT TO STOP, CUT, AND START INDIVIDUAL TOWS DURING FIBER PLACEMENT.

SCENE 30.
AL30A, tape 705, 20:12:08-20:12:44
c.u., zoom out, fiber placement machine placing prepreg on mold

NARRATION (VO):

THE TOWS FEED DOWN INTO A HEATER FOR TACK ADJUSTMENT IF NECESSARY AND THEN PROCEEDS TO A ROLLER MECHANISM THAT COMPACTS THE MATERIAL INTO FLAT TAPE FOR APPLICATION.

SCENE 31.
AL31A, tape 705, 20:21:42-20:22:09
zoom out, fiber placement machine placing prepreg on mold
AL31B, tape 705, 20:32:18-20:32:29
c.u. tow rolling off creel

NARRATION (VO):

TOW BAND WIDTH CAN BE ALTERED BY ADDING OR DROPPING TOWS. FIBER-PLACEMENT SPEEDS RANGE

FROM 600 TO 2400 INCHES, OR 15,000 TO 61,000 MILLIMETERS, PER MINUTE, AND PLACEMENT ACCURACY IS WITHIN TWO-TEN THOUSANDTHS OF AN INCH OR FIVE THOUSANDTHS OF A MILLIMETER. INDIVIDUAL TOW WIDTH TYPICALLY IS ONE-EIGHTH INCH OR THREE-MILLIMETER.

SCENE 32.
AL32A, tape 705, 20:18:20-20:18:46
c.u., zoom out, fiber placement machine placing prepreg on mold

NARRATION (VO):

SINCE INDIVIDUAL TOW CAN BE INDEPENDENTLY DISPENSED, CLAMPED, CUT, AND RESTARTED DURING OPERATION, PARTS OF COMPOUND CURVATURE WITH CONVEX AND CONCAVE SURFACES AND SMALL BEND RADII CAN BE PRODUCED WITHOUT GAPS OR WRINKLES.

--- TOUCH BLACK ---

SCENE 33.
AL33A, tape 05, 05:09:27-05:09:49
zoom out, robotic spray up system
AL33B, tape 03, 03:08:56-03:09:15
zoom out, robotic spray up operation

NARRATION (VO):

SPRAY-UP TECHNOLOGY HAS ALSO BEEN AUTOMATED, MAINLY THROUGH THE USE OF INDUSTRIAL ROBOT SYSTEMS. SPRAY-UP GUNS MOUNTED TO THE WRIST OF AN ARTICULATED ROBOT CAN ACCURATELY DEPOSIT FIBER AND RESIN IN THE DESIRED METERED PROPORTIONS.

SCENE 34.
AL34A, tape 03, 03:06:01-03:06:30
zoom out, robot starting the spray up of large mold
AL34B, CGS: Consistent, Reliable Performance
Repetitive Accuracy
Capability to Work in Harsh Environments

NARRATION (VO):

ADVANTAGES OF INDUSTRIAL ROBOTS FOR COMPOSITES MANUFACTURING INCLUDE:
CONSISTENT, RELIABLE PERFORMANCE,
REPETITIVE ACCURACY,
AND THE CAPABILITY TO WORK IN HARSH

ENVIRONMENTS.

SCENE 35.
continue previous shot
AL35A, tape 03, 03:13:54-03:14:19
robot spraying up of large mold

NARRATION (VO):

ANOTHER KEY ADVANTAGE IS THE ROBOT'S FLEXIBILITY TO BE REPROGRAMMED TO ACCOMMODATE CHANGES IN PRODUCTS OR MANUFACTURING OPERATIONS.

SCENE 36.
AL36A, tape 05, 05:08:05-05:08:24
tilt down, robotic spray up system
AL36B, CGS: Improved Productivity & Quality
Reduced Labor Costs
Relief of Workers from Difficult, Repetitive, & Dangerous Tasks

NARRATION (VO):

THESE ADVANTAGES ALL CONTRIBUTE TO IMPROVED PRODUCTIVITY AND QUALITY,
REDUCED LABOR COSTS,
AND THE RELIEF OF WORKERS FROM DIFFICULT, REPETITIVE, AND DANGEROUS TASKS.

SCENE 37.
AL37A, tape 692, 08:02:03-08:02:40
zoom out, robotic spray up
AL37B, CGS: Relatively Costly & Complex to Design
Require a Certain Degree of Programming Expertise
Proper Maintenance is an Absolute Must to Maintain Reliability
Require Unique Safety Precautions for Worker Protection

NARRATION (VO):

THE DISADVANTAGES WITH REGARDS TO ROBOTIC SYSTEMS IS THAT THEY CAN BE RELATIVELY COSTLY AND COMPLEX TO DESIGN,
THEY REQUIRE A CERTAIN DEGREE OF PROGRAMMING EXPERTISE,
PROPER MAINTENANCE IS AN ABSOLUTE MUST TO MAINTAIN RELIABILITY,
AND THEY REQUIRE UNIQUE SAFETY PRECAUTIONS FOR WORKER PROTECTION.

SCENE 38.
AL38A, tape 03, 03:18:56-03:19:25
zoom out, manually rolling robotic spray up

NARRATION (VO):

TYPICALLY, THE DEPOSITED FIBER AND RESIN MUST BE MANUALLY CONSOLIDATED, ALTHOUGH THERE ARE COMPLETELY AUTOMATED ROBOTIC SYSTEMS THAT MANIPULATE THE MOLD, SPRAY HEAD AND

CONSOLIDATION ROLLERS.

--- FADE TO BLACK ---

SCENE 39.
AL39A, GRAPHIC: Review
white text on black
AL39B, peter carey narration
AL39C, review music

MUSIC UP AND UNDER

NARRATION (VO):

LET'S REVIEW THE MATERIAL CONTAINED IN THIS PROGRAM.

SCENE 40.
AL40A, tape 15, 15:01:25-15:01:42
manual layup operation
AL40B, tape 21, 21:03:23-21:03:40
manual spray up operation

NARRATION (VO):

TRANSFORMING PLASTIC-MATRIX COMPOSITES INTO USEFUL PRODUCTS BY MANUAL LAYUP...,
AND SPRAY-UP IS A FAIRLY LABORIOUS PROCESS CONSIDERING ALL THE PRODUCTION VARIABLES.

SCENE 41.
AL41A, tape 03, 03:07:31-03:07:59
zoom out, robotic spray up
AL41B, tape 01, 01:17:56-01:18:03
automated ply cutting
AL41C, tape 23, 20:23:00-20:23:06
tape layup machine
AL41D, tape 705, 20:24:53-20:25:00
fiber placement machine

NARRATION (VO):

THUS SEVERAL TECHNOLOGIES HAVE BEEN DEVELOPED TO AUTOMATE COMPOSITES MANUFACTURING, THEREBY INCREASING PRODUCTIVITY AND QUALITY IMPROVEMENT WHILE, MORE OFTEN THAN NOT, REDUCING PRODUCT COST.

--- TOUCH BLACK ---

SCENE 42.
AL42A, tape 23, 20:04:57-20:05:11
zoom out, prepreg tape being laid up

NARRATION (VO):

MUCH OF THE AUTOMATION REGARDING LAYUP PERTAINS TO THE USE OF PREPREG, OR PREIMPREGNATED, MATERIAL.

SCENE 43.
AL43A, tape 705, 20:28:31-20:28:49
zoom out, fiber placement machine placing prepreg on mold
AL43B, CGS: Glass
Carbon/Graphite
Aramid
Boron

NARRATION (VO):

THE PRIMARY REINFORCEMENT FIBERS USED ARE GLASS,
CARBON OR GRAPHITE,

AND ARAMID,

AND IN SOME CASES, BORON.

SCENE 44.
AL44A, tape 27, 03:19:41-03:19:55
prepreg tape being laid
AL44B, tape 705, 20:01:09-20:01:16
c.u. prepreg fibers coming out of fiber placement machine
AL44C, CGS: Epoxy
Bismaleimide

NARRATION (VO):

ALTHOUGH THE MATRIX FOR PREPREG CAN BE A THERMOSET OR THERMOPLASTIC RESIN, THERMOSETS DOMINATE, WITH THE EPOXY AND BISMALEIMIDE MATRIX MATERIALS BEING PRIMARILY USED.

--- TOUCH BLACK ---

SCENE 45.
AL45A, tape 01, 01:18:18-01:18:36
wide, ply cutting operation, plies being cut and marked
AL45B, CGS: Ply Cutting

NARRATION (VO):

PLY CUTTING WAS THE FIRST OPERATION TO BE AUTOMATED WITH THE USE OF PREPREG.

SCENE 46.
AL46A, tape 01, 01:22:25-01:22:39
c.u. ply cutting operation
AL46B, tape 01, 01:20:45-01:21:06
zoom out, ply cutting operation

NARRATION (VO):

CUTTING INVOLVES THE USE OF EITHER RECIPROCATING-KNIFE, ROTARY-KNIFE, MECHANICAL, ULTRASONIC, LASER OR WATER JET CUTTERS, OPERATING FROM A GANTRY.

SCENE 47.
AL47A, tape 01, 01:18:37-01:18:49
ply cutting operation, plies being cut and marked
AL47B, tape 01, 01:01:47-01:02:06
plies being collated into kits

NARRATION (VO):

SHEETS AND PLIES CAN BE MARKED FOR IDENTIFICATION DURING CUTTING, FOR LATER COLLATION INTO BAGS CALLED KITS, FOR LAYUP.

SCENE 48.
AL48A, tape 01, 01:21:46-01:21:58
zoom in, nesting software

NARRATION (VO):

PLY CUTTING OPERATIONS HAVE BEEN CLOSELY INTEGRATED WITH AUTOMATED NESTING TECHNOLOGIES.

--- TOUCH BLACK ---

SCENE 49.
AL49A, tape 23, 20:06:00-20:06:14
zoom out, tape laying operation
AL49B, CGS: Tape Lamination Machines

NARRATION (VO):

FOR FLAT AND VERY MILDLY CONTOURED PARTS, PLY DEPOSITION USING TAPE LAMINATION MACHINES HAS MARKEDLY DECREASED LAYUP TIME OVER MANUAL METHODS.

SCENE 50.
AL50A, tape 28, 04:38:09-04:38:34
tape laying operation
AL50B, tape 28, 04:36:45-04:37:06
wide, tape laying showing multiple axes
AL50C, CGS: Y Axis
AL50D, GRAPHIC: arrow showing y-axis
AL50E, CGS: X Axis
AL50F, GRAPHIC: arrow showing x-axis

NARRATION (VO):

TAPE LAMINATION MACHINES ARE FULLY PROGRAMMABLE GANTRY-STYLE COMPUTER-NUMERICALLY-CONTROLLED MACHINES. TYPICALLY THESE MACHINES HAVE A 'Y-AXIS' CROSS MEMBER...,

THAT SLIDES ON 'X-AXIS' WAYS...,

AND SUPPORTS A MULTIAXIS TAPE-LAYING HEAD.

SCENE 51.
AL51A, tape 24, 22:02:50-22:03:24
wide, tape laying operation

NARRATION (VO):

THERE IS ESSENTIALLY NO LIMIT TO THE SIZE OF WORKPIECES THAT CAN BE PRODUCED USING TAPE LAMINATION MACHINES, BUT TYPICALLY THE SHAPE OF THE WORKPIECE HAS TO BE RELATIVELY FLAT DUE TO THE LIMITED COMPLIANCE OF TAPE TO CURVATURE.

--- TOUCH BLACK ---

SCENE 52.
AL52A, tape 705, 20:09:01-20:09:16
wide, fiber placement machine moving into position on slides
AL52B, CGS: Fiber Placement Machines
AL52C, tape 705, 20:15:50-20:16:18
wide, fiber placement machine placing prepreg on mold

NARRATION (VO):

TO OVERCOME THE LIMITATIONS OF TAPE LAMINATION MACHINES, AUTOMATIC, MULTIAXIS, FIBER-PLACEMENT MACHINES WERE INTRODUCED. THESE MACHINES AUTOMATICALLY CONTROL DISPENSING NUMEROUS INDIVIDUAL UNIDIRECTIONAL PREPREG

TOWS OR SLIT TAPE, WHICH ARE COLLIMATED AS THEY ARE LAID ON A MOLD SURFACES.

SCENE 53.
AL53A, tape 705, 20:18:20-20:18:46
c.u., zoom out, fiber placement machine placing prepreg on mold

NARRATION (VO):

SINCE INDIVIDUAL TOW CAN BE INDEPENDENTLY DISPENSED, CLAMPED, CUT, AND RESTARTED DURING OPERATION, PARTS OF COMPOUND CURVATURE WITH CONVEX AND CONCAVE SURFACES AND SMALL BEND RADII CAN BE PRODUCED WITHOUT GAPS OR WRINKLES.

--- TOUCH BLACK ---

SCENE 54.
AL54A, tape 05, 05:09:27-05:09:49
zoom out, robotic spray up system
AL54B, tape 03, 03:08:56-03:09:15
zoom out, robotic spray up operation

NARRATION (VO):

SPRAY-UP TECHNOLOGY HAS ALSO BEEN AUTOMATED, MAINLY THROUGH THE USE OF INDUSTRIAL ROBOT SYSTEMS. SPRAY-UP GUNS MOUNTED TO THE WRIST OF AN ARTICULATED ROBOT CAN ACCURATELY DEPOSIT FIBER AND RESIN IN THE DESIRED METERED PROPORTIONS.

SCENE 55.
AL55A, tape 03, 03:18:56-03:19:25
zoom out, manually rolling robotic spray up

NARRATION (VO):

TYPICALLY, THE DEPOSITED FIBER AND RESIN MUST BE MANUALLY CONSOLIDATED, ALTHOUGH THERE ARE COMPLETELY AUTOMATED ROBOTIC SYSTEMS THAT MANIPULATE THE MOLD, SPRAY HEAD AND CONSOLIDATION ROLLERS.

--- FADE TO BLACK ---

SCENE 56.
AL56A CG, ROLL: credits
white text on black, fade up mid-screen

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SCENE 57.
AL57A, GRAPHIC: 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 58.
AL58A, SME logo open, with music