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COMPOSITES MANUFACTURING

Pultrusion

SCENE 1.
PU01A, GRAPHIC: FBI warning
white text centered on black to blue gradient

WARNING

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SCENE 2.
PU02A, 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 pultrusion equipment. Make sure all machine guards are in place, and follow all safety procedures when working with or near pultrusion equipment.

SCENE 3.
PU03A, GRAPHIC: PCC/SME screen
white text centered on black to blue gradient

This program was produced using the technical resources of the Plastics, Composites & Coatings Community of SME.
For more information on composites and pultrusion, please visit our website at:
www.sme.org

SCENE 4.
PU04A, SME logo open, with music

SCENE 5.
PU05A, composites manufacturing open, with music
PU05B, 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.
PU06A, GRAPHIC: Pultrusion
white text centered on black

NARRATION (VO):

THIS PROGRAM IS AN INTRODUCTION TO PULTRUSION.

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SCENE 7.
PU07A, tape 698, 02:03:00-02:03:16
wide, zoom in, pultrusion operation
PU07B, tape 44, 16:19:32-16:20:18
room tone

NARRATION (VO):

PULTRUSION IS A CONTINUOUS, HORIZONTAL PROCESS USED PRIMARILY FOR PRODUCING LONG, STRAIGHT SHAPES OF CONSTANT CROSS-SECTION IN FIBER-REINFORCED POLYMERS.

SCENE 8.
PU08A, tape 697, 01:26:31-01:26:46
zoom in, roving and mat impregnated in thermosetting resin

NARRATION (VO):

CONTINUOUS REINFORCING FIBERS CALLED 'ROVING', STITCHED MAT AND OR CONTINUOUS FILAMENT MAT ARE SATURATED AND IMPREGNATED WITH TYPICALLY A THERMOSETTING RESIN MATRIX.

SCENE 9.
PU09A, tape 697, 01:28:14-01:28:26
pan, resin impregnated roving and mat going into die
PU09B, tape 698, 02:01:17-02:01:29
zoom out, part coming out of die

NARRATION (VO):

THESE MATERIALS ARE THEN SHAPED AND GUIDED INTO A HEATED DIE HAVING THE SAME CROSS SECTION OF THE PART BEING MANUFACTURED. THE HEATED DIE ACCELERATES THE CURING OF THE RESIN, SOLIDIFYING THE PART AS IT MOVES THROUGH THE DIE.

SCENE 10.
PU10A, tape 890, 05:11:01-05:11:11
zoom out, extrusion of plastic
PU10B, tape 698, 02:15:47-02:15:55
pultrusion being pulled
PU10C, tape 697, 01:11:56-01:12:08
special pultrusion shape being produced

NARRATION (VO):

THE PULTRUSION PROCESS IS SIMILAR TO PLASTIC EXTRUSION EXCEPT THAT THE MATERIAL IS PULLED RATHER THAN PUSHED THROUGH A DIE. VIRTUALLY ANY SHAPE THAT CAN BE EXTRUDED CAN BE PULTRUDED IN ESSENTIALLY ANY LENGTH.

SCENE 11.
PU11A, tape 699, 03:06:41-03:06:48
zoom out, u-shaped parts stacked up
PU11B, tape 699, 03:05:12-03:05:18
c.u. solid square parts
PU11C, tape 699, 03:04:12-03:04:25
zoom in, hollow square parts
PU11D, tape 699, 03:05:41-03:05:50

NARRATION (VO):

THESE SHAPES INCLUDE A GAMUT OF SOLID..., AND HOLLOW CROSS-SECTIONAL SHAPES, RANGING FROM SIMPLE SQUARES...,

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solid cylindrical parts
PU11E, tape 699, 03:05:54-03:06:04
complex parts stacked up

AND CIRCLES...,

TO MORE COMPLEX DESIGNS.

SCENE 12.
PU12A, tape 34, 06:23:12-06:23:36
pulling large pultrusion off bed of machine
PU12B, CGS: Transportation
Medical
Appliance
Marine
Electrical
Architectural
Consumer

NARRATION (VO):

PULTRUSION PRODUCT APPLICATIONS CAN BE FOUND

IN VIRTUALLY EVERY INDUSTRY, INCLUDING:

TRANSPORTATION,

MEDICAL,

APPLIANCE,

MARINE,

ELECTRICAL,

ARCHITECTURAL,

AND CONSUMER.

--- TOUCH BLACK ---

SCENE 13.
PU13A, tape 35, 07:02:50-07:03:20
zoom out, e-glass pultrusion
PU13B, CGS: E-Glass
Aramid
Carbon/Graphite

NARRATION (VO):

THE USUAL PULTRUDED FIBERS ARE:

E-GLASS, OR 'ELECTRICAL GLASS',

ARAMID,

AND CARBON, OR GRAPHITE,

WITH E-GLASS BEING THE MOST COMMON.

SCENE 14.
PU14A, tape 697, 01:27:23-01:27:34
resin bath, slow down shot if needed
PU14B, CGS: Polyester
Vinyl Ester
Epoxy

NARRATION (VO):

THERMOSETTING POLYMERS, SUCH AS POLYESTER,

VINYL-ESTER,

AND EPOXY ARE THE USUAL MATRIX MATERIALS FOR

PULTRUSION, WITH POLYESTER DOMINATING.

SCENE 15.
PU15A, still, thermoplastic pultrusion operation
PU15B, still, thermoplastic pultrusion operation
PU15C, still, thermoplastic

NARRATION (VO):

PULTRUSION IS ALSO PERFORMED IN VERY LIMITED

CAPACITIES USING THERMOPLASTIC POLYMERS SUCH

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pultrusion
PU15D, CGS: Nylon
Polyphenylene Sulfide
Polyether Ether Ketone

AS NYLON,

POLYPHENYLENE SULFIDE,

AND POLYETHER ETHER KETONE.

--- TOUCH BLACK ---

SCENE 16.
PU16A, tape 697, 01:29:29-01:29:49
zoom in, preshaping operation

NARRATION (VO):

BEING A CONTINUOUS PROCESS, PULTRUSION LENDS ITSELF TO HIGH-THROUGHPUT PRODUCTION. OTHER THAN START-UP WASTE, RAW MATERIALS ARE USED VERY EFFICIENTLY IN THE PULTRUSION PROCESS, WITH TYPICALLY LESS THAN 5% SCRAP RATE.

SCENE 17.
PU17A, tape 36, 08:17:16-08:17:40
pan, pultrusion operation, preshaping to die, resin squeezed out

NARRATION (VO):

ACCURATE RESIN CONTENT IS ALSO READILY MAINTAINED BECAUSE OF THE CONSTANT CROSS-SECTION TYPICAL OF THE PULTRUSION BEING PRODUCED. CONSTANT PART CROSS-SECTION MEANS CONSTANT MATERIAL VOLUME PASSING THROUGH THE DIE. ANY EXCESS RESIN IS SQUEEZED OUT AND RETURNED TO THE RESIN BATH.

SCENE 18.
PU18A, tape 697, 01:25:01-01:25:16
pan down, reinforcement to resin bath

NARRATION (VO):

REINFORCEMENT CONTENT IN PULTRUSIONS IS HIGH, TYPICALLY 50 TO 60% FIBER BY WEIGHT FOR STRUCTURAL APPLICATIONS.

--- TOUCH BLACK ---

SCENE 19.
PU19A, tape 35, 07:06:08-07:06:28
zoom out, resin saturation
PU19B, tape 698, 02:03:33-02:03:45
tilt, forming of saturated material to pultrusion coming out of die

NARRATION (VO):

THE PRINCIPAL STEPS IN TYPICAL PULTRUSION OPERATIONS INCLUDE:

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SATURATION AND IMPREGNATION...,

FORMING...,

AND CURING.

SCENE 20.
PU20A, tape 697, 01:14:01-01:14:27
pan, from storage through preforming

NARRATION (VO):

THE CONTINUOUS FIBER ROVINGS ARE COMMONLY FED FROM LARGE-CAPACITY BOOKSHELF-STYLE STORAGE THROUGH A GENERAL GUIDING, OR PREFORMING, SYSTEM.

SCENE 21.
continue previous shot
PU21A, tape 34, 06:18:12-06:18:27
continuous filament mat being incorporated into pultrusion for transverse strength

NARRATION (VO):

THE CONTINUOUS FIBER ROVINGS ARE UNIDIRECTIONAL AND ONLY PROVIDE LONGITUDINAL TENSILE STRENGTH, THAT IS TENSILE STRENGTH ALONG THE LENGTH OF THE PULTRUSION PROFILE. TO PROVIDE TRANSVERSE STRENGTH, CONTINUOUS FILAMENT MAT, OR WOVEN OR STITCHED FABRIC REINFORCEMENT IS ALSO INCORPORATED IN THE PULTRUSION.

SCENE 22.
PU22A, tape 37, 09:25:42-09:26:07
pan, resin wet-out station, resin squeezed out

NARRATION (VO):

THESE REINFORCEMENT MATERIALS ARE PULLED THROUGH A RESIN WET-OUT STATION WHERE THEY ARE SATURATED AND IMPREGNATED WITH LIQUID RESIN. MECHANICAL ROLLERS OR OTHER DEVICES ARE USED TO ENSURE THAT THE FIBERS ARE SATURATED AND WELL WETTED WITH THE RESIN AS THEY PASS THROUGH THE WET-OUT STATION.

SCENE 23.
PU23A, tape 697, 01:23:08-01:23:19
zoom in, surfacing material

NARRATION (VO):

A SURFACING MATERIAL, COMMONLY CALLED 'VEIL',

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IS TYPICALLY ADDED ONCE THESE LONGITUDINAL AND TRANSVERSE MATERIALS ARE WET-OUT.

SCENE 24.
PU24A, tape 35, 07:18:02-07:18:26
pan, resin bath to die opening, slow down shot if needed

NARRATION (VO):

SUITABLE RESINS FOR PULTRUSION TYPICALLY HAVE LOW INITIAL VISCOSITY TO ENSURE FULL FIBER SEPARATION BEFORE IMPREGNATION. WHEN APPLIED, THE RESIN SHOULD BE STABLE ENOUGH TO PRECLUDE REACTION IN THE DIE. THEN, ON APPLICATION, POLYMERIZATION SHOULD BE FAST ENOUGH FOR ADEQUATE CURING SO THAT IT CAN BE PULLED THROUGH THE DIE AT AN ECONOMIC SPEED.

SCENE 25.
PU25A, tape 37, 09:24:20-09:24:34
pan, wide, open bath wet-out station
PU25B, tape 34, 06:02:59-06:03:22
zoom out, resin impregnation within die

NARRATION (VO):

OPEN-BATH WET-OUT STATIONS ARE THE SIMPLEST AND MOST COMMON METHOD OF SATURATING AND IMPREGNATING REINFORCEMENT MATERIALS. RESIN IMPREGNATION CAN ALSO BE INDUCED UNDER PRESSURE WITHIN THE PULTRUSION DIE. THIS METHOD REDUCES RESIN EMISSIONS AND RESIN LOSS BUT REQUIRES COSTLY DIES.

SCENE 26.
PU26A, tape 697, 01:30:27-01:30:38
zoom out, preforming of saturated material
PU26B, tape 37, 09:18:01-09:18:26
zoom out, preforming of wet-out reinforcement material

NARRATION (VO):

AFTER PASSING THROUGH THE WET-OUT STATION, THE RESIN IMPREGNATED REINFORCEMENT MATERIALS ARE SHAPED WITHIN A PROGRESSIVE PREFORMING SYSTEM. DURING PREFORMING, EXCESS RESIN IS REMOVED AS THE APPROXIMATE DESIRED PROFILE OR PULTRUSION IS SHAPED AND POSITIONED FOR ENTRANCE INTO THE PULTRUSION DIE FOR CURING.

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SCENE 27.
PU27A, tape 37, 09:29:20-09:29:45
pan, pultrusion going into, coming out of die

NARRATION (VO):

CURING DETERMINES THE PULTRUSION PRODUCTION RATE. TYPICAL PULTRUSION SPEEDS RANGING FROM 1 FOOT, OR 3 TENTHS OF A METER, TO 4 FEET, OR 1.2 METERS, PER MINUTE. PULTRUSION PART DIAMETER CAN RANGE FROM AS SMALL AS 1 INCH, OR 25 MILLIMETERS, TO AS LARGE AS 15 FEET, OR 5 METERS.

SCENE 28.
PU28A, tape 34, 06:01:40-06:01:52
zoom out, pultrusion coming out of die

NARRATION (VO):

SEVERAL METHODS ARE USED FOR CURING PULTRUSIONS, WITH THE MOST COMMON BEING DIE CURING.

SCENE 29.
PU29A, tape 38, 10:12:18-10:12:43
zoom out, pultrusion coming out of die
PU29B, tape 36, 08:02:26-08:02:35
zoom in, pultrusion coming out of die

NARRATION (VO):

DIE CURING INVOLVES RAPIDLY CURING THE RESIN AND REINFORCEMENT MATERIALS WHILE THE PULTRUDED PART OR PROFILE IS STILL IN THE DIE. THIS OFTEN REQUIRES THE USE OF MULTIPLE DIES, STARTING FROM A LOW TEMPERATURE AND INCREASING, WITH A HEAT-CONTROL ZONE IN EACH. DIE CURING IS EASY TO CONTROL MAKING IT IDEAL FOR A STEADY-STATE PULTRUSION PRODUCTION PROCESS.

SCENE 30.
PU30A, tape 35, 07:10:34-07:10:47
zoom out, pultrusion coming out of die

NARRATION (VO):

DIES CAN EXERT LARGE HYDRAULIC OR MECHANICAL FORCE ON THE RESIN TO IMPREGNATE AND COMPLETELY WET-OUT THE FIBERS AND SHAPE THE PULTRUSION.

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SCENE 31.
PU31A, GRAPHICS: fixed die
PU31B, GRAPHICS: die with floating segment
PU31C, tape 34, 06:09:42-06:09:51
zoom out, hollow part coming out of pultrusion operation

NARRATION (VO):

DIES MAY BE FIXED...,

OR HAVE A FLOATING OR MOVABLE SEGMENT, SUCH AS INTERNAL MANDRELS USED IN PRODUCING HOLLOW PARTS.

SCENE 32.
PU32A, tape 38, 10:13:51-10:14:10
grinding of pultrusion die
PU32B, tape 38, 10:16:21-10:16:40
milling of pultrusion die component
PU32C, tape 37, 09:18:38-09:19:05
zoom out, pultrusions coming out of multiple dies

NARRATION (VO):

PULTRUSION DIES ARE MOST COMMONLY MADE OF A MOLD STEEL SUCH AS P20 TOOL STEEL, A DEEP-HARDENING, OIL-QUENCHED ALLOY STEEL THAT CAN BE SUPPLIED IN THE HARDENED CONDITION. DIE LIFE CAN EXCEED 150,000 FEET OR 45,700 METERS OF PULTRUSION LENGTH. THESE DIES ARE OFTEN CHROMIUM-PLATED FOR GREATER WEAR RESISTANCE.

SCENE 33.
PU33A, tape 35, 07:29:22-07:29:42
pan, preforming to microwave unit

NARRATION (VO):

THE USE OF IN-LINE MICROWAVES OR RADIO-FREQUENCY ENERGY FOR THE PRECURING OR CURING OF PULTRUSIONS IS SOMETIMES REQUIRED. TYPICALLY COMPOSITE OR CERAMIC DIES ARE USED TO ALLOW THIS TYPE OF ENERGY TO REACH THE PULTRUDED PART OR PROFILE.

SCENE 34.
PU34A, tape 698, 02:14:10-02:14:26
wide, caterpillar pullers
PU34B, tape 36, 08:08:55-08:09:16
c.u., zoom out, double-clamp pullers
PU34C, tape 36, 08:25:58-08:26:08
zoom out, caterpillar pullers

NARRATION (VO):

PULTRUSIONS ARE MOVED THOROUGH THE ENTIRE PROCESS USING TWO PRIMARY TYPES OF PULLING EQUIPMENT, OR PULLERS, INCLUDING:

DOUBLE-CLAMP PULLERS...,

AND CATERPILLAR PULLERS.

SCENE 35.
PU35A, tape 34, 06:07:38-06:07:56

NARRATION (VO):

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zoom out, med, step puller
PU35B, tape 34, 06:10:54-06:11:35
zoom in, step pullers

WITH DOUBLE-CLAMP PULLERS, WHICH ARE ALSO REFERRED TO AS 'STEP PULLERS' AND 'RECIPROCATING PULLERS', THE PULTRUSION IS CLAMPED BETWEEN PADS AND PULLED FORWARD..., AT THE END OF THE PULLING STROKE, ANOTHER PULLER IN POSITION CLAMPS THE PULTRUSION AND BEGINS PULLING IT AS THE FIRST CLAMP RELEASES AND MOVES BACK TO ITS BEGINNING POSITION. THESE PULLERS ALTERNATE IN THIS MANNER PROVIDING CONTINUOUS PULLING ACTION.

SCENE 36.
PU36A, tape 36, 08:20:09-08:20:27
zoom in, caterpillar pullers

NARRATION (VO):

CATERPILLAR PULLERS USE TWO CONTINUOUS BELTS THROUGH WHICH THE PULTRUSION PASSES. MOUNTED TO THESE BELTS ARE CONTOURED RUBBER OR URETHANE PADS MATCHING THE PROFILE OF THE SPECIFIC PULTRUSION.

SCENE 37.
PU37A, tape 697, 01:07:54-01:08:40
c.u. flying cut off saw in operation

NARRATION (VO):

ONCE FREE OF THE PULLER EQUIPMENT, THE CURED PULTRUSION PROCEEDS TO A FLYING CUTOFF SAW. THIS SAW TRAVELS LONGITUDINALLY AT THE SAME SPEED AS THE PULTRUSION AS IT CUTS TRANSVERSELY. FLYING CUTOFF SAWS SEPARATE PULTRUSIONS TO THE REQUIRED LENGTH WITHOUT INTERRUPTING THE CONTINUOUS PULLING PROCESS.

SCENE 38.
PU38A, tape 38, 10:02:02-10:02:30
zoom in, flying cut off saw in operation

NARRATION (VO):

FLYING CUTOFF SAWS ARE MOST COMMONLY USED DRY, AND DEPENDING ON THE THERMOSETTING RESINS USED

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MAY REQUIRE THE USE OF DIAMOND OR CARBIDE BLADES.

--- FADE TO BLACK ---

SCENE 39.
PU39A, GRAPHIC: Review
white text on black
PU39B, peter carey narration

MUSIC UP AND UNDER

NARRATION (VO):

LET'S REVIEW THE MATERIAL CONTAINED IN THIS PROGRAM.

SCENE 40.
PU40A, tape 698, 02:03:00-02:03:16
wide, zoom in, pultrusion operation
PU40B, review music, up and under

NARRATION (VO):

PULTRUSION IS A CONTINUOUS, HORIZONTAL PROCESS USED PRIMARILY FOR PRODUCING LONG, STRAIGHT SHAPES OF CONSTANT CROSS-SECTION IN FIBER-REINFORCED POLYMERS.

SCENE 41.
PU41A, tape 699, 03:06:41-03:06:48
zoom out, u-shaped parts stacked up
PU41B, tape 699, 03:05:12-03:05:18
c.u. solid square parts
PU41C, tape 699, 03:04:12-03:04:25
zoom in, hollow square parts
PU41D, tape 699, 03:05:41-03:05:50
solid cylindrical parts
PU41E, tape 699, 03:05:54-03:06:04
complex parts stacked up

NARRATION (VO):

THESE SHAPES INCLUDE A GAMUT OF SOLID...,

AND HOLLOW CROSS-SECTIONAL SHAPES, RANGING

FROM SIMPLE SQUARES...,

AND CIRCLES...,

TO MORE COMPLEX DESIGNS.

--- TOUCH BLACK ---

SCENE 42.
PU42A, tape 35, 07:02:50-07:03:20
zoom out, e-glass pultrusion
PU42B, CGS: E-Glass
Aramid
Carbon/Graphite

NARRATION (VO):

THE USUAL PULTRUDED FIBERS ARE:

E-GLASS, OR 'ELECTRICAL GLASS',

ARAMID,

AND CARBON, OR GRAPHITE,

WITH E-GLASS BEING THE MOST COMMON.

SCENE 43.
PU43A, tape 697, 01:27:23-01:27:34

NARRATION (VO):

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resin bath, slow down shot if needed
PU43B, CGS: Polyester
Vinyl Ester
Epoxy

THERMOSETTING POLYMERS, SUCH AS POLYESTER,

VINYL-ESTER,

AND EPOXY ARE THE USUAL MATRIX MATERIALS FOR

PULTRUSION, WITH POLYESTER DOMINATING.

SCENE 44.
PU44A, still, thermoplastic pultrusion operation
PU44B, still, thermoplastic pultrusion operation

NARRATION (VO):

PULTRUSION IS ALSO PERFORMED IN VERY LIMITED

CAPACITIES USING THERMOPLASTIC POLYMERS.

--- TOUCH BLACK ---

SCENE 45.
PU45A, tape 35, 07:06:08-07:06:28
zoom out, resin saturation
PU45B, tape 698, 02:03:33-02:03:45
tilt, forming of saturated material to pultrusion coming out of die

NARRATION (VO):

THE PRINCIPAL STEPS IN TYPICAL PULTRUSION

OPERATIONS INCLUDE:

SATURATION AND IMPREGNATION...,

FORMING...,

AND CURING.

SCENE 46.
PU46A, tape 697, 01:14:01-01:14:27
pan, from storage through preforming

NARRATION (VO):

CONTINUOUS REINFORCING FIBERS CALLED 'ROVING'

ARE COMMONLY FED FROM LARGE-CAPACITY

BOOKSHELF-STYLE STORAGE THROUGH A GENERAL

GUIDING, OR PREFORMING, SYSTEM.

SCENE 47.
continue previous shot
PU47A, tape 34, 06:18:12-06:18:27
continuous filament mat being incorporated into pultrusion for transverse strength

NARRATION (VO):

THESE CONTINUOUS FIBER ROVINGS ARE

UNIDIRECTIONAL AND ONLY PROVIDE LONGITUDINAL

TENSILE STRENGTH. TO PROVIDE TRANSVERSE

STRENGTH, CONTINUOUS FILAMENT MAT, OR WOVEN OR

STITCHED FABRIC REINFORCEMENT IS ALSO

INCORPORATED IN THE PULTRUSION.

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SCENE 48.
PU48A, tape 37, 09:25:42-09:26:07
pan, resin wet-out station, resin squeezed out

NARRATION (VO):

THESE REINFORCEMENT MATERIALS ARE PULLED THROUGH A RESIN WET-OUT STATION WHERE THEY ARE SATURATED AND IMPREGNATED WITH LIQUID RESIN.

SCENE 49.
PU49A, tape 697, 01:23:08-01:23:19
zoom in, surfacing material

NARRATION (VO):

A SURFACING MATERIAL, COMMONLY CALLED 'VEIL', IS TYPICALLY ADDED ONCE THESE LONGITUDINAL AND TRANSVERSE MATERIALS ARE WET-OUT.

SCENE 50.
PU50A, tape 697, 01:30:27-01:30:38
zoom out, preforming of saturated material
PU50B, tape 37, 09:18:01-09:18:26
zoom out, preforming of wet-out reinforcement material

NARRATION (VO):

AFTER PASSING THROUGH THE WET-OUT STATION, THE RESIN IMPREGNATED REINFORCEMENT MATERIALS ARE SHAPED WITHIN A PROGRESSIVE PREFORMING SYSTEM. DURING PREFORMING, EXCESS RESIN IS REMOVED AS THE APPROXIMATE DESIRED PROFILE OR PULTRUSION IS SHAPED AND POSITIONED FOR ENTRANCE INTO THE PULTRUSION DIE FOR CURING.

SCENE 51.
PU51A, tape 34, 06:01:40-06:01:52
zoom out, pultrusion coming out of die

NARRATION (VO):

SEVERAL METHODS ARE USED FOR CURING PULTRUSIONS, WITH THE MOST COMMON BEING DIE CURING.

SCENE 52.
PU52A, tape 38, 10:12:18-10:12:43
zoom out, pultrusion coming out of die
PU52B, tape 36, 08:02:26-08:02:35
zoom in, pultrusion coming out of die

NARRATION (VO):

DIE CURING INVOLVES RAPIDLY CURING THE RESIN AND REINFORCEMENT MATERIALS WHILE THE PULTRUDED PART OR PROFILE IS STILL IN THE DIE.

SCENE 53.
PU53A, tape 35, 07:10:34-07:10:47
zoom out, pultrusion coming out of die

NARRATION (VO):

DIES CAN EXERT LARGE HYDRAULIC OR MECHANICAL

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FORCE ON THE RESIN TO IMPREGNATE AND COMPLETELY WET-OUT THE FIBERS AND SHAPE THE PULTRUSION.

SCENE 54.
PU54A, GRAPHICS: fixed die
PU54B, GRAPHICS: die with floating segment
PU54C, tape 34, 06:09:42-06:09:51
zoom out, hollow part coming out of pultrusion operation

NARRATION (VO):

DIES MAY BE FIXED...,
OR HAVE A FLOATING OR MOVABLE SEGMENT, SUCH AS INTERNAL MANDRELS USED IN PRODUCING HOLLOW PARTS.

SCENE 55.
PU55A, tape 34, 06:10:54-06:11:35
zoom in, step pullers
PU55B, tape 36, 08:25:58-08:26:08
zoom out, caterpillar pullers

NARRATION (VO):

PULTRUSIONS ARE MOVED THOROUGH THE ENTIRE PROCESS USING TWO PRIMARY TYPES OF PULLING EQUIPMENT, OR PULLERS, INCLUDING:
DOUBLE-CLAMP PULLERS...,
AND CATERPILLAR PULLERS.

SCENE 56.
PU56A, tape 697, 01:07:54-01:08:40
c.u. flying cut off saw in operation

NARRATION (VO):

ONCE FREE OF THE PULLER EQUIPMENT, THE CURED PULTRUSION PROCEEDS TO A FLYING CUTOFF SAW, WHICH SEPARATES THE PULTRUSION TO THE REQUIRED LENGTH WITHOUT INTERRUPTING THE CONTINUOUS PULLING PROCESS.

--- FADE TO BLACK ---

SCENE 57.
PU57A, CG, ROLL: credits
white text on black, fade up mid-screen

Produced By:
Society of Manufacturing Engineers

Executive Producer:
Steven R. Bollinger

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Producer/Director/Cameraman:
Jerome T. Cook

Written By:
John A. Vaccari

Graphics By:
Jerome T. Cook

Equipment Access Provided By:
Creative Pultrusions, Inc.

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Adam Aircraft Industries
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The Wind Turbine Company

Technical & Editorial Consulting:
Dustin Troutman,
Director of Marketing & Product Development
Creative Pultrusions, Inc.
Shane E. Weyant,
Chief Operating Officer
Creative Pultrusions, Inc.

Production Assistance Provided By:
Lance Rosol

Video Editing:
Jim O'Donnell

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SCENE 58.
PU58A, 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 59.
PU59A, SME logo open, with music