

FUNDAMENTAL MANUFACTURING PROCESSES

Holemaking - HO

SCENE 1.

FMP01A, CGS: FBI warning
text centered on black to transparent
gradient
FMP BKG, motion background

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SCENE 2.

continue motion background
FMP02A, CGS: DRL screen
text centered on black to transparent
gradient

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SCENE 3.

continue motion background
FMP03A, 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 4.

FMP SME, SME logo open, with music

SCENE 5.

FMP05A, FMP open, with music
HO05B, edited peter carey narration
HO05C, unedited peter carey narration

MUSIC UP AND UNDER

NARRATION (VO) :

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

SCENE 6.

continue FMP open
HO06A, CGS: Holemaking

NARRATION (VO) :

white text, centered on background
FMP06B, blue background
FMP06C, sound slug

SCENE 7.

HO07A, SME3984, 11:10:23:00-11:10:40:00
zoom out, turning hole
HO07B, SME3454, 22:05:53:00-22:06:22:00
zoom out, plastics drilling operation
HO07C, SME4111, 02:20:43:00-02:20:56:00
zoom out, drilling operation

SCENE 8.

HO08A, FMP025, 03:38:00:00-03:38:16:00
c.u. honing operation, loop if necessary
HO08B, CGS: Reaming
 Boring
 Roller Burnishing
 Honing
HO08C, FMP021, 21:52:18:00-21:52:39:00
counterboring operation
HO08D, CGS: Counterboring
 Countersinking
HO08E, FMP024, 02:05:00:00-02:05:13:00
edm holemaking operation

SCENE 9.

HO09A, ANI: drilling through hole
HO09B, ANI: drilling blind hole
HO09C, ANI: drilling interrupted hole
HO09D, ANI: drilling oblique entry and

THIS PROGRAM EXPLORES THE BASICS OF
HOLEMAKING.

NARRATION (VO) :

THE TERM 'HOLEMAKING' REPRESENTS A GROUP
OF PROCESSES THAT PRODUCE HOLES IN SOLID
MATERIALS. HOLEMAKING IS THE MOST COMMON
MACHINING OPERATION, CONSUMING ROUGHLY
HALF OF ALL CUTTING TOOLS USED IN CHIP-
MAKING PROCESSES. THE MOST COMMON
HOLEMAKING PROCESS IS DRILLING, WHICH IS
THE PRIMARY FOCUS OF THIS PROGRAM.

NARRATION (VO) :

VARIOUS HOLE-FINISHING PROCESSES ARE
ALSO IMPORTANT, INCLUDING:
REAMING,
BORING,
ROLLER BURNISHING,
AND HONING,
AS ARE OPERATIONS THAT CREATE SPECIAL
HOLE FEATURES, SUCH AS:
COUNTERBORING,
AND COUNTERSINKING.
ALTERNATIVE APPROACHES TO HARD-TOOL
HOLEMAKING HAVE ALSO BECOME MORE
IMPORTANT IN RECENT YEARS.

NARRATION (VO) :

HOLES COME IN MANY FORMS:

exit holes

'THROUGH' HOLES THAT GO THROUGH A
WORKPIECE...,
'BLIND' HOLES THAT DON'T GO ALL THE WAY
THROUGH...,
'INTERRUPTED' HOLES, THAT CONNECT WITH
OTHER HOLES INSIDE A WORKPIECE...,
AND HOLES WITH 'OBLIQUE' ENTRY...,
AND/OR EXIT ANGLES.

SCENE 10.

HO10A, FMP024, 02:37:16:00-02:37:24:00

tapping operation

HO10B, still, zoom in, bolt circle

HO10C, FMP028, 06:02:16:00-06:02:37:00

zoom in, inspection hole on lathe

**HO10D, CGS: Lighten a Heavy Workpiece
Allow Coolant or Lubrication
to Reach Inaccessible Areas
Provide Access for Parts
Inspection**

NARRATION (VO) :

SOME HOLES MAY BE THREADED FOR A
FASTENER. OTHERS ARE PRECISELY LOCATED
IN WHAT IS CALLED A BOLT CIRCLE FOR A
SERIES OF BOLTS.
HOLES CAN ALSO BE DRILLED TO LIGHTEN A
HEAVY WORKPIECE,
OR TO ALLOW COOLANT OR LUBRICATION TO
REACH INACCESSIBLE AREAS,
OR PROVIDE ACCESS FOR PARTS INSPECTION.

--- FADE TO BLACK ---

SCENE 11.

HO11A, CGS: Drilling Basics

white text, centered on background

FMP BKG, motion background

SCENE 12.

HO12A, SME4128, 20:22:34:00-20:23:05:00

zoom in, hole being drilled, chips formed

HO12B, SME4113, 04:18:17:00-04:18:55:00

holemaking on lathe

NARRATION (VO) :

DRILLING INTO SOLID MATERIAL CREATES
CYLINDRICAL HOLES. THE MATERIAL IN THE
HOLE IS CUT INTO CHIPS BY THE RELATIVE
ROTATION OF THE DRILL AND THE WORKPIECE,

COMBINED WITH A LINEAR FEED MOVEMENT. TYPICALLY THE DRILL ROTATES INTO A STATIONARY WORKPIECE, BUT ON A LATHE, THE DRILL IS USUALLY HELD FIXED WHILE BEING FED INTO A ROTATING WORKPIECE.

SCENE 13.

HO13A, FMP024, 02:09:23:00-02:09:52:00

zoom out, hole being drilled, chips formed

NARRATION (VO) :

SINCE DRILLING TAKES PLACE INSIDE A WORKPIECE, THE CHIPS AND HEAT GENERATED BY THE PROCESS ARE CONFINED. THUS, THE GREATER THE DEPTH OF THE HOLE, THE MORE DIFFICULT IT IS TO CONTROL HEAT BUILDUP AND REMOVE THE CHIPS.

SCENE 14.

HO14A, FMP024, 02:29:50:00-02:30:10:00

zoom out, drilling operation with coolant

NARRATION (VO) :

FOR THIS REASON, SUPPLYING A SUFFICIENT AMOUNT OF COOLANT TO THE DRILL TIP IS VITAL. THE COOLANT LUBRICATES THE CUT, COOLS THE DRILL POINT, AND FLUSHES OUT CHIPS.

SCENE 15.

HO15A, FMP012, 12:43:08:00-12:43:36:00

drill with through the end coolant transport

NARRATION (VO) :

SOME DRILLS TRANSPORT COOLANT THROUGH THE DRILL BODY TO THE CUTTING EDGES, TO PROVIDE SUPERIOR COOLING AND CHIP EVACUATION.

SCENE 16.

HO16A, SME2506, 01:04:25:00-01:04:40:00

high pressure coolant used with drill

NARRATION (VO) :

WHEN STANDARD COOLANT PRESSURE ON THE MACHINE TOOL IS INSUFFICIENT, HIGH-PRESSURE COOLANT SYSTEMS CAN PROVIDE

POWERFUL COOLANT FLOW AND CHIP-REMOVAL ACTION.

SCENE 17.

HO17A, SME3928, 23:24:32:00-23:24:56:00
drilling three holes

HO17B, CGS: Rigidity of a Cylinder is
Proportional to the Fourth
Power of its Diameter

HO17C, FMP028, 06:08:12:00-06:08:30:00
half inch drilling operation

HO17D, FMP028, 06:09:45:00-06:10:04:00
one inch drilling operation

NARRATION (VO) :

DRILLING OPERATIONS ARE ALSO CHALLENGING BECAUSE THE TOOL IS OFTEN LONG AND SLENDER, MEANING THE TOOL IS NOT RIGID. A GENERAL RULE OF MECHANICS IS THAT THE RIGIDITY OF A CYLINDER IS PROPORTIONAL TO THE FOURTH POWER OF ITS DIAMETER. IN OTHER WORDS, A HALF-INCH, OR APPROXIMATELY 12.5 MILLIMETER DRILL IS APPROXIMATELY ONE SIXTEENTH AS RIGID AS A ONE-INCH, OR APPROXIMATELY 25 MILLIMETER DRILL.

SCENE 18.

HO18A, FMP003, 03:40:46:00-03:41:10:00
drilling operation on lathe

HO18B, CGS: Hole Size
Hole Depth
Required Tolerances
Material & Shape
Machine Tool's
Power & Stability
Production Volume

NARRATION (VO) :

ALONG WITH RIGIDITY, THE CHOICE OF THE PROPER DRILL AND DRILLING METHOD IS DETERMINED BY SUCH THINGS AS:
HOLE SIZE,
HOLE DEPTH,
REQUIRED TOLERANCES,
THE WORKPIECE MATERIAL AND SOMETIMES ITS SHAPE,
THE MACHINE TOOL'S POWER AND STABILITY,
AND THE PRODUCTION VOLUME.

-- TOUCH BLACK --

SCENE 19.

HO19A, SME2551, 02:02:06:00-02:02:22:00

NARRATION (VO) :

peck drilling operation

HO19B, SME4111, 02:02:09:00-02:02:19:00

wide, deep drilling operation

DRILLING IS OFTEN DIVIDED BETWEEN SHORT-HOLE DRILLING, WHICH CONSTITUTES THE VAST MAJORITY OF HOLEMAKING OPERATIONS..., AND DEEP-HOLE DRILLING.

SCENE 20.

HO20A, CGS: Short Hole Drilling

HO20B, SME4111, 02:26:36:00-02:27:00:00

short hole drilling, 2 holes

HO20C, still, steel graphic

HO20D, still, steel graphic with small diameter hole

HO20E, still, steel graphic with small diameter hole, depth highlighted

HO20F, still, steel graphic with small highlighted diameter hole and larger diameter hole

HO20G, still, steel graphic with small highlighted diameter hole and larger diameter hole highlighted

NARRATION (VO) :

SHORT-HOLE DRILLING REFERS TO HOLES WHOSE DEPTH IS SHALLOW, RELATIVE TO THE HOLE DIAMETER. FOR HOLE DIAMETERS UP TO 1.2 INCHES OR THIRTY MILLIMETERS, 'SHORT HOLES' HAVE DEPTHS NO MORE THAN FIVE TO SIX TIMES THE HOLE DIAMETER. FOR LARGER DIAMETER HOLES, 'SHORT HOLES' ARE NO MORE THAN TWO AND A HALF TIMES HOLE DIAMETER.

SCENE 21.

HO21A, SME4111, 02:27:50:00-02:28:14:00

frequent drill removal, clearing chips

HO21B, CGS: Peck Drilling

NARRATION (VO) :

DRILLING DEEPER WITH CONVENTIONAL DRILLS REQUIRES LONGER DRILLS AND FREQUENT REMOVAL OF THE DRILL FROM THE HOLE TO CLEAR THE CHIPS. THIS IS CALLED PECK-DRILLING.

SCENE 22.

HO22A, CGS: Deep Hole Drilling

HO22B, SME4111, 02:03:03:00-02:03:20:00

pan, deep hole drilling operation

HO22C, SME4111, 02:07:00:00-02:07:32:00

drill set up for deep hole operation, edit at multiple points

HO22D, still, c.u. deep hole drill

NARRATION (VO) :

DEEP HOLE DRILLING IS MUCH MORE CHALLENGING THAN ORDINARY DRILLING BECAUSE THE HOLE MUST BE KEPT STRAIGHT, THE CHIPS BROKEN AND EJECTED, AND THE DRILL POINT KEPT COOL AND LUBRICATED -

ALL OVER A LONGER DISTANCE THAN IN ORDINARY SHORT HOLE DRILLING. TO ACHIEVE THESE OBJECTIVES, DEEP HOLE DRILLING REQUIRES SPECIAL DRILLS, GUIDES AND EQUIPMENT.

SCENE 23.

HO23A, CGS: Trepanning

HO23B, SME3928, 23:01:44:00-23:01:53:00
c.u. trepanning of large hole

HO23C, SME2564, 01:05:37:00-01:05:57:00
trepanning operation

NARRATION (VO) :

TREPANNING IS OFTEN USED WHEN DRILLING LARGE HOLE DIAMETERS. TREPANNING TOOLS MAKE A RING-SHAPED CUT ALONG THE HOLE DIAMETER, REDUCING ONLY THE OUTER RING OF THE HOLE TO CHIPS, INSTEAD OF DRILLING OUT ALL OF THE SOLID WORKPIECE MATERIAL.

SCENE 24.

HO24A, SME2564, 01:13:21:00-01:13:25:00
core removed

HO24B, SME2564, 01:09:22:00-01:09:41:00
trepanning on machine

HO24C, SME3928, 23:21:05:00-23:21:32:00
zoom in, trepanning of large hole

NARRATION (VO) :

THE CENTRAL CORE OF THE HOLE IS CUT OUT AS A CYLINDER. THIS MAKES IT POSSIBLE TO GENERATE LARGE-DIAMETER SHORT HOLES USING SMALL MACHINES OR HAND TOOLS, SINCE TREPANNING REQUIRES MUCH LESS HORSEPOWER THAN STANDARD DRILLING.

SCENE 25.

HO25A, SME4304, 04:23:48:00-04:24:18:00
edm holemaking

NARRATION (VO) :

ALTERNATIVE APPROACHES TO HARD-TOOL HOLEMAKING CAN ALSO BE USEFUL IN SPECIAL SITUATIONS. FOR EXAMPLE, SPECIAL ELECTRICAL DISCHARGE MACHINING, OR 'EDM', MACHINES CAN BE USED TO DRILL SMALL, DEEP HOLES AND SLOTS OF ROUND, OR

IRREGULAR SHAPES IN TOUGH ALLOYS.

SCENE 26.

HO26A, FMP019, 19:54:15:00-19:54:39:00
zoom out, tubular electrode starting edm
process
HO26B, still, electrode ends
HO26C, still, electrode ends
HO26D, still, electrode ends
HO26E, still, electrode ends
HO26F, FMP024, 02:03:59:00-02:04:18:00
zoom in, edming of hole

NARRATION (VO) :

THESE MACHINES USE TUBULAR ELECTRODES UP TO A FOOT LONG, WITH DIAMETERS RANGING FROM ONE-HUNDREDTH OF AN INCH, OR TWENTY FIVE HUNDREDTHS OF A MILLIMETER, TO ONE-EIGHTH OF AN INCH, OR APPROXIMATELY THREE MILLIMETERS. THESE ROUND ELECTRODES ARE ROTATED AT MODERATE SPEEDS OF UP TO 100 REVOLUTIONS PER MINUTE DURING DRILLING. THIS ROTATION AIDS IN FLUSHING THE CUT, AND TENDS TO CREATE UNIFORM ELECTRODE WEAR.

SCENE 27.

HO27A, FMP019, 19:53:04:00-19:53:34:00
zoom in, tubular electrode starting edm
process

NARRATION (VO) :

'EDM' MACHINES CAN DRILL NUMEROUS SMALL HOLES OF ONE OR MULTIPLE DIAMETERS TO ACCURACIES NEAR PLUS OR MINUS ONE-THOUSANDTH OF AN INCH, OR TWENTY FIVE THOUSANDTHS OF A MILLIMETER. ADDITIONALLY, THIS PROCESS CAN OBTAIN HOLE LENGTH TO DIAMETER RATIOS OF 30 TO 1 OR BETTER.

SCENE 28.

HO28A, FMP027, 05:15:20:00-05:15:30:00
laser holemaking on sheet metal
HO28B, FMP027, 05:17:32:00-05:17:46:00
laser holemaking on tube

NARRATION (VO) :

BECAUSE OF ITS SPEED, EASE OF AUTOMATION, AND ABILITY TO PENETRATE VERY HARD MATERIALS, LASER DRILLING IS A NON-CONTACT ALTERNATIVE TO CONVENTIONAL

HOLEMAKING PROCESSES.

SCENE 29.

HO29A, FMP027, 05:10:50:00-05:11:08:00
laser holemaking on stamping

NARRATION (VO) :

LARGE HOLES ARE CUT BY TREPANNING, WHICH USUALLY SWEEPS THE FOCUSED LASER BEAM IN A CIRCLE. SMALLER HOLES CAN BE PRODUCED USING SINGLE OR MULTIPLE HIGH POWER PULSES FOR SHORT TIMES. THIS IS CALLED PERCUSSION DRILLING.

--- FADE TO BLACK ---

SCENE 30.

HO30A, CGS: The Drill
white text, centered on background
FMP BKG, motion background

NARRATION (VO) :

A DRILL HAS ONE OR MORE CUTTING EDGES ALONG ITS LENGTH IN THE FORM OF ONE OR MORE STRAIGHT OR HELICAL FLUTES. DRILLS WITH TWO EDGES AND FLUTES ARE BY FAR THE MOST COMMON.

SCENE 32.

HO32A, SME4308, 08:02:28:00-08:02:39:00
zoom in, twist drill operation
HO32B, SME2506, 01:01:24:00-01:01:38:00
indexable insert drill

NARRATION (VO) :

DRILL TYPES INCLUDE HELICALLY-FLUTED TWIST DRILLS, MADE OF EITHER HIGH-SPEED STEEL OR CARBIDE..., AND INDEXABLE-INSERT DRILLS, WHICH HAVE STEEL BODIES WITH ONE, TWO, OR MORE CARBIDE CUTTING INSERTS ATTACHED.

SCENE 33.

HO33A, SME2558, 01:15:58:00-01:16:12:00
solid carbide drill operation
HO33B, FMP004, 04:17:17:00-04:17:30:00

NARRATION (VO) :

CARBIDE DRILLS ARE STIFFER THAN HIGH-

zoom out, carbide, drilling
HO33C, SME4111, 02:21:29:00-02:21:43:00
zoom in, drilling operation

SPEED STEEL DRILLS, SO DEFLECTION IS LESS, CUTTING SPEEDS ARE FASTER, AND HOLES ARE MORE ACCURATE. CARBIDE DRILLS ARE ESPECIALLY USEFUL WITH HARD OR ABRASIVE MATERIALS.

SCENE 34.
HO34A, SME4302, 01:56:53:00-01:57:07:00
solid drill operation
HO34B, FMP021, 21:34:06:00-21:34:18:00
spade drill operation

NARRATION (VO) :
SOLID DRILLS OF HIGH-SPEED STEEL OR CARBIDE DOMINATE APPLICATIONS UP TO ABOUT THREE-QUARTERS OF AN INCH, OR 20 MILLIMETERS, IN DIAMETER. SPADE DRILLS AND INDEXABLE INSERT DRILLS COVER THE LARGER SIZE RANGES.

SCENE 35.
HO35A, SME2552, 03:15:26:00-03:15:36:00
twist drill, turning slowly

NARRATION (VO) :
THE TWIST DRILL IS A ROUGHING TOOL WITH TWO CUTTING LIPS.

SCENE 36.
HO36A, FMP021, 21:16:15:00-21:16:32:00
twist drill tilt, shank to drill point
HO36B, SME2552, 03:01:40:00-03:01:58:00
alternate shot, twist drill tilt, shank to drill point

NARRATION (VO) :
THE THREE ESSENTIAL PARTS OF THE TWIST DRILL INCLUDE THE SHANK...,
THE FLUTES...,
AND THE POINT.

SCENE 37.
HO37A, CGS: Drill Shank
HO37B, SME2552, 03:21:39:00-03:21:46:00
straight shank put in collet
HO37C, SME2552, 03:22:21:00-03:22:26:00
straight shank in collet, freeze last frame
HO37D, FMP015, 15:27:21:00-15:27:34:00
straight shank put in keyed chuck
HO37E, FMP015, 15:28:06:00-15:28:17:00
straight shank put in keyless chuck
HO37F, FMP021, 21:09:19:00-21:09:27:00
tilt, tapered drill shank
HO37G, FMP021, 21:04:40:00-21:04:55:00

NARRATION (VO) :
THE SHANK IS THE MEANS BY WHICH THE DRILL IS HELD AND DRIVEN.
TWIST DRILL SHANKS MAY BE STRAIGHT, FOR USE IN COLLETS...,
KEYED CHUCKS...,
OR KEYLESS DRILL CHUCKS.

shank in sleeve, mounted to spindle

SHANKS MAY ALSO BE TAPERED, FOR MOUNTING DIRECTLY INTO MACHINE SPINDLES OR SLEEVES THAT FIT INTO SPINDLES.

SCENE 38.

HO38A, CGS: Drill Flutes

HO38B, **FMP008**, **09:05:17:00-09:05:52:00**
holemaking on machining center

NARRATION (VO) :

FLUTES LET COOLANT INTO, AND CARRY CHIPS OUT OF, THE DRILLED HOLE. BOTH OF THESE FUNCTIONS ARE ESSENTIAL FOR THE DRILL POINT TO CONTINUE ROTATING AT HIGH SPEED IN AN ENCLOSED SPACE.

SCENE 39.

HO39A, still, three drills with various helix angles

HO39B, **SME2552**, **03:06:19:00-03:06:27:00**
drill with standard helix angle

HO39C, **FMP008**, **09:08:02:00-09:08:14:00**
zoom out, drilling of steel

HO39D, **SME2552**, **03:05:07:00-03:05:15:00**
drill with high helix angle

HO39E, **SME3349**, **06:02:23:00-06:02:38:00**
zoom out, drilling of aluminum

HO39F, **SME2552**, **03:06:39:00-03:06:48:00**
drill with low helix angle

HO39G, **SME3454**, **22:24:12:00-22:24:27:00**
zoom out, drilling of plastics

NARRATION (VO) :

THE HELIX ANGLE OF A DRILL'S FLUTES CAN VARY, DEPENDING ON THE MATERIAL TO BE DRILLED. A STANDARD HELIX ANGLE OF 25 TO 33 DEGREES IS OPTIMAL FOR STEEL AND CAST IRON...,
A HIGH HELIX OR FAST SPIRAL ANGLE OF 35 TO 40 DEGREES IS USED FOR LOW-STRENGTH MATERIALS SUCH AS ALUMINUM...,
AND A LOW-HELIX OR SLOW-SPIRAL ANGLE OF 15 TO 20 DEGREES IS USED FOR DRILLING VARIOUS PLASTIC MATERIALS AND SOFT BRASS.

SCENE 40.

HO40A, CGS: Drill Point

HO40B, **FMP028**, **06:06:10:00-06:06:28:00**
c.u. twist drill point entering work

HO40C, **FMP021**, **21:06:20:00-21:06:30:00**
alternate shot, zoom out, drill point

NARRATION (VO) :

THE DRILL POINT, WHICH DOES THE WORK OF METAL CUTTING, IS FORMED BY THE TWO CUTTING LIPS AND THE CHISEL EDGE.

SCENE 41.

HO41A, CGS: Cutting Lips

NARRATION (VO) :

HO41B, ANI: drill, cutting lips, chisel edge, arrows
HO41C, CGS: Chisel Edge

THE CUTTING LIPS, WHEN THE DRILL IS CORRECTLY GROUND, FORM TWO STRAIGHT LINES CONNECTED BY THE CHISEL EDGE.

SCENE 42.

HO42A, ANI: chisel edge, web thickness, arrows
HO42B, CGS: Drill Web

NARRATION (VO) :

THE LENGTH OF THE CHISEL EDGE DEPENDS ON THE ANGLE IT MAKES WITH THE CUTTING LIPS AND THE THICKNESS OF THE DRILL WEB, OR CORE.

SCENE 43.

continue animation
HO43A, **SME2550**, **01:26:49:00-01:27:03:00**
zoom out, holemaking operation
HO43B, **SME4128**, **20:15:53:00-20:16:10:00**
alternate shot, holemaking operation

NARRATION (VO) :

THE WEB THICKNESS AT THE DRILL POINT IS A COMPROMISE BETWEEN THICKNESS, FOR RIGIDITY, AND THINNESS, FOR RAPID PENETRATION RATES, GREATER FLUTE SPACE, AND GOOD CHIP CLEARANCE.

SCENE 44.

HO44A, ANI: standard drill point, 118 angle, dissolve to clearance angle arrow

NARRATION (VO) :

THE STANDARD DRILL POINT COMMONLY HAS A 118 DEGREE POINT ANGLE, SYMMETRICAL CUTTING LIPS, AND A CLEARANCE ANGLE TYPICALLY BETWEEN 10 AND 20 DEGREES.

SCENE 45.

HO45A, **SME4111**, **02:19:01:00-02:19:26:00**
zoom in, holemaking operation
HO45B, ANI: thinned web drill
HO45C, ANI: split-point drill
HO45D, **FMP028**, **06:31:00:00-06:31:13:00**
zoom out, split point drilling
HO45E, **SME4111**, **02:28:50:00-02:29:01:00**
zoom out, thinned web drilling

NARRATION (VO) :

TWO COMMON VARIATIONS ON THE STANDARD POINT SHAPE HAVE BEEN DEVELOPED OVER THE YEARS TO IMPROVE DRILL EFFICIENCY; THESE INCLUDE:

THE THINNED WEB, WHICH REDUCES THE LENGTH OF THE NON-CUTTING CHISEL EDGE AND LETS THE DRILL CUT MORE FREELY,

AND THE SPLIT POINT, WHICH RELIEVES THE DRILL HEELS ON BOTH SIDES. THE SPLIT POINT CREATES NARROWER CHIPS AND ALLOWS BETTER CHIP FLOW.

SCENE 46.

SCENE DELETED

SCENE 47.

HO47A, SME2537, 01:13:20:00-01:13:33:00
indexable insert drill operation
HO47B, SME2537, 01:05:26:00-01:05:38:00
alternate shot, indexable insert drill operation

NARRATION (VO) :

A CARBIDE INDEXABLE INSERT DRILL IS A RIGID, SHORT-HOLE DRILL THAT DRILLS FASTER THAN A CONVENTIONAL TWIST DRILL.

SCENE 48.

HO48A, SME4303, 03:16:10:00-03:17:43:00
hole being drilled, chips formed

NARRATION (VO) :

IT CAN USE A SINGLE INSERT FOR SMALLER DIAMETER HOLES, OR TWO INSERTS FOR LARGER DIAMETERS, WHERE THE OUTER INSERT CUTS THE HOLE DIAMETER WHILE THE INNER INSERT CUTS THE CORE OF THE HOLE.

SCENE 49.

HO49A, SME2565, 00:05:50:00-00:05:50:01
still, freeze, drill insert
HO49B, SME2572, 00:09:39:00-00:09:39:01
still, freeze, drill insert
HO49C, SME2572, 00:06:54:00-00:06:54:01
still, freeze, drill insert
HO49D, still, helical fluted insert drill
HO49E, still, straight fluted insert drill

NARRATION (VO) :

A VARIETY OF INSERT DESIGNS AND INSERT PLACEMENTS IN THE DRILL BODY ARE USED...,
FLUTES MAY BE HELICAL...,
OR STRAIGHT.

SCENE 50.

HO50A, SME2553, 04:09:10:00-04:09:25:00
zoom out, spade drill operation

NARRATION (VO) :

THERE ARE NUMEROUS DRILL TYPES FOR SPECIAL PURPOSES.

SCENE 51.

HO51A, CGS: Center Drill
HO51B, FMP021, 21:31:37:00-21:31:50:00
center drill, drilling hole
HO51C, FMP021, 21:32:24:00-21:32:40:00

NARRATION (VO) :

A CENTER DRILL IS VERY SHORT AND HAS A

drilling on center drill hole

60 DEGREE COUNTERSINK. IT IS USED TO PRODUCE START HOLES FOR TWIST DRILLS, AND HOLES IN THE ENDS OF WORKPIECES THAT WILL GO BETWEEN CENTERS ON LATHES OR GRINDERS.

SCENE 52.

HO52A, CGS: Spade Drill

HO52B, **FMP021**, **21:42:15:00-21:42:31:00**

zoom in, spade drill blade

HO52C, **SME2553**, **04:11:34:00-04:11:44:00**

zoom out, spade drill blade

HO52D, **FMP021**, **21:38:21:00-21:38:45:00**

spade drill operation

HO52E, **SME2553**, **04:09:26:00-04:09:52:00**

zoom in, spade drill operation

NARRATION (VO) :

SPADE DRILLS CONSIST OF A HOLDER AND AN INTERCHANGEABLE FLAT BLADE FOR ITS POINT. THEY'RE GENERALLY USED IN LOW VOLUME WORK TO DRILL HOLES FROM A ONE INCH OR 25 MILLIMETER DIAMETER TO A SIX INCH OR 150 MILLIMETER DIAMETER, OR WHERE TREPANNING IS IMPRACTICAL. MOST SPADE DRILLS CUT SLOWLY, ALTHOUGH SOME DESIGNS DO RIVAL CARBIDE INSERT DRILLS' PRODUCTIVITY.

SCENE 53.

HO53A, CGS: Core Drill

HO53B, **SME2553**, **04:17:45:00-04:18:10:00**

zoom in, core drilling operation

NARRATION (VO) :

CORE DRILLS ARE THREE- OR FOUR-FLUTE DRILLS USED FOR ENLARGING AND FINISHING A DRILLED OR CAST HOLE. CORE DRILLS FOLLOW EXISTING HOLES AND ARE INCAPABLE OF DRILLING HOLES IN SOLID MATERIAL, OR OF IMPROVING A HOLE'S LOCATION.

SCENE 54.

HO54A, CGS: Step Drill

HO54B, **SME2552**, **03:12:00:00-03:12:10:00**

step drill pan

HO54C, **SME2552**, **03:13:55:00-03:14:10:00**

step drill operation

HO54D, **SME2572**, **00:10:49:00-00:10:53:00**

indexable insert step drill

NARRATION (VO) :

STEP DRILLS PRODUCE TWO OR MORE DIAMETERS IN ONE HOLE. EACH 'STEP' CAN CREATE SQUARE, ANGLED, OR CONTOURED

TRANSITIONS. THESE DRILLS MAY BE GROUND FROM TWIST DRILLS OR CONSTRUCTED AS INDEXABLE INSERT-TYPE DRILLS.

SCENE 55.

HO55A, CGS: Drilling End Mill

HO55B, SME2496, 00:09:37:00-00:10:09:00
drilling end mill, multiple shots

NARRATION (VO) :

DRILLING END MILLS CAN DRILL INTO SOLID MATERIAL TO SHALLOW DEPTHS. USED IN A MILLING MACHINE, THEY CAN BE MOVED LATERALLY TO CREATE ROUND AND NON-ROUND HOLES, OR POCKETS. THE DRILLING END MILL'S ADVANTAGE IS THAT ONE TOOL CAN CREATE A VARIETY OF HOLE SIZES, SHAPES, AND LOCATIONS COMPLETELY GOVERNED BY THE MACHINE'S MOVEMENTS.

SCENE 56.

HO56A, SME3914, 09:02:17:00-09:02:55:00

zoom in, multiple holes being drilled using drill press

HO56B, SME3444, 12:22:58:00-12:23:17:00

zoom out, drill jig used with long plastic part

NARRATION (VO) :

OTHER TOOLS ENHANCE THE PERFORMANCE OF STANDARD DRILLS. FOR EXAMPLE, SINCE A TWIST DRILL IS NOT A RIGID TOOL, IT REQUIRES SUPPORT, EITHER FROM THE HOLE IT IS CREATING OR FROM A DRILL JIG. A DRILL JIG IS DESIGNED TO HOLD, SUPPORT, AND LOCATE THE WORKPIECE, WHILE CONTROLLING THE POSITION AND ALIGNMENT OF THE DRILL. IT GUIDES THE DRILL OR REAMER USING A BUSHING.

SCENE 57.

HO57A, SME3418, 02:26:32:00-02:26:56:00

zoom out, dual drilling with bushings

HO57B, SME3416, 12:16:41:00-12:17:02:00

zoom out, drill with coolant being used to cut composite part

NARRATION (VO) :

DRILL BUSHINGS ARE HARDENED STEEL CYLINDERS SIZED TO SUPPORT SPECIFIC

DRILL DIAMETERS. THE CLEARANCE BETWEEN
DRILL AND BUSHING BORE IS ONE-THOUSANDTH
OF AN INCH OR TWENTY FIVE THOUSANDTHS OF
A MILLIMETER, OR LESS.

SCENE 58.

HO58A, SME3444, 12:27:35:00-12:27:53:00
zoom out, drill jig used with long plastic
part

NARRATION (VO) :

THE DRILL JIG RESISTS THE TENDENCY OF
THE DRILL TO WANDER AND THE TENDENCY OF
THE WORKPIECE TO CLIMB UP THE DRILL'S
FLUTES ONCE THE DRILL IS THROUGH THE
WORKPIECE.

--- FADE TO BLACK ---

SCENE 59.

HO59A, CGS: Holemaking Machines
white text, centered on background
FMP BKG, motion background

SCENE 60.

HO60A, SME4111, 02:28:15:00-02:28:35:00
drilling of two holes

NARRATION (VO) :

EVEN THOUGH DRILLING IS THE MOST COMMON
METALCUTTING OPERATION, THE MAJORITY OF
DRILLING IS NOT PERFORMED ON DRILL
PRESSES OR OTHER DEDICATED DRILLING
MACHINES.

SCENE 61.

HO61A, SME2537, 01:02:37:00-01:02:49:00
wide, holemaking on lathe
HO61B, FMP008, 09:38:02:00-09:38:32:00
holemaking on machining center
HO61C, still, high-production transfer
machine
HO61D, FMP019, 19:13:00:00-19:13:12:00
radial drill being used

NARRATION (VO) :

MOST HOLEMAKING IS DONE WITH 'CNC'
MACHINE TOOLS, INCLUDING LATHES...,
MACHINING CENTERS.
OR HIGH-PRODUCTION TRANSFER MACHINES.
HOWEVER, DEDICATED DRILLING MACHINES ARE
STILL IMPORTANT.

--- TOUCH BLACK ---

SCENE 62.

HO62A, CGS: Sensitive Drill Press
HO62B, **SME3914**, **09:16:09:00-09:16:37:00**
zoom in, manual holemaking operation using
drill press

NARRATION (VO) :

THE SENSITIVE DRILL PRESS IS A LOW-
POWERED DRILLING MACHINE USED FOR
DRILLING ONE HOLE AT A TIME IN
WORKPIECES WITH SMALL-DIAMETER TWIST
DRILLS.

SCENE 63.

HO63A, **FMP028**, **06:20:55:00-06:21:08:00**
manual drill press feed

NARRATION (VO) :

ITS NAME IS BASED ON THE SENSITIVE
CONTROL IT GIVES THE OPERATOR OVER DRILL
FEEDING.

SCENE 64.

HO64A, **FMP028**, **06:29:40:00-06:29:52:00**
tilt of drill press
HO64B, **SME2550**, **01:06:43:00-01:06:52:00**
alternate shot, tilt of drill press
HO64C, **FMP015**, **15:04:14:00-15:04:24:00**
zoom out, knee mill
HO64D, **SME2502**, **01:11:50:00-01:12:03:00**
alternate shot, tilt of knee mill

NARRATION (VO) :

IN MANY SHOPS, THE DRILL PRESS HAS BEEN
REPLACED BY THE MORE VERSATILE KNEE MILL
FOR MANUAL, LOW-VOLUME HOLEMAKING.

--- TOUCH BLACK ---

SCENE 65.

HO65A, CGS: Radial Drill
HO65B, **FMP019**, **19:10:14:00-19:10:46:00**
tapping with radial drill

NARRATION (VO) :

THE RADIAL DRILL IS USED FOR DRILLING IN
LARGE WORKPIECES. IT CAN DRILL SURFACES
THAT CANNOT OTHERWISE BE REACHED EASILY.

SCENE 66.

HO66A, **FMP019**, **19:26:27:00-19:26:50:00**
moving radial drillhead

NARRATION (VO) :

ITS ARM CARRIES AN ADJUSTABLE DRILLHEAD
THAT CAN BE RAISED, LOWERED, AND PIVOTED
AROUND THE COLUMN.

--- TOUCH BLACK ---

SCENE 67.

HO67A, CGS: Self-Feeding Drilling Units
HO67B, **FMP026**, **04:51:50:00-04:52:21:00**
wide, drilling units, operating, edit at
multiple points
HO67C, **FMP026**, **04:02:30:00-04:02:53:00**
drilling units in row

NARRATION (VO) :

SELF-FEEDING DRILLING UNITS OPERATE
AUTOMATICALLY FOR REPETITIVE WORK, ONCE
THE STROKE, SPEED, THRUST, AND FEED HAVE
BEEN SET. THEY CAN BE USED FOR REAMING,
TAPPING, OR OTHER OPERATIONS, AS WELL AS
DRILLING, AND CAN BE MOUNTED SINGLY OR
IN GROUPS.

--- TOUCH BLACK ---

SCENE 68.

HO68A, CGS: Multi-Spindle Drilling Units
HO68B, **SME2338**, **10:23:55:00-10:24:09:00**
zoom out, multi-spindle drilling operation
HO68C, **SME2338**, **10:19:10:00-10:19:24:00**
zoom out, multi-spindle tapping operation
HO68D, **SME2338**, **10:20:16:00-10:20:42:00**
zoom out, multi-spindle tapping operation,
alternate shot

NARRATION (VO) :

IN MASS PRODUCTION, DRILLING IS OFTEN
PERFORMED USING MULTI-SPINDLE DRILLING
UNITS. THESE HAVE ANYWHERE FROM TWO TO
TEN OR MORE INDIVIDUAL DRILL SPINDLES,
WITH ROTARY MOTION FROM A CENTRAL SOURCE
TRANSMITTED TO EACH SPINDLE. THE
POSITIONS OF THE INDIVIDUAL SPINDLES ARE
SET FOR EACH SPECIFIC PART.

--- TOUCH BLACK ---

SCENE 69.

HO69A, CGS: Drill & Tap Centers
HO69B, still, drill & tap center
HO69C, still, drill & tap center
HO69D, drilling operations in drill & tap
center
HO69E, c.u. tapping operations in drill &
tap center
HO69F, drilling operations in drill & tap
center, alternate shot
HO69G, c.u. tapping operations in drill &
tap center, alternate shot

NARRATION (VO) :

'CNC' DRILL AND TAP CENTERS ARE LIKE
LIGHTWEIGHT MACHINING CENTERS, BUT ARE
USED PRIMARILY FOR HOLEMaking RATHER
THAN MILLING. THE TOOLCHANGER IS USUALLY
EQUIPPED WITH 12 TO 20 TOOLS, ALLOWING
MULTIPLE OPERATIONS TO BE PERFORMED ON
SINGLE OR MULTIPLE HOLES.

--- FADE TO BLACK ---

SCENE 70.

HO70A, CGS: Drilling Operating Parameters
white text, centered on background
FMP BKG, motion background

SCENE 71.

HO71A, **SME4116**, **06:18:09:00-06:18:28:00**
zoom out, holemaking on lathe
HO71B, CGS: Cutting Speed
Feed/Penetration Rate
HO71C, **FMP004**, **04:15:48:00-04:16:02:00**
c.u. drilling operation

NARRATION (VO) :

THE KEY OPERATING PARAMETERS IN DRILLING
INCLUDE:
CUTTING SPEED,
AND FEED, OR PENETRATION, RATE.
DRILLING CONDITIONS INFLUENCE THESE
PARAMETER SELECTIONS.

SCENE 72.

HO72A, CGS: Cutting Speed
HO72B, **SME4128**, **20:23:06:00-20:23:21:00**
zoom out, drilling operation
HO72C, **SME4111**, **02:25:40:00-02:25:57:00**
zoom in, large drill during holemaking

NARRATION (VO) :

CUTTING SPEED FOR DRILLING IS MEASURED
AT THE PERIPHERY OF THE DRILL AND IS
EXPRESSED AS SURFACE DISTANCE PER
MINUTE. IT VARIES FROM A MAXIMUM AT THE
PERIPHERY OF THE DRILL TO ZERO AT ITS
CENTER AXIS. AS A RULE, THE HARDER THE
MATERIAL BEING DRILLED, THE SLOWER THE
SPEED USED.

SCENE 73.

HO73A, CGS: Feed/Penetration Rate
HO73B, **FMP021**, **21:50:38:00-21:50:59:00**
c.u. drilling operation

NARRATION (VO) :

THE FEED OR PENETRATION RATE IS A
DISTANCE PER UNIT TIME, AND IS EXPRESSED
IN INCHES OR MILLIMETERS PER REVOLUTION
OF THE DRILL, OR IN INCHES OR
MILLIMETERS PER MINUTE.

SCENE 74.

HO74A, **FMP028**, **06:14:46:00-06:15:07:00**

NARRATION (VO) :

zoom in, drilling on sloped surface
HO74B, FMP028, 06:15:27:00-06:15:39:00
drilling pre-drilled hole

GENERALLY, THE FEED RATE MUST BE REDUCED
-SOMETIMES UP TO FIFTY PERCENT- WHEN
DRILLING INTO CURVED OR SLOPING
SURFACES, DRILLING ACROSS ANOTHER
DRILLED HOLE, OR WHEN ENLARGING A PRE-
DRILLED HOLE.

SCENE 75.
HO75A, SME2552, 03:19:00:00-03:19:10:00
c.u. damaged lips
HO75B, FMP021, 21:25:02:00-21:25:10:00
broken drill

NARRATION (VO) :
EXCESSIVE FEED RATES CAN CAUSE CHIPPING
OR FRACTURE OF THE CUTTING LIPS, AS WELL
AS SPLITTING OF THE DRILL'S WEB.

--- TOUCH BLACK ---

SCENE 76.
HO76A, FMP021, 21:45:49:00-21:46:07:00
wide, drilling operation
HO76B, FMP021, 21:21:38:00-21:21:46:00
zoom out, broken drill
HO76C, SME2551, 02:06:17:00-02:06:33:00
c.u. squealing drill
HO76D, SME2550, 01:06:42:00-01:06:59:00
audio only, squealing sound
HO76E, SME2550, 01:23:33:00-01:23:42:00
axial pressure applied to drive drill

NARRATION (VO) :
OVER TIME, THE CUTTING EDGES OF A DRILL
BECOME DULL. THIS WEAR CAN QUICKLY CAUSE
BREAKAGE AND OTHER DAMAGE. THUS IT IS
IMPORTANT TO STOP DRILLING WHEN SIGNS OF
BLUNTNESS APPEAR. THOSE SIGNS INCLUDE:
SQUEALING IN THE CUT...,
AND AN INCREASE IN THE AXIAL PRESSURE
REQUIRED TO DRIVE THE DRILL.

SCENE 77.
HO77A, FMP022, 22:13:14:00-22:13:23:00
c.u. drill grinding
HO77B, SME2550, 01:06:15:00-01:06:24:00
manual grinding of drill point
HO77C, FMP024, 02:40:28:00-02:40:48:00
zoom out, drill grinding operation

NARRATION (VO) :
FOR OPTIMAL RESULTS, DULL DRILL POINTS
SHOULD ALWAYS BE REGROUND USING MACHINES
DESIGNED FOR DRILL GRINDING, RATHER THAN
WITH MANUAL, FREEHAND GRINDING. DRILL
GRINDERS COME IN A VARIETY OF SIZES AND
TYPES TO ACCOMMODATE ALMOST ALL

REGRINDABLE DRILL-POINT STYLES.

--- FADE TO BLACK ---

SCENE 78.

HO78A, CGS: Hole Finishing Operations
white text, centered on background
FMP BKG, motion background

SCENE 79.

HO79A, **SME2519**, **02:26:30:00-02:26:42:00**
holemaking operation
HO79B, **SME2519**, **02:28:38:00-02:28:48:00**
reaming operation

NARRATION (VO) :

SINCE DRILLING PRODUCES A FAIRLY ROUGH
HOLE SURFACE WITH LIMITED DIMENSIONAL
ACCURACY, IT IS COMMONLY FOLLOWED BY A
HOLE FINISHING OPERATION.

SCENE 80.

HO80A, **SME2551**, **02:19:45:00-02:20:15:00**
boring operation
HO80B, CGS: Final & Precise Size
Location
Surface Finish
Special Features

NARRATION (VO) :

FINISHING OPERATIONS GIVE A ROUGH HOLE
ITS FINAL AND PRECISE SIZE,
LOCATION,
SURFACE FINISH,
OR SPECIAL FEATURES, SUCH AS THREADS OR
SLOTS.

SCENE 81.

HO81A, **FMP025**, **03:04:24:00-03:04:46:00**
zoom in, honing operation, edit at
multiple points
HO81B, CGS: Reaming
Boring
Honing
Roller Burnishing

NARRATION (VO) :

TYPICAL HOLE FINISHING OPERATIONS
INCLUDE:
REAMING,
BORING,
HONING,
AND ROLLER BURNISHING.

SCENE 82.

HO82A, CGS: Reaming
HO82B, **FMP008**, **09:04:40:00-09:05:07:00**
reaming operation on multiple holes
HO82C, **SME2551**, **02:26:23:00-02:26:58:00**
reaming operation, alternate shot
HO82D, **SME2552**, **03:07:28:00-03:07:31:00**

NARRATION (VO) :

REAMING ENLARGES A HOLE TO ITS FINAL
DIAMETER AND GIVES IT A GOOD FINISH,

right/left handed, straight
HO82E, SME2553, 04:19:39:00-04:20:12:00
tapered, straight
HO82F, SME2552, 03:07:34:00-03:07:37:00
fluted reamer

REMOVING ONLY A SMALL AMOUNT OF
MATERIAL. REAMERS ARE FLUTED, MULTI-EDGE
TOOLS, MADE TO CLOSE TOLERANCES. REAMERS
MAY BE RIGHT- OR LEFT-HANDED. THEY MAY
BE STRAIGHT...,
OR TAPERED, WITH STRAIGHT FLUTES...,
OR HELICAL FLUTES.

SCENE 83.
HO83A, FMP021, 21:26:48:00-21:27:00:00
drilling operation
HO83B, FMP021, 21:27:50:00-21:27:59:00
reaming operation on same hole

NARRATION (VO) :
REAMING ACCURACY DEPENDS ON THE
CONDITION OF THE STARTING HOLE. LIKE
CORE DRILLS, THE REAMER IS UNABLE TO
IMPROVE A HOLE'S LOCATION.

SCENE 84.
HO84A, CGS: Boring
HO84B, SME4113, 04:07:24:00-04:07:50:00
zoom out, boring operation

NARRATION (VO) :
BORING IS BASICALLY INTERNAL TURNING. IT
ENLARGES AND FINISHES A HOLE TO THE
PRECISE SIZE WITH A SINGLE-POINT TOOL,
OR WITH A TOOL WITH TWO OR THREE EDGES.
UNLIKE REAMING, BORING CAN IMPROVE HOLE
GEOMETRY AND LOCATION, SINCE THE HOLE
SHAPE IS PRIMARILY DETERMINED BY MACHINE
TOOL MOTIONS.

SCENE 85.
HO85A, SME4303, 03:11:28:00-03:11:38:00
zoom out, boring operation on mill

NARRATION (VO) :
BORING IS PERFORMED ON DEDICATED BORING
MACHINES, MILLS, MACHINING CENTERS, AND
LATHES.

SCENE 86.
HO86A, SME4113, 04:28:22:00-04:28:35:00
zoom out, boring on lathe
HO86B, FMP003, 03:41:59:00-03:42:35:00

NARRATION (VO) :
ON A LATHE, THE WORKPIECE ROTATES WHILE

boring on lathe with long boring bar

A BORING BAR MOVES ALONG THE AXIS OF THE PART INSIDE THE DRILLED HOLE. THE DEPTH AND DIAMETER OF THE HOLE DETERMINES THE LENGTH AND DIAMETER OF THE BORING BAR. STABILITY OF BORING IS A MAJOR CONCERN BECAUSE OF BORING BAR OVERHANG.

SCENE 87.

HO87A, CGS: Honing

HO87B, **FMP025**, **03:38:39:00-03:39:08:00**

honing operation

NARRATION (VO) :

HONING IS AN ABRASIVE HOLE-SIZING AND FINISHING OPERATION. HONING USES ABRASIVE STONES PRESSED AGAINST THE HOLE'S WALL TO QUICKLY AND ACCURATELY REMOVE THE FINAL STOCK FROM THE SURFACE, WITH A COMBINED RECIPROCATING AND ROTATING MOTION.

SCENE 88.

HO88A, **FMP020**, **20:06:28:00-20:06:44:00**

honing stones being replace around honing tool head

NARRATION (VO) :

THE ABRASIVE STONES ARE SPACED IN AXIALLY PARALLEL AND RADIALY ADJUSTABLE POSITIONS AROUND THE PERIPHERY OF THE HONING TOOL HEAD, WHICH IS ATTACHED TO A DRIVING SHAFT.

SCENE 89.

HO89A, **FMP020**, **20:23:07:00-20:23:19:00**

large, long bore

HO89B, **FMP020**, **20:37:57:00-20:38:31:00**

wide, long bore

HO89C, still, cross hatched surface

NARRATION (VO) :

HONING'S ADVANTAGE IS THAT IT MAY BE USED ON ANY LENGTH OF BORE. THE FINISHED HOLE SURFACE TYPICALLY HAS A CHARACTERISTIC CROSS-HATCHED PATTERN.

SCENE 90.

HO90A, CGS: Roller Burnishing

HO90B, **FMP026**, **04:25:52:00-04:26:04:00**

zoom in, roller burnishing tool

NARRATION (VO) :

ROLLER BURNISHING IS A POLISHING

HO90C, SME2841, 01:06:18:00-01:07:04:00
roller burnishing operation

OPERATION IN WHICH A ROTATING TOOL WITH A SERIES OF ROLLS ENTERS A HOLE AND PRESSES ON THE WALLS OF THE HOLE TO QUICKLY REDUCE SURFACE IRREGULARITIES. NO MATERIAL IS REMOVED. ROLLER BURNISHING CAN PRODUCE A MIRROR-LIKE FINISH ON A HOLE SURFACE.

--- TOUCH BLACK ---

SCENE 91.

HO91A, FMP021, 21:59:21:00-21:59:45:00
counterboring operation on angled part
HO91B, CGS: Counterboring
Countersinking

NARRATION (VO) :

OPERATIONS THAT ADD OTHER FEATURES TO A HOLE INCLUDE:
COUNTERBORING,
AND COUNTERSINKING.

SCENE 92.

HO92A, CGS: Counterboring
HO92B, FMP021, 21:56:03:00-21:56:51:00
counterboring operation, edit at several spots

NARRATION (VO) :

COUNTERBORING IS USED TO ENLARGE A PORTION OF AN EXISTING DRILLED OR CAST HOLE. THE COUNTERBORE TOOL IS A PILOT-GUIDED, END-CUTTING, FLUTED TOOL. COUNTERBORING IS SOMETIMES USED TO ACCOMMODATE THE HEAD OF A BOLT.

SCENE 93.

HO93A, CGS: Countersinking
HO93B, FMP021, 21:46:45:00-21:47:16:00
countersink operation
HO93C, FMP030, 09:01:11:00-09:01:18:00
hinge with countersunk hole
HO93D, FMP030, 09:01:45:00-09:01:55:00
countersunk hinge hole holding screw

NARRATION (VO) :

COUNTERSINKING PRODUCES AN ANGLED ENTRY TO A HOLE, WITH THE ANGLE DEFINED BY THE COUNTERSINK TOOL, TYPICALLY 60 OR 82 DEGREES. COUNTERSINKING TYPICALLY ACCOMMODATES THE HEAD OF A SCREW.

--- FADE TO BLACK ---

SCENE 94.

FMP RVW, CGS: Review
white text, centered on background
FMP BKG, motion background

MUSIC UP AND UNDER

NARRATION (VO) :

LET'S REVIEW THE MATERIAL CONTAINED IN
THIS PROGRAM.

SCENE 95.

HO07A, SME3984, 11:10:23:00-11:10:40:00
zoom out, turning hole
HO07C, SME4111, 02:20:43:00-02:20:56:00
zoom out, drilling operation

NARRATION (VO) :

DRILLING IS THE MOST COMMON HOLEMAKING
PROCESS AND PRODUCES CHIPS BY THE
RELATIVE ROTATION OF THE DRILL AND THE
WORKPIECE, COMBINED WITH A LINEAR FEED
MOVEMENT.

SCENE 96.

HO35A, SME2552, 03:15:26:00-03:15:36:00
twist drill, turning slowly
**HO41B, ANI: drill, cutting lips, chisel
edge, arrows**
**HO44A, ANI: standard drill point, 118
angle, dissolve to clearance angle arrow**

NARRATION (VO) :

THE TWIST DRILL IS A ROUGHING TOOL WITH
TWO CUTTING LIPS AND TWO FLUTES...,
THE DRILL POINT, WHICH DOES THE WORK OF
METAL CUTTING, IS FORMED BY THE TWO
CUTTING LIPS AND THE CHISEL EDGE...,
THE STANDARD DRILL POINT COMMONLY HAS A
118 DEGREE POINT ANGLE, SYMMETRICAL
CUTTING LIPS, AND A CLEARANCE ANGLE
TYPICALLY BETWEEN 10 AND 20 DEGREES.

SCENE 97.

HO32A, SME4308, 08:02:28:00-08:02:39:00
zoom in, twist drill operation
HO32B, SME2506, 01:01:24:00-01:01:38:00
indexable insert drill

NARRATION (VO) :

STANDARD DRILL TYPES INCLUDE HELICALLY-
FLUTED TWIST DRILLS MADE OF HIGH-SPEED
STEEL OR CARBIDE...,
AND CARBIDE INDEXABLE INSERT DRILLS.

SCENE 98.

HO51B, FMP021, 21:31:37:00-21:31:50:00
center drill, drilling hole
HO51A, CGS: Center Drill

NARRATION (VO) :

SPECIAL-PURPOSE DRILLS INCLUDE:

HO52D, FMP021, 21:38:21:00-21:38:45:00
spade drill operation
HO52A, CGS: Spade Drill
HO53B, SME2553, 04:17:45:00-04:18:10:00
zoom in, core drilling operation
HO53A, CGS: Core Drill
HO54C, SME2552, 03:13:55:00-03:14:10:00
step drill operation
HO54A, CGS: Step Drill
HO55A, CGS: Drilling End Mill
HO55B, SME2496, 00:09:37:00-00:10:09:00
drilling end mill, multiple shots
HO55A, CGS: Drilling End Mill

THE CENTER DRILL...,
SPADE DRILL...,
CORE DRILL...,
STEP DRILL...,
AND DRILLING END MILL.

SCENE 99.

HO61A, SME2537, 01:02:37:00-01:02:49:00
wide, holemaking on lathe
HO61B, FMP008, 09:38:02:00-09:38:32:00
holemaking on machining center
HO61C, still, high-production transfer machine
HO62A, CGS: Sensitive Drill Press
HO63A, FMP028, 06:20:55:00-06:21:08:00
manual drill press feed
HO65A, CGS: Radial Drill
HO65B, FMP019, 19:10:14:00-19:10:46:00
tapping with radial drill
HO67A, CGS: Self-Feeding Drilling Units
HO67B, FMP026, 04:51:50:00-04:52:21:00
wide, drilling units, operating, edit at multiple points
HO68A, CGS: Multi-Spindle Drilling Units
HO68B, SME2338, 10:23:55:00-10:24:09:00
zoom out, multi-spindle drilling operation
HO69A, CGS: Drill & Tap Centers
HO69B, still, drill & tap center

NARRATION (VO) :

MOST HOLEMAKING IS DONE WITH 'CNC'
MACHINE TOOLS, INCLUDING LATHES...,
MACHINING CENTERS...,
OR HIGH-PRODUCTION TRANSFER MACHINES.
HOWEVER, DEDICATED DRILLING MACHINES ARE
STILL USED, INCLUDING:
THE SENSITIVE DRILL PRESS, WHICH GIVES
AN OPERATOR A 'FEEL' FOR THE
DRILLING...,
RADIAL DRILLS...,
SELF-FEEDING DRILLING UNITS...,
MULTI-SPINDLE DRILLING UNITS...,
AND 'CNC' DRILL AND TAP CENTERS.

SCENE 100.

HO72B, SME4128, 20:23:06:00-20:23:21:00
zoom out, drilling operation
HO72A, CGS: Cutting Speed
HO72C, SME4111, 02:25:40:00-02:25:57:00
zoom in, large drill during holemaking
HO73A, CGS: Feed/Penetration Rate
HO73B, FMP021, 21:50:38:00-21:50:59:00
c.u. drilling operation

NARRATION (VO) :

OPERATING PARAMETERS IN DRILLING
INCLUDE:
THE CUTTING SPEED, WHICH IS MEASURED AT
THE PERIPHERY OF THE DRILL AND IS
EXPRESSED AS SURFACE DISTANCE PER
MINUTE...,

AND FEED OR PENETRATION RATE, WHICH IS A DISTANCE PER UNIT TIME, AND IS EXPRESSED IN INCHES OR MILLIMETERS PER REVOLUTION OF THE DRILL, OR IN INCHES OR MILLIMETERS PER MINUTE.

SCENE 101.

HO76C, SME2551, 02:06:17:00-02:06:33:00
c.u. squealing drill
HO76D, SME2550, 01:06:42:00-01:06:59:00
audio only, squealing sound
HO77C, FMP024, 02:40:28:00-02:40:48:00
zoom out, drill grinding operation

NARRATION (VO) :

GOOD PRACTICES IN DRILLING INCLUDE:
REMEMBERING TO STOP DRILLING WHEN THE
SIGNS OF DRILL POINT BLUNTNESS
APPEAR...,
AND ALWAYS REGRIND DULL DRILLS USING
EQUIPMENT DESIGNED FOR DRILL GRINDING.

SCENE 102.

HO79A, SME2519, 02:26:30:00-02:26:42:00
holemaking operation
HO79B, SME2519, 02:28:38:00-02:28:48:00
reaming operation
HO82A, CGS: Reaming
HO82B, FMP008, 09:04:40:00-09:05:07:00
reaming operation on multiple holes
HO84A, CGS: Boring
HO84B, SME4113, 04:07:24:00-04:07:50:00
zoom out, boring operation
HO87A, CGS: Honing
HO87B, FMP025, 03:38:39:00-03:39:08:00
honoring operation
HO90A, CGS: Roller Burnishing
HO90C, SME2841, 01:06:18:00-01:07:04:00
roller burnishing operation
HO92A, CGS: Counterboring
HO92B, FMP021, 21:56:03:00-21:56:51:00
counterboring operation, edit at several
spots
HO93A, CGS: Countersinking
HO93B, FMP021, 21:46:45:00-21:47:16:00
countersink operation

NARRATION (VO) :

SINCE DRILLING PRODUCES A FAIRLY ROUGH
HOLE SURFACE WITH LIMITED DIMENSIONAL
ACCURACY, IT IS COMMONLY FOLLOWED BY A
HOLE FINISHING OPERATION. TYPICAL HOLE
FINISHING OPERATIONS INCLUDE:
REAMING...,
BORING...,
HONING...,
ROLLER BURNISHING...,
COUNTERBORING...,
AND COUNTERSINKING.

--- FADE TO BLACK ---

SCENE 103.

continue music, up and under
HO CRX, CGS, ROLL: credits
white text, fade up mid-screen

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FMP EXM, extended motion background

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SCENE 104.
continue motion background
FMP 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 105.
FMP SME, SME logo open, with music