FUNDAMENTAL MANUFACTURING PROCESSES

CUTTING TOOL GEOMETRIES

SCENE 1.
CG: FBI warning

SCENE 2.
Tape 40, 01:00:00-01:00:12
ANI: SME logo

SCENE 3.
tape 25, 01:01:06-01:01:20
series opening title:
FUNDAMENTAL MANUFACTURING
PROCESSES
tape 63, 12:06:32-12:09:06
opening music

MUSIC UP AND UNDER

NARRATION (VO):

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

SCENE 4.
program title:
CG: CUTTING TOOL GEOMETRIES
white text centered on black

NARRATION (VO):

THIS PROGRAM IS AN INTRODUCTION TO CUTTING TOOLS AND TOOL GEOMETRIES FOR TURNING AND MILLING.

SCENE 5.
tape 217, 00:07:30-00:07:40
milling part
tape 2, 00:02:57-00:03:05
cutting tool, parting off,
dissolve to contouring
tape 4, 00:07:01-00:07:04
machining of part
tape 2, 00:05:21-00:05:29
turning operation
tape 92, 01:06:47-01:06:55
boring operation
tape 2, 00:10:11-00:10:13
slot milling

NARRATION (VO):

CUTTING TOOLS FOR METALCUTTING HAVE MANY SHAPES, EACH OF WHICH IS DESCRIBED BY ITS ANGLES OR GEOMETRY. EVERY METALCUTTING TOOL SHAPE HAS A SPECIFIC PURPOSE.

SCENE 6.
tape 208, 01:27:12-01:27:20
facing of workpiece
tape 239, 06:02:36-06:02:43
turkey carved with butter knife
tape 187, 00:16:59-00:17:10
end milling of part

NARRATION (VO):

CUTTING EFFICIENTLY REQUIRES USING THE RIGHT SHAPED TOOL FOR THE TASK. IF YOU TRY TO CARVE A TURKEY WITH A BUTTER KNIFE, YOU'LL MOST LIKELY

FAIL. THIS IS ALSO TRUE WITH METALCUTTING, WHERE THE SELECTION OF CUTTING TOOLS IS CONSIDERABLY MORE DEMANDING.

--- FTB ---

SCENE 7.
tape 209, 02:07:03-02:07:15
turning process producing chips
tape 219, 01:01:13-01:01:35
photomicrography of continuous chips forming, cut to discontinuous chips forming
CG, SUPER: CONTINUOUS CHIPS
DISCONTINUOUS CHIPS
tape 1, 00:04:32-00:04:42
slow motion of chips breaking

NARRATION (VO):

THE FIRST GOAL IN MACHINING IS TO ACHIEVE THE MOST EFFICIENT SEPARATION OF CHIPS FROM THE METAL WORKPIECE. THE EDGES OF THE CUTTING TOOL, DRIVEN BY THE POWER OF THE MACHINE TOOL INTO THE WORKPIECE, FORCES GRAINS OF THE METAL TO MOVE AWAY FROM THE ADVANCING CUTTING EDGE. THIS DISPLACEMENT CAUSES THE METAL TO FAIL. A CHIP FORMS ALONG THIS LINE OF FAILED METAL, WHICH SEPARATES FROM THE WORK MATERIAL.

SCENE 8.
tape 50, 01:06:00-01:06:06
c.u. chips breaking in milling
tape 225, 02:01:00-02:02:30
blue background
CG: WORK MATERIAL
TOOL MATERIAL
TOOL GEOMETRY
MACHINE TOOL FORCES
PROCESS CONDITIONS

NARRATION (VO):

HOW THAT MATERIAL FAILURE AND CHIP FORMATION TAKES PLACE IS INFLUENCED BY THE WORK MATERIAL, THE TOOL MATERIAL, THE TOOL GEOMETRY, THE FORCES APPLIED BY THE MACHINE TOOL, AND VARIOUS CONDITIONS IN THE PROCESS, SUCH AS HEAT AND VIBRATION.

SCENE 9.
tape 210, 03:03:04-03:03:10
c.u. facing of part
tape 235, 01:09:51-01:10:01
c.u. end milling
tape 79, 02:19:47-02:20:00
c.u. boring of part
tape 234, 02:05:42-02:05:46
c.u. peripheral milling
tape 17, 10:21:17-10:21:25
c.u. straight turning

NARRATION (VO):

AN EFFICIENT CUTTING TOOL GEOMETRY IS ONE THAT MINIMIZES HEAT IN THE CUT AND ACHIEVES A COOL, PROPERLY FORMED, MANAGEABLE CHIP WHILE CUTTING THE GIVEN WORKPIECE MATERIAL.

SCENE 10.
tape 235, 01:13:14-01:13:22

NARRATION (VO):

blown tool holder
tape 225, 02:01:00-02:02:30
blue background
CG: FAIL TO CUT
ACCELERATE TOOL WEAR
CAUSE TOOL BREAKAGE
DAMAGE PARTS

USING THE WRONG CUTTING TOOLS FOR A GIVEN OPERATION MAY CAUSE THE TOOL TO NOT CUT AT ALL, WEAR THE TOOL OUT TOO QUICKLY, BREAK THE TOOL, DAMAGE A WORKPIECE, OR FAIL IN OTHER WAYS.

SCENE 11.
tape 50, 01:06:28-01:06:33
milling of part
tape 1, 00:05:41-00:05:51
turning workpiece
tape 225, 02:01:00-02:02:30
blue background
CG: WORKPIECE COMPOSITION AND HARDNESS
WORKPIECE SHAPE AND SURFACE CONDITION
MACHINE'S HORSEPOWER
FEED AND SPEED RANGE
WORKHOLDING RIGIDITY
tape 225, 02:01:00-02:02:30
blue background
CG: TOOL SHAPE
TOOL MATERIAL
PROCESS PARAMETERS

NARRATION (VO):

BEFORE FINAL SELECTION OF A CUTTING TOOL CAN BE MADE, CERTAIN PROCESS PARAMETERS MUST BE KNOWN--SUCH AS: THE COMPOSITION AND HARDNESS OF THE WORKPIECE, IT'S SHAPE AND SURFACE CONDITION, THE MACHINE'S HORSEPOWER, THE MACHINE'S FEED AND SPEED CAPABILITY, AND THE RIGIDITY AND SECURITY OF THE WORKHOLDING METHOD. ALL THESE VARIABLES FACTOR INTO THE SELECTION OF TOOL SHAPE, TOOL MATERIAL, AND MACHINING PROCESS PARAMETERS.

--- FTB ---

SCENE 12.
CG: TURNING & SINGLE POINT TOOLS
white text on black

SCENE 13.
tape 215, 00:01:45-00:01:55
c.u. single point contour turning

NARRATION (VO):

NEARLY ALL TURNING USES SINGLE POINT CUTTING TOOLS, THAT IS, TOOLS THAT CUT WITH A SINGLE CUTTING EDGE.

SCENE 14.
tape 227, 02:28:56-02:29:10
c.u. carbide insert, turning
tape 34, 05:03:54-05:04:00
c.u. hss turning
tape 235, 03:00:42-03:00:52

NARRATION (VO):

MOST TURNING TODAY IS DONE WITH COATED INDEXABLE CARBIDE INSERTS, BUT THE TOOL MATERIAL MAY ALSO BE

c.u. brazed carbide turning
tape 239, 07:01:18-07:01:37
c.u. ceramic insert turning
tape 227, 02:23:50-02:23:59
c.u. cbn insert turning
tape 226, 01:27:52-01:28:03
c.u. pcd insert turning

HIGH SPEED STEEL...,

BRAZED CARBIDE...,

OR INSERTS OF CERAMIC...,

CUBIC BORON NITRIDE...,

OR POLYCRYSTALLINE DIAMOND.

SCENE 15.
tape 226, 01:12:29-01:12:36
turning operation
tape 225, 02:01:00-02:02:30
blue background
CG: TOOL MATERIAL/GRADE
TOOL GEOMETRY
TOOLHOLDER DESIGN
tape 1, 00:02:50-00:02:53
2 shots, diff. inserts
tape 1, 00:06:28-00:06:30
triangular insert
tape 1, 00:03:04-00:03:08
2 shots, diff. inserts

NARRATION (VO):

SEVERAL DECISIONS ARE REQUIRED WHEN CHOOSING TOOLS FOR TURNING, INCLUDING THE SELECTION OF THE MATERIAL OR GRADE, THE GEOMETRY, AND THE TOOLHOLDER DESIGN. JUST A FEW BASIC GEOMETRIES AND CARBIDE GRADES ARE USED IN SEVENTY FIVE PERCENT OF TURNING APPLICATIONS.

SCENE 16.
tape 15, 01:01:26-01:01:31
holemaking on lathe
tape 58, 03:23:47-03:23:57
boring on lathe
tape 36, 00:07:45-00:07:51
threading on lathe
tape 2, 00:03:28-00:03:36
parting-off of part

NARRATION (VO):

TOOLING DECISIONS FOR LATHE OPERATIONS SUCH AS HOLEMAKING...,

BORING...,

THREADING...,

AND PARTING-OFF, REQUIRE UNIQUE SELECTIONS OF GRADE, GEOMETRY, AND TOOLHOLDER.

--- FTB ---

SCENE 17.
tape 208, 01:10:36-01:10:56
zoom into c.u. insert in toolholder, cutting

NARRATION (VO):

WHEN TURNING WITH INSERTS, MUCH OF THE REQUIRED GEOMETRY, SUCH AS CLEARANCE ANGLES, IS BUILT INTO THE TOOLHOLDER, RATHER THAN THE INSERT ITSELF. BUT LET'S FOCUS FIRST ON INSERTS.

SCENE 18.
tape 236, 01:25:07-01:25:15
c.u. insert

NARRATION (VO):

tape 225, 02:01:00-02:02:30
blue background
CG: INSERT SHAPE
RELIEF/CLEARANCE ANGLE
INSERT TOLERANCE
INSERT TYPE
INSCRIBED CIRCLE SIZE
INSERT THICKNESS
NOSE RADIUS
CHIPBREAKER DESIGN

THE GEOMETRY OF AN INSERT INCLUDES ITS SHAPE,

RELIEF OR CLEARANCE ANGLE,

TOLERANCE,

TYPE,

IT'S INSCRIBED CIRCLE OR "IC" SIZE,

THICKNESS,

NOSE RADIUS,

AND THE INSERT'S CHIPBREAKER DESIGN.

SCENE 19.
CG, SUPER: INSERT SHAPE
tape 237, 01:11:28-01:11:36
tilt of still, insert shapes
tape 3, 00:07:53-00:07:58
round insert performing contour
tape 17, 10:09:39-10:09:47
square insert roughing part

NARRATION (VO):

FOR TURNING, INSERT SHAPE SELECTION IS BASED ON

THE TRADE-OFF BETWEEN STRENGTH AND VERSATILITY.

THE LARGER POINT ANGLES ARE THE STRONGEST AND MOST

ECONOMICAL. THOSE INCLUDE ROUND INSERTS FOR

CONTOURING...,

AND SQUARE INSERTS FOR ROUGHING AND FINISHING.

SCENE 20.
tape 226, 01:28:16-01:28:23
35 degree insert contouring
tape 56, 01:06:52-01:07:03
55 degree insert contouring

NARRATION (VO):

THE SMALLER ANGLES, SUCH AS THE 35 DEGREE

DIAMOND...,

AND THE 55 DEGREE DIAMOND, PROVIDE THE GREATEST

VERSATILITY FOR INTRICATE CONTOURING.

SCENE 21.
tape 228, 03:02:35:00
still, c.u. trigon insert
tape 228, 03:05:56-03:06:00
diamond shaped insert
tape 228, 03:00:40-03:00:56
c.u. trigon insert, cutting

NARRATION (VO):

TRIGON INSERTS HAVE SIX CUTTING EDGES YET HAVE THE

STRENGTH OF 80 DEGREE DIAMONDS--WHICH HAVE ONLY

FOUR EDGES. COST PER EDGE IS LOWER, SO TRIGONS ARE

A POPULAR TURNING INSERT SHAPE FOR LIGHT TO MEDIUM

DEPTHS OF CUT.

SCENE 22.
tape 2, 00:03:37-00:03:40

NARRATION (VO):

insert cutting
tape 1, 00:06:46-00:06:52
insert being molded
tape 2, 00:09:45-00:09:49,
insert being ground, dissolve
tape 2, 00:09:52-00:09:56
insert being ground for cutting operation

INSERTS ARE MOLDED OR GROUND. MOLDED INSERTS ARE MORE ECONOMICAL AND HAVE WIDE APPLICATION. GROUND INSERTS ARE REQUIRED WHEN INDEXABILITY MUST BE HELD WITHIN CLOSE TOLERANCES, OR WHEN WELL-DEFINED OR SHARP CUTTING EDGES ARE NEEDED.

--- FTB ---

SCENE 23.
tape 36, 00:01:12-00:01:25
cutting tool introduced into workpiece
tape 244, 01:02:01-01:02:13
ANI: lines forming positive angle of inclination
CG, SUPER: ANGLE OF INCLINATION
tape 239, 07:07:47-07:08:00
toolholder with positive insert orientation
CG, SUPER: POSITIVE
tape 239, 07:07:10-07:07:20
toolholder with negative insert orientation
CG, SUPER: NEGATIVE
tape 239, 07:09:15-07:09:25
toolholder with neutral insert orientation
CG, SUPER: NEUTRAL

NARRATION (VO):

SEVERAL ANGLES ARE IMPORTANT WHEN INTRODUCING A CUTTING TOOL'S CUTTING EDGE INTO A ROTATING WORKPIECE. THOSE ANGLES INCLUDE:
THE "ANGLE OF INCLINATION", WHICH WHEN VIEWED FROM THE SIDE OR FRONT, IS THE ANGLE OF THE INSERT SEAT OR POCKET IN THE TOOLHOLDER, FROM FRONT-TO-BACK.
THE "ANGLE OF INCLINATION" MAY BE POSITIVE...,
NEGATIVE...,
OR NEUTRAL.

SCENE 24.
CG, SUPER: RAKE ANGLE
tape 244, 01:04:05-01:04:12
ANI: lines forming positive rake angle
CG, SUPER: POSITIVE
tape 245, 02:04:10-02:04:20
ANI: lines forming negative rake angle
CG, SUPER: NEGATIVE
tape 244, 01:05:20-01:05:30
ANI: lines forming neutral rake angle
CG, SUPER: NEUTRAL

NARRATION (VO):

THE CUTTING TOOL'S "RAKE" ANGLE IS THE RELATION OF IT'S CUTTING EDGE TO THE CUT ITSELF AND MAY ALSO
BE POSITIVE...,
NEGATIVE...,
OR NEUTRAL.

SCENE 25.
CG, SUPER: EFFECTIVE RAKE
tape 245, 02:06:05-02:06:20
ANI: lines forming effective rake

NARRATION (VO):

THE "EFFECTIVE RAKE" IS A COMBINATION OF THE TOOLHOLDERS' ANGLE OF INCLINATION AND THE RAKE

BUILT INTO THE INSERT.

SCENE 26.
tape 226, 01:05:43-01:05:52
c.u. tool plunging into workpiece
CG, SUPER: TOP/BACK RAKE ANGLE
tape 245, 02:07:25-02:07:43
ANI: lines forming top/back rake angle

NARRATION (VO):

THE LARGEST INFLUENCE ON CHIP FLOW IN TURNING IS THE "TOP" OR "BACK" RAKE ANGLE. VIEWED FROM THE SIDE OF THE TOOLHOLDER, THIS IS THE ANGLE CREATED BY THE TOP OF THE CUTTING TOOL AND AN IMAGINARY LINE DRAWN HORIZONTALLY THROUGH THE WORKPIECE DIAMETER.

SCENE 27.
tape 244, 01:09:22-01:09:30
ANI: positive rake tool

NARRATION (VO):

A "POSITIVE" TOP RAKE TOOL CUTS FREELY, WITH REDUCED POWER REQUIREMENTS AND REDUCED TEMPERATURES.

SCENE 28.
tape 245, 02:09:38-02:09:50
ANI: negative rake tool

NARRATION (VO):

A "NEGATIVE" TOP RAKE TOOL IS GENERALLY STRONGER, BUT IT GENERATES MORE FORCE AND REQUIRES MORE POWER.

SCENE 29.
tape 227, 02:05:39-02:05:55
cast iron rough cut

NARRATION (VO):

A "NEGATIVE" OR A "NEUTRAL" TOP RAKE IS PREFERRED FOR ROUGH TURNING OPERATIONS, PARTICULARLY FOR CAST IRON.

SCENE 30.
tape 227, 02:28:37-02:28:55
c.u. insert entering cut, cutting

NARRATION (VO):

IN ADDITION TO THE ANGLES BUILT INTO AN INSERT AND A TOOLHOLDER, THE ANGLE AT WHICH THE PRIMARY CUTTING EDGE OF THE INSERT ENTERS THE WORKPIECE, CALLED THE "LEAD" ANGLE, IS ALSO IMPORTANT.

SCENE 31.
CG, SUPER: LEAD/ENTRY ANGLE
tape 244, 01:11:51-01:12:05

NARRATION (VO):

ANI: lines forming lead/entry angle

THE "LEAD" OR "ENTRY" ANGLE IS THE ANGLE BETWEEN THE DIRECTION OF THE CUTTING TOOL FEED AND THE CUTTING EDGE. SOMETIMES THE WORKPIECE SHAPE DETERMINES THE LEAD ANGLE.

SCENE 32.
tape 17, 10:34:04-10:34:17
part being turned

NARRATION (VO):

THE LEAD ANGLE ALSO INFLUENCES THE VARIETY OF CUTS THAT MAY BE TAKEN WITH THAT TOOL.

SCENE 33.
CG, SUPER: TOOL NOSE RADIUS
tape 244, 01:13:30-01:13:45
ANI: tool nose radius in equal radius cut, dissolve to, c.u. smaller tool nose radius in same radius cut
tape 56, 01:28:27-01:28:46
c.u. tool nose radius in tight radius cut

NARRATION (VO :

THE "TOOL NOSE RADIUS" MUST BE EQUAL TO OR SMALLER THAN THE SMALLEST RADIUS ON THE WORKPIECE FOR CUTS MADE WITH THAT TOOL. OTHER FACTORS INFLUENCING TOOL NOSE RADIUS SELECTION INCLUDE:
THE SURFACE FINISH REQUIREMENTS,
AND THE TOOL STRENGTH, WITH THE LARGEST TOOL NOSE RADIUS PERMISSIBLE GIVING THE GREATEST STRENGTH.

SCENE 34.
tape 239, 07:01:44-07:02:03
c.u. large tool nose radius in cut
tape 239, 07:00:42-07:00:48
c.u. large tool nose radius in cut

NARRATION (VO):

THE LARGER THE "TOOL NOSE RADIUS" AND THE STRONGER THE CORNER, THE GREATER IS THE CUTTING TOOLS' ABILITY TO ABSORB HEAT, AND PRODUCE A SMOOTHER SURFACE. HOWEVER, A LARGER RADIUS ALSO GENERATES GREATER RADIAL CUTTING FORCES, AND RUNS THE RISK OF VIBRATION.

SCENE 35.
tape 56, 01:08:34-01:08:43
part turned, completed, stops

NARRATION (VO):

THE QUALITY OF THE FINISHED TURNED SURFACE IS MAINLY FROM A COMBINATION OF THE CUTTING TOOLS' "TOOL NOSE RADIUS" AND THE FEED PER REVOLUTION.

--- FTB ---

SCENE 36.
tape 236, 01:25:17-01:25:37
ANI: insert, inscribed circle appears
CG, SUPER: INSCRIBED CIRCLE
tape 228, 03:13:06-03:13:12
c.u. offset angle, small & large inserts, thickness'

NARRATION (VO):

INSERT SIZE IS DESIGNATED BY THE LARGEST CIRCLE WHICH CAN BE INSCRIBED WITHIN THE PERIMETER OF THE INSERT; CALLED THE "INSCRIBED CIRCLE" OR "IC". AS THE SIZE OF THE INSERT INCREASES, SO DOES THE INSERTS THICKNESS.

SCENE 37.
tape 226, 01:11:08-01:11:17
insert positioned, cutting
tape 226, 01:09:54:00
freeze, toolholder, without insert
tape 226, 01:10:26-01:10:33
insert in toolholder

NARRATION (VO):

INSERT SIZE IS DIRECTLY CONNECTED TO THE TOOLHOLDER SELECTED. THE POCKET SIZE OF THE TOOLHOLDER AND THE INSCRIBED CIRCLE SIZE OF THE INSERT MUST BE SELECTED TOGETHER.

SCENE 38.
tape 237, 01:02:10-01:02:20
still of valenite toolholders

NARRATION (VO):

THE HOLDER POCKET SHAPE IS DETERMINED BY THE SHAPE OF THE INSERT.

SCENE 39.
tape 56, 01:07:44-01:07:57
c.u. turning of part

NARRATION (VO):

INSERT SIZE IS SELECTED ACCORDING TO THE MAXIMUM DEPTH OF CUT TO BE TAKEN, AND THE LEAD ANGLE. THIS PROVIDES MAXIMUM CUTTING EDGE ENGAGEMENT.

SCENE 40.
tape 227, 02:06:35-02:06:48
c.u. insert cutting

NARRATION (VO):

IF THE EFFECTIVE CUTTING EDGE LENGTH IS LESS THAN THE DEPTH OF CUT, A LARGER INSERT SHOULD BE SELECTED--OR THE DEPTH OF CUT REDUCED.

SCENE 41.
tape 17, 10:10:30-10:10:36
c.u. cut with small insert
tape 246, 10:10:49-10:11:05
dissolve with, another cut with small insert

NARRATION (VO):

LIGHT CUTS CAN BE DONE WITH A SMALLER INSERT--BUT TOO SMALL AN INSERT MIGHT REQUIRE TWO PASSES TO BE MADE INSTEAD OF ONE, WHICH IS UNECONOMICAL.

SCENE 42.
continue last shot
tape 237, 01:10:52-01:10:58
pan down of large to small toolholders

NARRATION (VO):

FOR EVEN THE SMALLEST JOBS, THERE ARE APPROPRIATELY SIZED INSERTS, TOOLHOLDERS, AND BORING BARS.

--- FTB ---

SCENE 43.
tape 236, 01:23:37-01:24:00
ANI: c.u. insert cross section in cut, sharp edge breaking, dissolves to, c.u. insert cross section, honed radius, dissolves to, c.u. insert cross section, chamfer, dissolves to, c.u. insert cross section, negative land

NARRATION (VO):

SINCE A SHARP EDGE IS WEAK AND FRACTURES EASILY, AN INSERT'S CUTTING EDGE IS PREPARED WITH PARTICULAR SHAPES TO STRENGTHEN IT. THOSE SHAPES INCLUDE:

A HONED RADIUS OR ROUNDING ON THE CORNER,

A CHAMFER TO BREAK THE EDGE,

A LAND OR SMALL NEGATIVE SLOPE,

OR A COMBINATION OF THE THREE.

SCENE 44.
tape 17, 10:13:32-10:13:42
fine finish turning with insert with small edge rounding
tape 56, 01:06:29-01:06:43
rough turning with large negative land insert

NARRATION (VO):

A FINE FINISHING INSERT MAY NEED ONLY A SMALL EDGE ROUNDING...,

WHILE A HEAVY ROUGHING INSERT MAY HAVE A SIGNIFICANT NEGATIVE LAND FOR EDGE STRENGTH. THE DRAWBACK OF NEGATIVE LANDS IS THAT THEY NEED MORE POWER AND ALTER CHIP FORMATION UNFAVORABLY.

--- FTB ---

SCENE 45.
tape 239, 07:12:00-07:12:29
medium shot of toolholder
CG, SUPER: SHANK
HEAD
POCKET

NARRATION (VO):

INSERT-TYPE TOOLHOLDERS FOR TURNING ARE MADE OF STEEL, AND CONSIST OF A SHANK...,

HEAD...,

POCKET...,

AND CLAMPING HARDWARE.

SCENE 46.
tape 226, 01:17:29-01:17:43
c.u., insert secured in pocket with carbide seat

NARRATION (VO):

TOOLHOLDER POCKETS ARE MACHINED TO ACCURATELY LOCATE AND ORIENT THE INSERT. SOMETIMES A CARBIDE SEAT IS USED BETWEEN THE POCKET AND THE INSERT.

SCENE 47.
tape 239, 07:11:16-07:11:26
left-handed toolholder
tape 239, 07:09:46-07:09:56
right-handed toolholder
tape 239, 07:10:47-07:10:57
neutral toolholder

NARRATION (VO):

TOOLHOLDERS ARE ALSO EITHER LEFT-HANDED...,

RIGHT-HANDED...,

OR NEUTRAL.

SCENE 48.
tape 227, 02:13:07-02:13:20
c.u. different tool types
tape 227, 02:14:41-02:14:46
boring bar, pull out
tape 225, 02:01:00-02:02:30
blue background
CG: SHANK SIZE
RIGHT/LEFT/NEUTRAL
CLAMPING METHOD
INSERT SHAPE
INSERT SIZE
INSERT STYLE
RAKE ANGLE

NARRATION (VO):

THERE IS A WIDE SELECTION OF TOOLHOLDERS...,

AND BORING BARS.

THEY ARE DESIGNATED BY THE SHANK SIZE, HAND OF THE TOOL, METHOD OF CLAMPING, INSERT SHAPE, INSERT SIZE, INSERT STYLE, AND RAKE ANGLE.

SCENE 49.
tape 2, 00:05:14-00:05:19
clamping insert into toolholder
tape 36, 00:05:48-00:05:53
insert clamped into toolholder
tape 2, 00:04:47-00:04:51
clamping insert into toolholder
tape 56, 01:06:45-01:06:48
clamping roughing insert into toolholder
tape 226, 01:17:54-01:17:58
clamping finishing insert into toolholder

NARRATION (VO):

TOOL MAKERS HAVE CLAMPING SYSTEMS FOR THEIR VARIOUS INSERT FAMILIES. ROUGHING AND FINISHING TOOLS MAY HAVE DIFFERENT CLAMPING MECHANISMS OR CLAMP CONFIGURATIONS.

SCENE 50.
tape 2, 00:05:25-00:05:32
c.u. toolholder while straight turning
tape 2, 00:09:00-00:09:09

NARRATION (VO):

THE SIZE AND TYPE OF TOOLHOLDER IS DETERMINED BY

facing operation
tape 56, 01:14:23-01:14:32
rough cut operation
tape 34, 05:03:28-05:03:35
manual turning operation
tape 2, 00:05:35-00:05:40
grooving of part
tape 3, 00:08:08-00:08:14
contour turning of odd shaped workpiece

THE TURNING OPERATION...,
THE FEED DIRECTION...,
THE SIZE OF THE CUTS...,
THE MACHINE TOOL DESIGN...,
THE NEED FOR ACCESSIBILITY...,
AND SOMETIMES THE SHAPE OF THE WORKPIECE, IF, FOR EXAMPLE, CONTOUR TURNING IS INVOLVED.

SCENE 51.
tape 239, 07:17:20-07:17:30
different toolholder style
tape 239, 07:15:50-07:16:00
different toolholder style
tape 239, 07:16:20-07:16:30
different toolholder style
tape 239, 07:15:20-07:15:30
different toolholder style
tape 239, 07:17:50-07:18:00
different toolholder style
tape 239, 07:18:20-07:18:30
different toolholder style
tape 239, 07:16:50-07:17:00
different toolholder style

NARRATION (VO):

TURNING TOOLHOLDER STYLES ARE DEFINED BY THEIR LEAD ANGLE AND THE SHANK OFFSET. LONGITUDINAL TURNING, FACING, AND VARIOUS CONTOUR CUTTING OPERATIONS REQUIRE CERTAIN TOOLHOLDER FORMS. THERE ARE HUNDREDS OF STYLES.

SCENE 52.
tape 239, 07:02:23-07:02:40
turning using 15/30 degree reverse lead angle

NARRATION (VO):

IN TURNING, A 15 TO 30 DEGREE REVERSE LEAD ANGLE TOOLHOLDER IS OFTEN USED. THIS STYLE DISTRIBUTES THE CUTTING STRESSES, THINS THE CHIP, AND REDUCES PRESSURE ON THE EDGE.

SCENE 53.
tape 239, 07:05:07-07:05:16
toolholder with zero lead angle
tape 239, 07:04:03-07:04:08
toolholder with negative 5 degree lead angle

NARRATION (VO):

WHEN TURNING TO A SQUARE SHOULDER, THE TOOLHOLDER SHOULD HAVE A ZERO DEGREE LEAD ANGLE...,
OR A NEGATIVE 5 DEGREE LEAD ANGLE.

SCENE 54.
tape 36, 00:06:00-00:06:14
boring bar with zero degree lead angle toolholder

NARRATION (VO):

IN BORING, A ZERO-DEGREE LEAD ANGLE IS PREFERRED, AS IT DIRECTS THE FEED FORCE ALONG THE AXIS OF THE

WORK, MINIMIZING DEFLECTION.

SCENE 55.
tape 57, 03:22:53-03:23:10
facing of workpiece

NARRATION (VO):

SOME TOOLHOLDERS ARE DESIGNED FOR FACING.

SCENE 56.
tape 239, 07:05:56-07:06:06
offset shank style toolholder
tape 239, 07:06:23-07:06:30
straight shank style toolholder

NARRATION (VO):

THE OFFSET STYLE TOOLHOLDER LETS WORK BE PERFORMED CLOSER TO THE CHUCK JAWS, AND IS GENERALLY CHOSEN OVER THE STRAIGHT SHANK.

SCENE 57.
tape 227, 02:20:23-02:20:36
positioning toolholders in toolblock

NARRATION (VO):

TOOLHOLDERS AND BORING BARS SHOULD BE POSITIONED AS FAR BACK IN THE TURRET OR TOOL BLOCK AS POSSIBLE, TO MAXIMIZE SUPPORT. OVEREXTENDED TOOLS CHATTER AND CAUSE INSERT BREAKAGE.

--- FTB ---

SCENE 58.
tape 216, 01:04:27-01:04:45
chipbreaking turning operation

NARRATION (VO):

IN TURNING, EFFECTIVELY BREAKING A CHIP IS JUST AS IMPORTANT AS MAKING THE CHIP. A PROPERLY BREAKING CHIP CONTRIBUTES TO AN EFFICIENT PROCESS AND A GOOD FINISH ON THE WORKPIECE.

SCENE 59.
tape 228, 03:03:58-03:04:06
birds nest chip being created

NARRATION (VO):

BADLY CONTROLLED CHIPS ARE A NUISANCE, A PRODUCTION BOTTLENECK, AND ARE POTENTIALLY UNSAFE.

SCENE 60.
tape 211, 04:04:34-04:04:38
turning operation with good chip breaking
tape 225, 02:01:00-02:02:30
blue background
CG: FEED RATE
DEPTH OF CUT
CHIPBREAKER GEOMETRY

NARRATION (VO):

PROPER CHIP BREAKING RESULTS FROM A BALANCE BETWEEN THE FEEDRATE, DEPTH OF CUT, AND THE CHIPBREAKER GEOMETRY IN THE CUTTING TOOL.

SCENE 61.
tape 228, 03:10:48-03:10:52
c.u. insert chipbreaker design
tape 228, 03:10:55-03:10:59
c.u. insert chipbreaker design
tape 228, 03:11:12-03:11:16
c.u. insert chipbreaker design
tape 228, 03:11:28-03:11:32
c.u. insert chipbreaker design
tape 228, 03:11:40-03:11:44
c.u. insert chipbreaker design
tape 228, 03:12:00-03:12:04
c.u. insert chipbreaker design

NARRATION (VO):

THE CHIPBREAKER GROOVE IS MOLDED INTO THE INSERT IN A WIDE VARIETY OF PROPRIETARY DESIGNS. GROOVES, BUMPS, WAVES, DIMPLES, AND ALL SORTS OF SHAPES HAVE BEEN DESIGNED INTO CUTTING TOOLS.

SCENE 62.
tape 228, 03:01:46-03:01:52
turning operation, chip breaking well

NARRATION (VO):

CHIPBREAKER GEOMETRIES ARE ALL DESIGNED TO WORK AT DESIGNATED FEED RATES AND DEPTH OF CUT.

SCENE 63.
tape 15, 01:07:03-01:07:09
high pressure coolant used in turning operation

NARRATION (VO):

HIGH-PRESSURE COOLANT EFFECTIVELY PROMOTES CHIP BREAKING, IF ALL ELSE FAILS.

--- FTB ---

SCENE 64.
tape 17, 10:15:06-10:15:12
turning operation with chips

NARRATION (VO):

THERE ARE FOUR BASIC CHIP TYPES IN TURNING.

SCENE 65.
tape 226, 01:15:05-01:15:14
c.u. “6” or “9” chips
tape 227, 02:10:25-02:10:34
turning operation generating a lot of chips

NARRATION (VO):

CHIPS THAT RESEMBLE SMALL SIXES OR NINES ARE THE IDEAL TYPE OF CHIP. THEY ARE EASIEST TO DISPOSE OF AND ARE MADE IN TURNING WHEN TOOLS ARE CUTTING MOST EFFICIENTLY.

SCENE 66.
tape 228, 03:07:18-03:07:25
c.u. helical chips

NARRATION (VO):

THE HELICAL CHIP IS ACCEPTABLE, IF SMALL ENOUGH.

SCENE 67.
tape 226, 01:23:06:00
still, hay chip
tape 210, 03:06:37-03:07:11
turning operation, “hay” chip

NARRATION (VO):

THE LONG STRINGY CHIP, SOMETIMES CALLED A “HAY

being created

CHIP", MAY SNARL THE WORK AND BECOME A SAFETY HAZARD. THE CHIPBREAKER, IF ONE IS PRESENT, IS TOO WIDE AND SHALLOW. MORE CHIP BREAKING ACTION IS REQUIRED, AND CAN BE ACHIEVED BY EITHER SELECTING ANOTHER INSERT DESIGN, OR BY MOVING THE CHIPBREAKER CLOSER TO THE CUTTING EDGE, OR BY INCREASING THE FEED RATE.

SCENE 68.
tape 226, 01:22:28:00
still c.u. corrugated chips
tape 226, 01:21:23-01:21:40
turning operation creating corrugated chip

NARRATION (VO):

A CORRUGATED CHIP IS THE OPPOSITE OF A STRINGY CHIP--IT IS CAUSED BY THE CHIPBREAKER BEING TOO NARROW AND DEEP, THUS "CROWDING" THE CHIP. THIS PROMOTES EXCESS CUTTING EDGE WEAR AND RAPID TOOL FAILURE. A CORRUGATED CHIP CAN BE REMEDIED BY MOVING THE CHIPBREAKER BACK, OR BY SELECTING A DIFFERENT CHIPBREAKER DESIGN.

SCENE 69.
tape 226, 01:24:00:00
still, c.u. blue chips
tape 3, 00:03:57-00:04:03
turning operation
tape 228, 03:01:17-03:01:38
turning operation, proper colored chips produced

NARRATION (VO):

IN TURNING STEEL, CHIP COLOR CAN INDICATE IF THE HEAT GENERATED BY THE MACHINING PROCESS IS BEING TRANSFERRED AWAY SUFFICIENTLY FROM THE PART AND INTO THE CHIP. A CHIP ABSORBING HEAT, LEAVES A STEEL WORKPIECE LIGHT GOLD IN COLOR, THEN TURNS BLUE. BUT IF THE CHIP IMMEDIATELY TURNS DARK BLUE AT THE CUTTING EDGE, THIS SUGGESTS EXCESSIVE HEAT IS BEING GENERATED.

--- FTB ---

SCENE 70.
CG: MILLING & MULTI-POINT TOOLS
white text on black

SCENE 71.
tape 233, 05:10:03-05:10:16
face milling of part, stopping, freeze last frame
tape 238, 01:04:52-01:04:59
hss end mill starting to spin
tape 80, 03:15:26-03:15:36
drill turning slowly
tape 79, 02:26:23-02:26:52
reamer, reaming
tape 80, 03:27:27-03:27:39
tap, tapping

NARRATION (VO):

A MULTI-POINT TOOL HAS TWO OR MORE CHIP-PRODUCING EDGES ON A COMMON BODY, AND IS ROTATED TO CUT. SOME EXAMPLES OF MULTI-POINT TOOLS INCLUDE: FACE MILLING CUTTERS...,

END MILLS...,

DRILLS...,

REAMERS...,

AND TAPS.

SCENE 72.
tape 5, 00:06:50-00:06:55
face milling of workpiece

NARRATION (VO):

LETS EXPLORE MULTI-POINT TOOLS BY FOCUSING ON FACE MILLING CUTTERS.

SCENE 73.
tape 232, 04:20:06-04:20:16
face milling cutter, cutting surface
tape 232, 04:13:38-04:13:47
c.u. insert place in face mill pocket, freeze last frame

NARRATION (VO):

FACE MILLING CUTTERS EFFECTIVELY GENERATE FLAT SURFACES WITH THE SPINDLE PERPENDICULAR TO THE WORK SURFACE. THE CUTTER BODY HAS MULTIPLE POCKETS TO ACCEPT A VARIETY OF INDEXABLE INSERT TYPES.

SCENE 74.
tape 232, 04:21:03-04:21:19
milling with chips

NARRATION (VO):

AS THE CUTTER ROTATES, EACH INSERT EDGE ALTERNATIVELY ENTERS AND LEAVES THE CUT, REMOVING A SMALL AMOUNT OF MATERIAL IN A SHORT, DISCONTINUOUS CHIP.

SCENE 75.
tape 5, 00:05:27-00:05:34
2 shots, chips produced from milling

NARRATION (VO):

THE CHIP THICKNESS AT THE START OF THE CUT IS CALLED THE UNDEFORMED CHIP THICKNESS.

SCENE 76.
tape 233, 05:12:02-05:12:15
indexable insert milling

NARRATION (VO):

tape 236, 01:27:28-01:27:53
ANI: insert biting thick to thin chip
CG, SUPER: CLIMB MILLING MODE

MOST MILLING WITH INDEXABLE INSERT MILLING CUTTERS IS PERFORMED USING THE "CLIMB MILLING MODE", WITH THE INSERT BITING INTO THE THICKEST PORTION OF THE CHIP FIRST, AND THEN THINNING TOWARDS ZERO UPON EXIT.

SCENE 77.
tape 236, 01:26:25-01:26:50
ANI: cutter biting thin to thick chip
CG, SUPER: CONVENTIONAL MILLING MODE

NARRATION (VO):

THIS IS THE REVERSE OF THE "CONVENTIONAL MILLING MODE", IN WHICH THE MILLING CUTTER BITES INTO THE MINIMUM CHIP THICKNESS AT THE START OF THE CUT AND EXITS AT THE MAXIMUM CHIP THICKNESS.

SCENE 78.
tape 4, 00:06:24-00:06:29
pan of face milled surface
tape 232, 04:10:53-04:11:04
c.u. teeth on cutter
tape 232, 04:19:38-04:19:50
face milling shoulder

NARRATION (VO):

THE MILLED SURFACE RESULTS FROM THE COMBINED ACTION OF CUTTING EDGES LOCATED ON THE PERIPHERY AND FACE OF THE CUTTER. THE FLAT MILLED SURFACE HAS NO RELATION TO THE CONTOUR OF THE INDIVIDUAL TEETH, EXCEPT WHEN MILLING A SHOULDER.

SCENE 79.
tape 233, 05:08:49-05:09:19
small face mill, ramping into part, milling pocket

NARRATION (VO):

NOT ALL FACE MILLS ARE USED FOR LARGE, STRAIGHT CUTS. SOME SMALL DIAMETER FACE MILLS ARE USED TO RAMP INTO A SURFACE, THEN PLUNGE TO A DEPTH, AND INTERPOLATE OUTWARDS TO MILL A LARGE POCKET MORE EFFICIENTLY THAN AN END MILL COULD.

--- FTB ---

SCENE 80.
tape 232, 04:10:53-04:11:08
face milling body, rotating
tape 225, 02:01:00-02:02:30
blue background
CG: CUTTER'S DIAMETER
RIGHT/LEFT HAND
CUTTER GEOMETRIES

NARRATION (VO):

THERE ARE MAJOR VARIABLES IN THE DESIGN OF FACE MILLING CUTTER BODIES WHICH MUST BE CONSIDERED WHEN SELECTING TOOLS. THESE INCLUDE:

INSERT POCKET DESIGN
CUTTER PITCH
MOUNTING METHOD

THE CUTTER'S DIAMETER...,

THE HAND OF CUT...,

THE CUTTER GEOMETRIES, INCLUDING RAKE AND LEAD ANGLES...,

THE INSERT POCKET DESIGN...,

THE MILLING CUTTER PITCH...,

AND THE CUTTER'S MOUNTING METHOD

SCENE 81.
CG, SUPER: EFFECTIVE DIAMETER
tape 5, 00:07:19-00:07:28
face mill cutting, wide in cut
tape 244, 01:15:05-01:15:15
ANI: effective diameter, line showing measurement across cutter

NARRATION (VO):

FOR CUTTING, THE "EFFECTIVE DIAMETER" IS THE MOST SIGNIFICANT CONCERN. THE EFFECTIVE DIAMETER IS MEASURED FROM THE HIGHEST POINT ON AN INSERT ON ONE SIDE TO THE HIGHEST POINT ON AN INSERT ON THE OPPOSITE SIDE.

SCENE 82.
tape 29, 01:01:54-01:02:16
face mill, cutting, end overhanging cut

NARRATION (VO):

FOR PROPER POSITIONING, THE FACE MILLING CUTTER'S EFFECTIVE DIAMETER SHOULD BE ABOUT ONE-AND-A-HALF TIMES THE WIDTH OF THE CUT DESIRED. THIS ALLOWS A QUARTER TO ONE THIRD OF THE CUTTER TO OVERHANG THE EDGES OF THE WORKPIECE, PROVIDING OPTIMAL CHIP FORMATION.

SCENE 83.
tape 236, 01:28:34-01:29:00
ANI: milling cutter improperly positioned, c.u. generating too thin of chip

NARRATION (VO):

IF THE DIAMETER OF THE FACE MILLING CUTTER IS THE SAME AS, OR "BARELY" LARGER THAN THE WIDTH OF THE WORKPIECE, THEN THE CHIPS GENERATED WILL BE TOO THIN AT THE ENTRY AND EXIT OF THE CUT. THIS RESULTS IN A BUILD UP OF HEAT AND FRICTION WHICH WILL REDUCE TOOL LIFE.

SCENE 84.
CG, SUPER: HAND OF CUTTER
tape 233, 05:10:19-05:10:32
face mill, rotating counterclockwise, flip image to simulate cutter rotating clockwise

NARRATION (VO):

THE HAND OF THE CUTTER IS DETERMINED BY EXAMINING THE CUTTER'S FACE WHILE RUNNING ON A MACHINE TOOL. A RIGHT HAND CUTTER ROTATES COUNTERCLOCKWISE..., AND A LEFT HAND CUTTER ROTATES CLOCKWISE.

SCENE 85.
tape 232, 04:16:42-04:16:49
c.u. face mill, insert in pocket
tape 225, 02:01:00-02:02:30
blue background
CG: RADIAL RAKE ANGLE
AXIAL RAKE ANGLE
tape 233, 05:05:49-05:05:59
inserts in milling pocket

NARRATION (VO):

"RAKE" ANGLES IN MILLING CUTTERS ARE DETERMINED BY THE CUTTER BODY, AND BY THE INSERT. TWO "RAKE" ANGLES, THE "RADIAL" RAKE, AND THE "AXIAL" RAKE ARE DETERMINED BY THE POSITION OF THE INSERT POCKETS IN THE CUTTER BODY.

SCENE 86.
CG, SUPER: RADIAL RAKE
tape 244, 01:16:29-01:16:50
ANI: lines forming a positive radial rake
CG, SUPER: POSITIVE RADIAL RAKE
CHIP GULLET
tape 245, 02:16:25-02:16:40
ANI: lines forming a negative radial rake
CG, SUPER: NEGATIVE RADIAL RAKE
CHIP GULLET

NARRATION (VO):

THE "RADIAL" RAKE IS THE ANGLE MEASURED BETWEEN THE INSERT FACE AND A RADIAL LINE DRAWN FROM THE CUTTER AXIS TO THE CUTTING EDGE, HENCE THE NAME RADIAL RAKE. IF THE INSERT TILTS "TOWARD" THE CHIP GULLET, IT HAS A "POSITIVE" RADIAL RAKE..., IF THE INSERT TILTS "AWAY" FROM THE CHIP GULLET, IT HAS A "NEGATIVE" RADIAL RAKE.

SCENE 87.
CG, SUPER: AXIAL RAKE
tape 244, 01:18:54-01:19:05
ANI: lines forming a positive axial rake
CG, SUPER: POSITIVE AXIAL RAKE
tape 245, 03:02:50-03:03:00
ANI: lines forming a negative axial rake
CG, SUPER: NEGATIVE AXIAL RAKE

NARRATION (VO):

THE AXIAL RAKE IS THE ANGLE MEASURED BETWEEN THE INSERT FACE AND AN AXIAL LINE OR PLANE, AND IT MAY ALSO BE POSITIVE..., OR NEGATIVE.

SCENE 88.
tape 233, 05:09:28-05:09:39
milling cutter, milling
CG, SUPER: NEGATIVE RADIAL/AXIAL
tape 245, 02:17:15-02:17:30
ANI: lines forming negative

NARRATION (VO):

THE COMBINATION OF "AXIAL" AND "RADIAL" RAKE ANGLES YIELD THREE GEOMETRIES OF MILLING CUTTERS:

radial/axial
CG, SUPER: POSITIVE RADIAL/AXIAL
tape 244, 01:21:30-01:21:45
ANI: lines forming positive radial/axial
CG, SUPER: NEGATIVE RADIAL/
POSITIVE AXIAL
tape 245, 02:18:45-02:19:00
ANI: lines forming negative radial/positive axial

"NEGATIVE RADIAL AND AXIAL"-- WHICH OFFERS THE STRONGEST EDGES BUT GENERATE THE GREATEST CUTTING FORCES...,

"POSITIVE RADIAL AND AXIAL"--WHICH PROVIDES THE FREEST CUTTING...,

AND "NEGATIVE RADIAL", "POSITIVE AXIAL"--WHICH PRESENTS A STRONG EDGE TO THE WORK, BUT PULLS THE CHIP UP.

SCENE 89.
tape 244, 01:23:33-01:23:50
ANI: insert rake angle along with radial & axial rake forming milling cutter's effective rake
CG, SUPER: EFFECTIVE RAKE

NARRATION (VO):

THE "RAKE" ANGLE ON THE FACE MILLING CUTTER INSERTS, IN CONJUNCTION WITH THE CUTTER BODY'S "RADIAL" AND "AXIAL" RAKE ANGLES, CONTRIBUTES TO THE CUTTER'S "EFFECTIVE" RAKE.

SCENE 90.
CG, SUPER: LEAD ANGLE
tape 245, 02:21:29-02:21:58
ANI: lines forming the milling cutter's lead angle, chip being formed

NARRATION (VO):

THE CUTTERS "LEAD ANGLE" INFLUENCES CUTTING FORCES AND CHIP THICKNESS. THE GREATER THE LEAD ANGLE, THE GREATER THE AXIAL FORCE AND THE LONGER, BUT THINNER, THE CHIP. STANDARD MILLING CUTTERS COME IN ZERO, 15, 30, AND 45 DEGREE LEAD ANGLES.

SCENE 91.
tape 232, 04:16:32-04:16:40
c.u. insert with chip gullet

NARRATION (VO):

MOST FACE MILLS ARE DESIGNED WITH INSERT POCKETS THAT ARE FIXED.

SCENE 92.
tape 233, 05:07:20-05:07:30
modular face mill with no insert cartridge in pocket
tape 233, 05:06:54-05:07:04
modular face mill with square insert in cartridge pocket
tape 233, 05:08:03-05:08:13
modular face mill with round insert in cartridge pocket

NARRATION (VO):

OTHER CUTTERS ARE MODULAR AND ACCEPT A VARIETY OF INTERCHANGEABLE INSERT CARTRIDGES THAT HOLD VARIOUS INSERT DESIGNS, AND SEAT THE INSERTS AT DIFFERENT ANGLES. THIS ALLOWS THE ORIENTATION OF

tape 232, 04:04:24-04:04:35
placing cartridges into modular face mill

THE INSERTS TO BE VARIED USING THE SAME CUTTER BODY.

SCENE 93.
CG, SUPER: CUTTER PITCH
tape 232, 04:06:00-04:06:10
face of cutters
tape 244, 01:26:13-01:26:25
ANI: underneath cutter, lines connect points on each cutter body insert

NARRATION (VO):

THE PITCH OF A MILLING CUTTER IS DETERMINED BY THE NUMBER OF INSERTS IN RELATION TO THE CUTTER DIAMETER, AND CAN BE DEFINED AS THE DISTANCE FROM A POINT ON ONE EDGE TO THE SAME POINT ON THE NEXT EDGE.

SCENE 94.
tape 232, 04:17:02-04:17:24
c.u. insert with chip gullet
tape 232, 04:12:40-04:12:55
coarse pitch cutter, milling
tape 232, 04:06:43-04:06:50
static, coarse pitch cutter
tape 232, 04:07:00-04:07:10
static, fine pitch cutter
tape 232, 04:09:54:00
freeze, extra-fine pitch cutter

NARRATION (VO):

THE COARSER THE PITCH, THE LARGER THE CHIP GULLET. GULLET SIZE IS IMPORTANT IN FACE MILLING, SINCE THE CHIPS ARE GENERALLY CONFINED TO THE GULLET UNTIL THE INSERT EXITS THE CUT. CUTTERS MAY BE COARSE-PITCH...,
FINE-PITCH...,
OR EXTRA-FINE PITCH.

SCENE 95.
tape 29, 01:03:58-01:04:12
fine pitch face mill cutter, milling cast iron

NARRATION (VO):

FINE-PITCH CUTTERS ARE USED PRIMARILY FOR MILLING CAST IRON, OR FOR FINISHING WORK.

SCENE 96.
tape 232, 04:14:23-04:14:34
coarse pitch cutter, milling wide cut

NARRATION (VO):

COARSE-PITCH CUTTERS PROVIDE A LARGE GULLET SPACE--NECESSARY FOR MILLING DUCTILE MATERIALS OR IN WIDE CUTS. THEY ARE CHOSEN FOR EVERYDAY WORK.

--- FTB ---

SCENE 97.
tape 233, 05:18:04-05:18:08
c.u. milling insert, different shape
tape 233, 05:16:50-05:16:54

NARRATION (VO):

MILLING INSERTS ARE AVAILABLE WITH VARIOUS GRADES

c.u. milling insert, different shape
tape 233, 05:17:25-05:17:29
c.u. milling insert, different shape
tape 233, 05:17:32-05:17:36
c.u. milling insert, different shape
tape 233, 05:17:47-05:17:54
c.u. milling insert, different shape
tape 239, 07:22:39-07:22:50
milling insert with radius
tape 239, 07:23:32-07:23:40
milling insert with wiper flat

AND SHAPES.

IN ADDITION, MILLING INSERTS HAVE THEIR OWN CORNER GEOMETRIES, INCLUDING THE RADIUS...,

AND THE WIPER FLAT.

SCENE 98.
tape 244, 01:27:22-01:27:35
ANI: c.u. large corner radius generated surface, dissolves to c.u. small corner radius generated surface, dissolves to c.u. corner wiper flat generated surface

NARRATION (VO):

A LARGE CORNER RADIUS PRODUCES A FINER FINISH THAN A SMALL RADIUS...,

BUT A CORNER WIPER FLAT ON THE INSERT PRODUCES THE FINEST SURFACE FINISH.

SCENE 99.
tape 239, 07:20:24-07:20:32
facemill spinning, one wiper flat with roughing inserts

NARRATION (VO):

SOMETIMES A SINGLE WIPER INSERT IN A CUTTER WILL IMPROVE THE SURFACE FINISH, EVEN IF ALL THE OTHERS ARE ROUGHING INSERTS.

SCENE 100.
tape 232, 04:02:20-04:02:38
face mill inserts being preset on cutter

NARRATION (VO):

FOR BEST SURFACE FINISH AND LONGEST TOOL LIFE, ALL INSERTS MUST BE PRESET TO CARRY AN EQUAL LOAD. ONE OR TWO INSERTS PROTRUDING FURTHER THAN THE OTHERS WILL CARRY THE CUTTING LOAD AND WEAR OUT PREMATURELY.

SCENE 101.
tape 233, 05:15:58-05:16:14
mounting face mill directly to spindle

NARRATION (VO):

TO HOLD CLOSE TOLERANCES IN MILLING, A VERY STABLE MOUNTING IS ESSENTIAL. THERE ARE SEVERAL METHODS OF MOUNTING FACE MILLING CUTTERS.

SCENE 102.
tape 239, 07:24:58-07:25:07
small face mill with integral-shank, mounted

NARRATION (VO):

MILLING CUTTERS UNDER THREE INCHES IN DIAMETER ARE USUALLY INTEGRAL-SHANK CUTTERS.

SCENE 103.
tape 232, 04:23:10-04:23:20
face mill mounted onto adapter, then to machine spindle

NARRATION (VO):

FACE MILLS BETWEEN THREE AND EIGHT INCHES IN DIAMETER ARE MOUNTED ONTO AN ADAPTER TO GO INTO THE SPINDLE.

SCENE 104.
tape 233, 05:15:38-05:15:48
large face mill, mounted directly to spindle

NARRATION (VO):

FACE MILLS FROM EIGHT INCHES DIAMETER AND UP MAY MOUNT DIRECTLY TO THE SPINDLE.

SCENE 105.
tape 233, 05:09:47-05:10:10
face milling operation

NARRATION (VO):

AS AN INTRODUCTION, WE'VE COVERED ONLY A FEW OF THE MANY ASPECTS OF MILLING WITH CARBIDE TOOLS. EXTENSIVE CALCULATIONS ARE ALSO INVOLVED WHEN CHOOSING EFFECTIVE CUTTER TYPES, CUTTER PATHS, AND CUTTING PARAMETERS.

--- FTB ---

SCENE 106.
CG: REVIEW
white text on black
tape 63, 12:00:15-12:03:49
review music

NARRATION (VO):

LET'S REEXAMINE THE MATERIAL CONTAINED IN THIS VIDEOTAPE.

SCENE 107.
tape 217, 00:03:05-00:03:10
endmilling of part
tape 92, 01:06:47-01:06:55
boring part
tape 3, 00:07:50-00:07:58
2 shots, turning cutting tool, contouring
tape 232, 04:20:06-04:20:16
face milling cutter, cutting surface

NARRATION (VO):

CUTTING TOOLS CUT WITH AN EDGE, AND THOSE EDGES CAN BE DESCRIBED BY THEIR GEOMETRY. FOR METALCUTTING EFFICIENCY, IT IS CRITICAL TO SELECT THE EDGE THAT CUTS BEST, GIVEN THE MATERIAL AND CUTTING CONDITIONS.

SCENE 108. tape 228, 03:01:46-03:01:52 turning operation, chip breaking well tape 225, 02:01:00-02:02:30 blue background CG: FAIL TO CUT CUT POORLY FAIL PREMATURELY DAMAGE WORKPIECE	**NARRATION (VO):** THE PURPOSE OF THE EDGE AND ITS GEOMETRY IS TO CREATE A CHIP. THE RIGHT GEOMETRY CREATES CHIPS CLEANLY AND EFFICIENTLY; THE WRONG GEOMETRY MAY NOT CUT AT ALL, OR CUT POORLY, FAIL PREMATURELY, OR DAMAGE THE WORKPIECE SURFACE.
SCENE 109. tape 227, 02:28:37-02:28:55 c.u. insert entering cut, cutting tape 232, 04:14:23-04:14:32 face milling of workpiece	**NARRATION (VO):** CUTTING TOOLS FALL INTO TWO BROAD CLASSES: SINGLE-POINT..., AND MULTI-POINT TOOLS.
SCENE 110. tape 227, 02:10:25-02:10:34 turning operation generating a lot of chips	**NARRATION (VO):** TURNING USES SINGLE POINT CUTTING TOOLS, USUALLY COATED INDEXABLE CARBIDE INSERTS.
SCENE 111. tape 228, 03:00:40-03:00:56 c.u. trigon insert, cutting tape 225, 02:01:00-02:02:30 blue background CG: INSERT GRADE INSERT GEOMETRY TOOLHOLDER DESIGN	**NARRATION (VO):** SELECTING TURNING INSERTS INVOLVES CHOICES OF INSERT GRADE, GEOMETRY, AND TOOLHOLDER DESIGN.
SCENE 112. tape 236, 01:25:07-01:25:15 c.u. insert tape 225, 02:01:00-02:02:30 blue background CG: INSERT SHAPE RELIEF/CLEARANCE ANGLE INSERT TOLERANCE INSERT TYPE INSCRIBED CIRCLE SIZE INSERT THICKNESS NOSE RADIUS CHIPBREAKER DESIGN	**NARRATION (VO):** THE GEOMETRY OF AN INSERT INCLUDES ITS SHAPE, RELIEF OR CLEARANCE ANGLE, TOLERANCE, TYPE, IT’S INSCRIBED CIRCLE OR “IC” SIZE, THICKNESS, NOSE RADIUS, AND THE INSERT’S CHIPBREAKER DESIGN.

SCENE 113.
tape 226, 01:05:43-01:05:52
c.u. tool plunging into workpiece
CG, SUPER: TOP/BACK RAKE ANGLE
tape 245, 02:07:25-02:07:43
ANI: lines forming top/back rake angle
tape 244, 01:09:22-01:09:30
ANI: positive rake tool
tape 245, 02:09:38-02:09:50
ANI: negative rake tool

NARRATION (VO):

THE LARGEST INFLUENCE ON CHIP FLOW IN TURNING IS THE "TOP" OR "BACK" RAKE ANGLE. THIS IS THE ANGLE CREATED BY THE TOP OF THE CUTTING TOOL AND AN IMAGINARY LINE DRAWN HORIZONTALLY THROUGH THE WORKPIECE DIAMETER.

A POSITIVE RAKE CUTS FREELY...,

A NEGATIVE RAKE IS STRONGER BUT GENERATES MORE FORCE IN CUTTING.

SCENE 114.
CG, SUPER: TOOL NOSE RADIUS
tape 56, 01:28:27-01:28:46
c.u. tool nose radius in tight radius cut

NARRATION (VO):

THE TOOL NOSE RADIUS HELPS DETERMINE INSERT STRENGTH AS WELL AS WORKPIECE SURFACE FINISH.

SCENE 115.
tape 236, 01:25:17-01:25:37
ANI: insert, inscribed circle appears
CG, SUPER: INSCRIBED CIRCLE
tape 226, 01:09:54:00
freeze, toolholder, without insert
tape 226, 01:10:26-01:10:33
insert in toolholder

NARRATION (VO):

INSERT SIZE IS DESIGNATED BY ITS "INSCRIBED CIRCLE", AND THE INSCRIBED CIRCLE SIZE OF THE INSERT MUST MATCH THE POCKET SIZE OF THE TOOLHOLDER.

SCENE 116.
tape 211, 04:04:34-04:04:38
turning operation with good chip breaking
tape 228, 03:10:48-03:10:52
c.u. insert chipbreaker design
tape 228, 03:10:55-03:10:59
c.u. insert chipbreaker design
tape 228, 03:11:12-03:11:16
c.u. insert chipbreaker design
tape 228, 03:11:28-03:11:32
c.u. insert chipbreaker design
tape 228, 03:11:40-03:11:44
c.u. insert chipbreaker design

NARRATION (VO):

IN TURNING, MAKING A CHIP IS ONLY HALF THE BATTLE--THE OTHER HALF IS EFFECTIVELY BREAKING THE CHIP WITH THE RIGHT CHIPBREAKERS AND OPERATING PARAMETERS.

SCENE 117.
tape 239, 07:17:20-07:17:30
different toolholder style
tape 239, 07:18:20-07:18:30

NARRATION (VO):

TOOLHOLDERS...,

different toolholder style
tape 239, 07:16:50-07:17:00
different toolholder style
tape 227, 02:14:41-02:14:46
boring bar, pull out
tape 225, 02:01:00-02:02:30
blue background
CG: SHANK SIZE
RIGHT/LEFT/NEUTRAL
CLAMPING METHOD
INSERT SHAPE
INSERT SIZE
INSERT STYLE
RAKE ANGLE

AND BORING BARS MAY BE DESIGNATED BY THEIR SHANK SIZE, HAND OF THE TOOL, METHOD OF CLAMPING, INSERT SHAPE, INSERT SIZE, INSERT STYLE, AND RAKE ANGLE.

SCENE 118.
tape 5, 00:09:52-00:09:57
c.u. end milling
tape 233, 05:11:40-05:11:49
milling operation

NARRATION (VO):

MULTI-POINT TOOLS ROTATE TO CUT. FACE MILLING CUTTERS ARE A TYPE OF MULTI-POINT TOOL.

SCENE 119.
continue previous shot
tape 225, 02:01:00-02:02:30
blue background
CG: DIAMETER
HAND OF CUT
GEOMETRY
PITCH
POCKET DESIGN
MOUNTING METHOD

NARRATION (VO):

FACE MILLING CUTTERS VARY IN: DIAMETER, HAND OF CUT, GEOMETRY, PITCH, INSERT POCKET DESIGN, AND MOUNTING METHOD.

SCENE 120.
CG, SUPER: RADIAL RAKE
tape 244, 01:16:29-01:16:50
ANI: lines forming a positive radial rake
CG, SUPER: AXIAL RAKE
tape 245, 03:02:50-03:03:00
ANI: lines forming a positive axial rake
tape 233, 05:09:28-05:09:39
milling cutter, milling
CG, SUPER: NEGATIVE RADIAL/AXIAL
tape 245, 02:17:15-02:17:30
ANI: lines forming negative radial/axial
CG, SUPER: POSITIVE RADIAL/AXIAL
tape 244, 01:21:30-01:21:45
ANI: lines forming positive radial/axial
CG, SUPER: NEGATIVE RADIAL/
POSITIVE AXIAL
tape 245, 02:18:45-02:19:00
ANI: lines forming negative

NARRATION (VO):

THE TWO RAKE ANGLES DETERMINED BY FACE MILLING CUTTER BODIES ARE “THE RADIAL RAKE”..., AND “THE AXIAL RAKE”.

THESE TWO MAY COMBINE IN THREE WAYS--FOR THREE DIFFERENT GEOMETRIES OF FACE MILLS:

“NEGATIVE RADIAL AND AXIAL”...,

“POSITIVE RADIAL AND AXIAL”...,

AND “NEGATIVE RADIAL”, “POSITIVE AXIAL”.

radial/positive axial

SCENE 121. tape 232, 04:06:43-04:06:50 static, coarse pitch cutter tape 232, 04:07:00-04:07:10 freeze, fine pitch cutter tape 232, 04:09:54:00 static, extra-fine pitch cutter tape 232, 04:05:56:00 freeze, two cutter tape 232, 04:17:02-04:17:24 c.u. insert with chip gullet side view, coarse pitch cutter	**NARRATION (VO):** FACE MILLS MAY BE COARSE PITCH..., FINE PITCH..., OR EXTRA FINE PITCH, DEPENDING ON THE NUMBER OF INSERTS RELATIVE TO THE TOOL'S DIAMETER. THE COARSER THE PITCH, THE LARGER THE GULLET SIZE.
SCENE 122. tape 239, 07:22:39-07:22:50 milling insert with radius tape 239, 07:23:32-07:23:40 milling insert with wiper flat	**NARRATION (VO):** MILLING INSERTS WITH A LARGE CORNER RADIUS..., OR A WIPER FLAT, PROVIDE A FINE SURFACE FINISH.

--- FTB ---

SCENE 123.
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Some Machinery In This Program Had Safety Equipment Removed To Allow Better Recording Of Certain Processes.
Always Read The Safety Information Provided In

SCENE 124.
tape 40, 01:00:00-01:00:12
ANI: SME logo