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FUNDAMENTAL MANUFACTURING PROCESSES

Measurement & Gaging

SCENE 1.
CG: FBI warning
white text centered on black to blue gradient

WARNING

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SCENE 2.
CG: disclaimer
white text centered on black to blue gradient

Always read the operating manual and safety information provided by the manufacturer before operating any measurement and gaging equipment. Make sure all machine guards are in place, and follow all safety procedures when working with or near measurement and gaging equipment.

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SCENE 3.
tape 40, 01:00:00-01:00:12
SME logo, with music
CG, SUPER: www.sme.org

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SCENE 4.
tape 25, 01:01:00-01:01:45
fundamental series open, with music
tape 553, 01:00:02-01:27:03
peter carey narration
tape 540, 04:23:00-04:29:00
room tone

MUSIC UP AND UNDER

NARRATION (VO):

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

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SCENE 5.
program title:
CG: Measurement & Gaging
white text centered on black

NARRATION (VO):

THIS PROGRAM IS AN INTRODUCTION TO MEASUREMENT AND GAGING.

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SCENE 6. **tape 538, 02:22:08-02:22:15** gaging of shop floor part **tape 547, 05:11:52-05:12:01** gaging of prototype part **tape 545, 09:21:25-09:21:33** final inspection of levels	**NARRATION (VO):** MEASUREMENT AND GAGING ARE CORNERSTONE ACTIVITIES IN ALL PHASES OF MANUFACTURING, FROM PROTOTYPING..., TO FINAL INSPECTION OF MANUFACTURED PARTS.
SCENE 7. **tape 415, 10:28:13-10:28:28** zoom out, factory floor manufacturing parts **tape 550, 02:20:54-02:21:03** c.u. measurement of time CG, SUPER: Time **tape 390, 03:14:59-03:15:05** c.u. measurement of weight CG, SUPER: Weight **tape 495, 02:27:37-02:27:42** c.u. measurement of temperature CG, SUPER: Temperature **tape 551, 06:05:45-06:05:50** pressure gage CG, SUPER: Pressure **tape 503, 15:22:07-15:22:12** measurement of hardness CG, SUPER: Hardness **tape 523, 10:02:59-10:03:35** c.u. measurement of part dimension CG, SUPER: Part Dimensions	**NARRATION (VO):** THERE ARE MANY MEASURABLE PROCESS CHARACTERISTICS IN MANUFACTURING. SOME INCLUDE: THE MEASUREMENT OF TIME..., WEIGHT..., TEMPERATURE..., PRESSURE..., HARDNESS..., AND THE MEASUREMENT OF PART DIMENSIONS.
SCENE 8. continue CG, SUPER continue previous shot CG, SUPER: Part Size & Shape Size, Form, Orientation, & Location Of Part Features	**NARRATION (VO):** PART DIMENSIONS REFER TO PHYSICAL PROPERTIES OF MANUFACTURED PARTS, INCLUDING: THE PART SIZE AND SHAPE, AND THE SIZE, FORM, ORIENTATION, AND LOCATION OF PART FEATURES.
SCENE 9. **tape 537, 01:18:27-01:18:34** micrometer used to gage part **tape 537, 01:29:15-01:29:20** calipers used to gage part **tape 537, 01:01:22-01:01:27** gaging of part using optical measurement projector	**NARRATION (VO):** PART DIMENSIONS ARE GAGED USING SOME TYPE OF MEASUREMENT TOOL. THIS PROGRAM FOCUSES ON THESE MEASUREMENT TOOLS AND THEIR APPLICATION.

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tape 538, 02:28:26-02:28:32
cmm gaging of part

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SCENE 10.
tape 552, 12:02:40-12:02:50
GRAPHIC: egyptian figures with scales, digital zoom
tape 548, 03:35:12-03:35:20
historical manufacturing shot
tape 548, 03:47:04-03:47:18
4 shots, historical manufacturing and gaging footage

NARRATION (VO):

HISTORICALLY, MEASUREMENT SYSTEMS LACKED UNIFORM STANDARDS AND PRECISION. BUT WITH THE ADVENT OF MASS PRODUCTION AND INTERCHANGEABLE PARTS, UNIFORM, WIDELY ACCEPTED STANDARDS AND SYSTEMS OF MEASUREMENT WERE DEVELOPED, SIGNIFICANTLY IMPROVING PRECISION.

SCENE 11.
tape 538, 02:01:53-02:02:04
gaging of part using micrometer
tape 554, 14:04:43-14:04:53
c.u. pan, inches on yard rule
CG, SUPER: English System
tape 554, 14:02:52-14:03:00
c.u. pan, millimeters on meter rule
CG, SUPER: Metric System

NARRATION (VO):

TODAY, TWO SYSTEMS FOR LINEAR MEASUREMENTS ARE MOST OFTEN USED:
THE ENGLISH SYSTEM, BASED ON THE YARD,
AND THE INTERNATIONAL METRIC SYSTEM, BASED ON THE METER.

SCENE 12.
tape 541, 05:04:38-05:04:58
pan of physical primary standard objects

NARRATION (VO):

MEASUREMENT SYSTEMS ARE CALIBRATED TO PRIMARY STANDARDS, WHICH ARE ACTUAL PHYSICAL OBJECTS THAT PROVIDE A COMMON REFERENCE FOR MEASUREMENT STANDARDIZATION.

SCENE 13.
tape 523, 10:25:13-10:25:28
gaging using thickness gage
tape 541, 05:29:00-05:29:13
wide, gaging with micrometer
CG, SUPER: Precision
Resolution
Accuracy
Repeatability
Reproducibility

NARRATION (VO):

EFFECTIVE APPLICATION OF MEASUREMENTS AND GAGES REQUIRES AN UNDERSTANDING OF CERTAIN CORE CONCEPTS, INCLUDING:
PRECISION,
RESOLUTION,
ACCURACY,

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REPEATABILITY,

AND REPRODUCIBILITY.

SCENE 14.
tape 540, 04:02:36-04:02:51
c.u. gaging of part using inside micrometer
CG, SUPER: Precision
The Quality Of Being Sharply Or Clearly Defined, Or How Closely The Indicated Value Matches The True Value

NARRATION (VO):

PRECISION IS THE QUALITY OF BEING SHARPLY OR CLEARLY DEFINED, OR HOW CLOSELY THE INDICATED VALUE MATCHES THE TRUE VALUE.

SCENE 15.
tape 545, 09:03:24-09:03:37
zoom in, digital gaging of part
CG, SUPER: Resolution
tape 552, 12:03:10-12:03:20
GRAPHIC: rule marked in half millimeters
tape 552, 12:03:40-12:03:50
GRAPHIC: rule marked in millimeters appears

NARRATION (VO):

THE PRECISION OF A MEASUREMENT DEVICE IS IN PART A FUNCTION OF IT'S RESOLUTION, WHICH IS THE SMALLEST GRADUATION INTO WHICH AN INSTRUMENT IS DIVIDED. FOR EXAMPLE, A RULE MARKED IN ONE-HALF MILLIMETERS HAS A HIGHER RESOLUTION, AND THUS CAN BE MORE PRECISE THAN A RULE MARKED IN MILLIMETERS.

SCENE 16.
tape 538, 02:08:32-02:08:46
sine plate being calibrated to gage blocks
CG, SUPER: Accuracy
The Degree To Which An Indicated Value Conforms To An Acceptable Standard Value
tape 552, 12:04:10-12:04:20
GRAPHIC: wide, two tape measures graduated in millimeters
tape 552, 12:04:40-12:04:50
GRAPHIC: same wide image, blow-up of ends exactly aligned, showing graduations in millimeters
tape 552, 12:05:10-12:05:20
GRAPHIC: same wide image, blow-up of area near 10 meters, alignment off by a few millimeters

NARRATION (VO):

ACCURACY IS DEFINED AS THE DEGREE TO WHICH AN INDICATED VALUE CONFORMS TO AN ACCEPTABLE STANDARD VALUE. FOR EXAMPLE, TWO TAPE MEASURES MAY BOTH HAVE THE SAME RESOLUTION OR GRADUATION, IN THIS CASE MILLIMETERS. HOWEVER, IF THESE TAPE MEASURES ARE NOT EQUALLY ACCURATE, THEIR DIFFERENCES BECOMES MORE NOTICEABLE AT GREATER LENGTHS.

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SCENE 17.
CG, SUPER: Repeatability
tape 537, 01:13:22-01:13:29
wide, part being gaged, dissolve to same image
tape 537, 01:13:36-01:13:44
wide, same part being gaged

NARRATION (VO):

REPEATABILITY IS THE DEGREE OF CONSISTENCY ACHIEVED WITH A MEASURING DEVICE WHEN ONE PERSON USES IT TO MEASURE THE SAME DIMENSION SEVERAL TIMES.

SCENE 18.
CG, SUPER: Reproducibility
tape 545, 09:20:23-09:20:30
wide, levels being inspected
tape 545, 09:21:47-09:21:55
wide, same levels being inspected by another person

NARRATION (VO):

REPRODUCIBILITY IS THE DEGREE OF CONSISTENCY ACHIEVED WITH A MEASURING OR REFERENCE DEVICE WHEN USED BY DIFFERENT PEOPLE TO MEASURE OR INSPECT THE SAME DIMENSIONS.

SCENE 19.
tape 541, 05:05:43-05:05:56
gage blocks used in calibrating precision measuring gage
CG, SUPER: Gage Blocks
tape 541, 05:07:25-05:07:46
calibrating precision measuring gage

NARRATION (VO):

TO ENSURE ACCURACY, SHOP FLOOR MEASURING DEVICES ARE CALIBRATED BY COMPARING THEM TO HIGHLY ACCURATE WORKING STANDARDS, USUALLY GAGE BLOCKS. GAGE BLOCKS ARE MACHINED AND LAPPED, OR FINISHED, TO VERY FLAT, HIGHLY ACCURATE SURFACES. GAGE BLOCKS ARE PRODUCED FROM HARD, STABLE MATERIAL, SUCH AS CHROMIUM CARBIDE STEEL.

SCENE 20.
tape 541, 05:09:00-05:09:15
calibrating precision measuring gage

NARRATION (VO):

BECAUSE OF THEIR HIGH DEGREE OF ACCURACY, GAGE BLOCKS ARE INVALUABLE IN CALIBRATING PRECISION MEASURING TOOLS, INSTRUMENTS, AND GAGES.

SCENE 21.
tape 541, 05:12:13-05:12:27
c.u. gage blocks being "wrung" together

NARRATION (VO):

IN ORDER TO OBTAIN THE PROPER LENGTH, BLOCKS OF DIFFERENT LENGTHS ARE "WRUNG" TOGETHER. THE BLOCKS ADHERE, AS THOUGH MAGNETIZED, TO FORM A HIGHLY ACCURATE STACK OF BLOCKS.

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SCENE 22.
tape 541, 05:03:30-05:03:40
pull out, box of gage blocks
tape 541, 05:01:55-05:02:09
pull out, box of angled gage blocks

NARRATION (VO):

GAGE BLOCKS ARE PRODUCED IN SEVERAL GRADES OR DEGREES OF ACCURACY, AND ARE ALSO PRODUCED WITH ANGLES TO FURNISH SIMPLE AND ACCURATE MEASUREMENT OF ANY ANGLE.

SCENE 23.
CG, SUPER: Surface Plates
tape 538, 02:16:13-02:16:33
wide, tilt down, sine plate being calibrated on granite surface plate, cut on action to next image
tape 538, 02:10:40-02:10:53
c.u., sine plate being calibrated on surface plate

NARRATION (VO):

IN ADDITION TO GAGE BLOCKS, MEASUREMENT AREAS TYPICALLY UTILIZE SURFACE PLATES, WHICH ARE FLAT PLANES PRODUCED FROM HARD, HOMOGENEOUS GRANITE. SURFACE PLATES HOLD EXTREMELY TIGHT TOLERANCES, AND ARE USED AS A REFERENCE SURFACE FROM WHICH DIMENSIONS OR OTHER MEASUREMENTS ARE TAKEN.

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SCENE 24.
CG: Measurement & Gaging Tools
white text centered on black

SCENE 25.
tape 537, 01:20:23-01:20:28
hand held, gaging with micrometer
tape 543, 07:27:56-07:28:07
gaging with vernier calipers
tape 538, 02:11:07-02:11:15
zoom in, gaging of part using a depth micrometer
tape 539, 03:22:30-03:22:32
gaging with vision system
tape 546, 10:21:29-10:22:12
gaging with cmm
tape 552, 12:01:00-12:02:00
blue background
CG: Inside Part Diameters
Outside Diameters
Height
Depth
Part Squareness
Angles
Bevels
Thicknesses

NARRATION (VO):

THERE IS A WIDE ASSORTMENT OF MEASUREMENT TOOLS USED TO VERIFY THAT MANUFACTURED PARTS MEET THEIR DESIGN INTENT. THESE TOOLS ARE USED TO MEASURE:

INSIDE PART DIAMETERS,

OUTSIDE DIAMETERS,

HEIGHT,

DEPTH,

PART SQUARENESS,

ANGLES,

BEVELS,

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Tapers	THICKNESSES, TAPERS, AND MANY OTHER PART FEATURES.
SCENE 26. **tape 543, 07:08:17-07:08:27** gaging with telescope gage **tape 538, 02:17:17-02:17:22** gaging with micrometer **tape 537, 01:14:48-01:14:54** gaging with tool having a dial indicator **tape 541, 05:18:29-05:18:38** gaging with tool having a electronic digital readout **tape 545, 09:18:59-09:19:10** optical measurement projector with part **tape 539, 03:23:52-03:23:58** vision system, scanning parts **tape 546, 10:13:21-10:13:30** coordinate measurement machine	**NARRATION (VO):** THESE TOOLS RANGE IN COMPLEXITY FROM NONGRADUATED MEASURING TOOLS AND GAGES, TO GRADUATED MEASURING TOOLS AND GAGES, WHICH ARE ENHANCED BY INCORPORATING DIAL INDICATORS, AND ELECTRONIC DIGITAL READOUT DISPLAYS. ADDITIONAL MEASUREMENT TOOLS INCLUDE: OPTICAL MEASUREMENT PROJECTORS..., VISION SYSTEMS..., COORDINATE MEASUREMENT MACHINES AND OTHERS.

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SCENE 27. CG, SUPER: Nongraduated Measuring Tools & Gages **tape 543, 07:04:14-07:04:22** c.u. calipers taking inside reading **tape 543, 07:05:09-07:05:18** calipers used to take outside measurement **tape 551, 06:06:07-06:06:23** go-no-go gage being used	**NARRATION (VO):** NONGRADUATED MEASURING TOOLS AND GAGES DO NOT HAVE LINEAR OR ANGULAR GRADUATIONS MARKED ON THE TOOL. THESE TOOLS ARE GENERALLY USED TO TRANSFER MEASUREMENTS TO OR FROM A GRADUATED MEASURING TOOL, OR AS A PASS/FAIL COMPARISON TO A STANDARD.
SCENE 28. continue previous shot **tape 552, 12:01:00-12:02:00** blue background CG: Nongraduated Tools & Gages Dividers Calipers Telescope Gages Small hole Gages Squares Straightedges	**NARRATION (VO):** THE PRIMARY TYPES OF NONGRADUATED TOOLS AND GAGES INCLUDE: DIVIDERS, CALIPERS,

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Adjustable Parallels Go-No-Go Gages	TELESCOPE GAGES, SMALL HOLE GAGES, SQUARES, STRAIGHTEDGES, ADJUSTABLE PARALLELS, AND GO-NO-GO GAGES.
SCENE 29. CG, SUPER: Dividers **tape 542, 06:03:40-06:03:48** static, dividers, zoom to pointed tips	**NARRATION (VO):** DIVIDERS HAVE TWO STRAIGHT LEGS WITH SHARP POINTED CONTACTS.
SCENE 30. **tape 543, 07:14:03-07:14:11** dividers used for measuring distances between lines **tape 543, 07:01:55-07:02:07** dividers used for transferring lengths taken from a graduated rule, then being used for scribing circle	**NARRATION (VO):** DIVIDERS ARE USED FOR MEASURING DISTANCES BETWEEN LINES OR POINTS..., FOR TRANSFERRING LENGTHS TAKEN FROM A GRADUATED RULE..., AND FOR SCRIBING CIRCLES OR ARCS.
SCENE 31. CG, SUPER: Calipers **tape 542, 06:04:56-06:05:04** static, calipers, zoom into contacts at end of legs **tape 543, 07:03:09-07:03:14** calipers measuring distance **tape 543, 07:03:41-07:03:47** calipers compared with a vernier calipers	**NARRATION (VO):** CALIPERS ARE SIMILAR TO DIVIDERS, BUT THE LEGS ARE SHAPED WITH FORMED CONTACTS AT THE ENDS. THEY ARE USED FOR MEASURING DISTANCES..., AND FOR COMPARING DIMENSIONS.
SCENE 32. **tape 542, 06:05:39-06:05:43** static, outside calipers #1 **tape 542, 06:06:05-06:06:10** static, outside calipers #2 **tape 542, 06:03:55-06:04:02** static, outside calipers **tape 542, 06:05:14-06:05:20** static, inside calipers	**NARRATION (VO):** CALIPERS ARE AVAILABLE IN VARIOUS TYPES, INCLUDING OUTSIDE CALIPERS..., AND INSIDE CALIPERS.
SCENE 33. CG, SUPER: Hermaphrodite Calipers	**NARRATION (VO):**

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tape 542, 06:06:38-06:06:46
static, hermaphrodite calipers
tape 543, 07:02:26-07:02:35
hermaphrodite calipers used for scribing parallel lines from an edge

HERMAPHRODITE CALIPERS COMBINE ELEMENTS OF BOTH THE DIVIDER AND CALIPER. HERMAPHRODITE CALIPERS MAY BE USED FOR SCRIBING PARALLEL LINES FROM AN EDGE, AND SEVERAL OTHER USES.

SCENE 34.
CG, SUPER: Telescope Gage
tape 542, 06:06:56-06:07:05
static, telescope gage
telescope gage measuring inside diameter
tape 543, 07:07:23-07:07:31
plungers telescoping out of each other, zoom into spherical contacts at cross arm end

NARRATION (VO):

THE TELESCOPE GAGE IS A TEE-SHAPED TOOL IN WHICH THE SHAFT OF THE TEE ACTS AS A HANDLE. THE TELESCOPE GAGE ALSO INCORPORATES TELESCOPING PLUNGERS THAT HAVE HARDENED RADIUSED ENDS.

SCENE 35.
tape 543, 07:05:37-07:05:55
telescope gage measuring inside diameter, taken out and distance measured

NARRATION (VO):

TELESCOPE GAGES ARE USED FOR MEASURING INSIDE DIAMETERS. THE COMPRESSED PLUNGERS ARE PLACED IN A HOLE, AND THEN ALLOWED TO EXPAND. THE GAGE IS THEN LOCKED, WITHDRAWN AND THE DISTANCE MEASURED.

SCENE 36.
CG, SUPER: Small Hole Gage
tape 542, 06:07:19-06:07:25
static, small hole gage
tape 543, 07:10:41-07:10:54
zoom out, small hole gage measuring hole
tape 543, 07:11:57-07:12:11
small hole gage measuring hole

NARRATION (VO):

THE SMALL HOLE GAGE AS THE NAME IMPLIES, IS USED TO MEASURE SMALL HOLES AND SHALLOW SLOTS AND RECESSES. THE SMALL HOLE GAGE IS SIMILAR IN DESIGN TO THE TELESCOPE GAGE BUT USES A SPLIT BALL AT THE CONTACT END WHICH IS EXPANDED TO OBTAIN THE MEASUREMENT.

SCENE 37.
CG, SUPER: Squares
tape 543, 07:12:53-07:13:01
square used for the measuring right angle
tape 542, 06:20:19-06:20:35
static, square with base and blade
CG, SUPER: Base
CG, SUPER: Blade
tape 542, 06:20:44-06:20:52

NARRATION (VO):

SQUARES ARE PRECISION TOOLS USED FOR THE MEASUREMENT OF RIGHT ANGLES. SQUARES CONSIST OF A BASE, INTO WHICH A BLADE IS SET. THIS BLADE MAY BE BEVELED...,

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c.u. pan, beveled blade
tape 542, 06:21:00-06:21:10
c.u. non-beveled blade

OR NON-BEVELED.

SCENE 38.
CG, SUPER: Straightedges
tape 542, 06:21:45-06:21:55
static, straightedge
tape 543, 07:13:33-07:13:40
steel straightedge used for scribing straight line

NARRATION (VO):

STRAIGHTEDGES ARE FLAT LENGTHS OF TOOL STEEL OR GRANITE, FINISHED TO EXTREMELY FINE TOLERANCES. THEY ARE USED FOR SCRIBING STRAIGHT LINES AND TO CHECK SURFACES FOR STRAIGHTNESS.

SCENE 39.
CG, SUPER: Adjustable Parallels
tape 542, 06:08:39-06:08:45
static, adjustable parallels
tape 544, 08:03:43-08:03:57
adjustable parallels placed in slot, measured with micrometers

NARRATION (VO):

ADJUSTABLE PARALLELS ARE EMPLOYED WIDELY IN LAYOUT, GAGING AND INSPECTION, AND EXPAND INTO A RANGE OF WIDTHS. THEY ARE COMMONLY USED FOR COMPARING SLOT AND OPENING SIZES AGAINST GRADUATED MEASURING TOOLS.

SCENE 40.
CG, SUPER: Go-No-Go Gage
tape 543, 07:18:59-07:19:26
"go", no-go" gage being used
tape 538, 02:02:30-02:02:37
c.u. "go" end fitting into hole, and the "no-go" not fitting

NARRATION (VO):

"GO", NO-GO" GAGES ARE USED TO ENSURE PART FEATURES ARE WITHIN PROPER TOLERANCES. TYPICAL "GO, NO-GO" GAGES HAVE ACCURATELY SIZED ENDS, ONE WITHIN TOLERANCE, CALLED THE "GO" END, AND ONE OUTSIDE OF TOLERANCE, CALLED THE "NO-GO" END. FOR A PART TO BE ACCEPTABLE, THE "GO" END MUST FIT, BUT THE "NO-GO" END MUST NOT.

SCENE 41.
tape 551, 06:10:27-06:10:33
custom "go", no-go" gage being used
tape 545, 09:15:15-09:15:20
"go", no-go" gage with graduated scale being used

NARRATION (VO):

THERE ARE NUMEROUS TYPES OF STANDARD AND CUSTOM MADE "GO", NO-GO" GAGES USED IN MANUFACTURING. MANY INCORPORATING GRADUATED SCALES.

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SCENE 42.
CG, SUPER: Graduated Measuring Tools & Gages
tape 544, 08:08:37-08:08:47
combination square being used
tape 538, 02:04:53-02:04:58
micrometers being used
tape 538, 02:02:55-02:02:59
vernier calipers being used

NARRATION (VO):

GRADUATED MEASURING TOOLS AND GAGES HAVE EITHER LINEAR OR ANGULAR GRADUATIONS AS PART OF THE TOOL, AND ARE AVAILABLE IN BOTH ENGLISH AND METRIC UNITS.

SCENE 43.
tape 544, 08:06:50-08:06:57
combination square being used
tape 552, 12:01:00-12:02:00
blue background
CG: Graduated Tools & Gages
Rules
Combination Squares
Calipers
Micrometers

NARRATION (VO):

THERE ARE VARIOUS TYPES OF GRADUATED TOOLS AND GAGES, INCLUDING:

RULES,

COMBINATION SQUARES,

CALIPERS,

AND MICROMETERS.

SCENE 44.
CG, SUPER: Rules
tape 542, 06:23:28-06:23:48
pull out, english rule
tape 542, 06:24:03-06:24:10
english rule
tape 542, 06:24:42-06:24:50
metric rule
tape 542, 06:25:14-06:25:28
small english/metric rule

NARRATION (VO):

RULES ARE BASIC MEASURING TOOLS FROM WHICH MANY OTHER TOOLS HAVE BEEN DEVELOPED. RULES ARE MADE FROM CARBON AND STAINLESS STEELS, AND ARE GRADUATED IN EITHER ENGLISH,

OR METRIC UNITS,

OR BOTH ON A SINGLE RULE.

SCENE 45.
tape 542, 06:22:51-06:23:08
pan of rule
tape 544, 08:13:16-08:13:21
spring tempered rule being used
tape 544, 08:10:36-08:10:41
tapered end rule used on hole
tape 544, 08:17:15-08:17:19
rule depth gage being used

NARRATION (VO):

RULES ARE AVAILABLE IN A WIDE VARIETY OF SIZES AND LENGTHS. SOME COMMON RULE TYPES INCLUDE:

SPRING TEMPERED RULES,

TAPERED END RULES FOR MEASURING IN SMALL SPACES,

AND RULE DEPTH GAGES.

SCENE 46.
CG, SUPER: Combination Square
tape 542, 06:26:00-06:26:10
static, combination square

NARRATION (VO):

THE BASIC COMBINATION SQUARE CONSISTS OF A

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tape 542, 06:26:40-06:26:52
static, combination square, c.u. of square head
CG, SUPER: add arrows
tape 554, 14:10:55-14:11:04
rule guided through head, secured with a lock bolt

HARDENED STEEL RULE AND A MOVABLE COMBINATION SQUARE AND MITER HEAD, WITH A LEVEL AND SCRIBER. THE RULE IS GUIDED BY A MACHINED SLOT THROUGH THE HEAD, AND SECURED WITH A LOCK BOLT.

SCENE 47.
tape 544, 08:07:15-08:07:24
combination squares being used for layout of square
tape 544, 08:07:40-08:07:45
combination squares being used for layout of 45 degree

NARRATION (VO):

COMBINATION SQUARES ARE USEFUL FOR LAYOUT AND MEASURING OF SQUARE...,
AND 45 DEGREE MITER ANGLES.

SCENE 48.
tape 544, 08:09:47-08:09:55
combination squares being used with center head, locating center of cylindrical work
tape 544, 08:10:21-08:10:25
combination squares being used with center head, locating center of square work
tape 544, 08:14:29-08:14:35
combination squares being used with adjustable protractor head

NARRATION (VO):

THE ADDITION OF A CENTER HEAD PROVIDES AN EASY MEANS OF LOCATING THE CENTER OF CYLINDRICAL...,
AND SQUARE WORK.
ADJUSTABLE PROTRACTOR HEADS ARE ALSO AVAILABLE.

SCENE 49.
CG, SUPER: Calipers
tape 543, 07:23:10-07:23:38
zoom in, vernier calipers being used
tape 552, 12:01:00-12:02:00
blue background
CG: Slide Calipers
Vernier Calipers

NARRATION (VO):

GRADUATED CALIPERS ARE A REFINEMENT OF THE STEEL RULE, AND MAKE IT POSSIBLE TO INSURE GREATER ACCURACY BY CONTACTING EDGES OR POINTS TO BE MEASURED. THE PRIMARY TYPES OF PRECISION GRADUATED CALIPERS USED FOR MEASURING AND GAGING INCLUDE:
SLIDE CALIPERS,
AND VERNIER CALIPERS.

SCENE 50.
CG, SUPER: Slide Calipers
tape 542, 06:11:12-06:11:20
zoom in, slide caliper jaws
tape 544, 08:18:44-08:18:50
slide calipers being used to gage outside surface
tape 544, 08:20:13-08:20:18
slide calipers being used to

NARRATION (VO):

SLIDE CALIPERS HAVE A BAR WHICH IS USUALLY GRADUATED, AND A PAIR OF JAWS THAT CONTACT THE PART. ONE JAW IS FIXED, AND THE OTHER MOVES ALONG

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gage outside surface
tape 544, 08:18:56-08:19:00
slide calipers being used to gage inside surface

THE SCALE. SLIDE CALIPERS ARE GRADUATED TO READ

OUTSIDE SURFACES...,

AND INSIDE SURFACES.

SCENE 51.
CG, SUPER: Vernier Calipers
tape 544, 08:20:54-08:20:59
vernier calipers being used
tape 538, 02:08:08-02:08:13
vernier calipers being used for outside reading
tape 544, 08:21:44-08:21:50
vernier calipers being used

NARRATION (VO):

VERNIER CALIPERS ARE GRADUATED CALIPERS THAT

INCORPORATE AN ADDITIONAL GRADUATED VERNIER SCALE

FOR GREATER PRECISION.

SCENE 52.
tape 554, 15:02:15-15:02:45
wide, static of vernier calipers
CG, SUPER: Stationary Bar
tape 554, 15:03:15-15:04:15
c.u. vernier plate on vernier calipers
CG, SUPER: Vernier Slide Assembly
CG, SUPER: Vernier Plate
CG, SUPER: Clamping Screws
CG, SUPER: Fine Adjustment Nut

NARRATION (VO):

VERNIER CALIPERS CONSIST OF A GRADUATED,

STATIONARY BAR WITH A FIXED JAW,

AND A MOVABLE VERNIER SLIDE ASSEMBLY THAT COMBINES

A MOVEABLE JAW,

A VERNIER PLATE GRADUATED INTO FIFTY UNITS,

CLAMPING SCREWS,

AND A FINE ADJUSTMENT NUT.

SCENE 53.
tape 552, 13:01:10-13:01:50
GRAPHIC: c.u. stationary bar and vernier plate area
CG, SUPER: arrow appears, scrolling along millimeters on the stationary bar
CG, SUPER: One Millimeter
tape 552, 13:02:02-13:02:28
GRAPHIC: c.u. stationary bar and vernier plate area, line showing fifty units on vernier plate continue previous CG, SUPER: One Millimeter
CG, SUPER: arrow appears, scrolling along fifty units on vernier plate
CG, SUPER: 0.02 Of A Millimeter
tape 552, 13:02:35-13:02:55
GRAPHIC: c.u. stationary bar and vernier plate area, fifty units on vernier plate highlighted
CG, SUPER: 50 Units

NARRATION (VO):

EACH GRADUATION ON THE STATIONARY BAR REPRESENTS

ONE MILLIMETER. THE VERNIER PLATE ESSENTIALLY

DIVIDES ONE MILLIMETER INTO FIFTY UNITS, WITH EACH

GRADUATION REPRESENTING TWO-ONE HUNDREDTHS OF A

MILLIMETER. THESE FIFTY UNITS REPRESENT EXACTLY

THE SAME DISTANCE AS 49 UNITS ON THE STATIONARY

BAR. BECAUSE OF THIS MINUTE DIFFERENCE, WHEN A

MEASUREMENT IS TAKEN, ONLY ONE GRADUATION ON THE

PLATE WILL EXACTLY COINCIDE WITH A GRADUATION ON

THE STATIONARY BAR. THIS INTERSECTION IS WHERE THE

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tape 552, 13:03:05-13:03:25
GRAPHIC: c.u. stationary bar and vernier plate area, fifty units on vernier plate and 49 units on stationary plate highlighted
continue previous CG, SUPER: 50 Units
CG, SUPER: 49 Units
tape 554, 14:11:16-14:11:24
vernier calipers measuring part
tape 552, 13:04:10-13:04:50
GRAPHIC: c.u. stationary bar and vernier plate area
CG, SUPER: 2 arrows appear across from each other, scrolling down vernier reading, stopping at .92, top arrow disappears

FRACTIONAL PORTION OF A VERNIER CALIPER MEASUREMENT IS READ.

SCENE 54.
tape 552, 13:05:10-13:05:20
GRAPHIC: wide, static of vernier calipers
tape 552, 13:05:35-13:06:25
GRAPHIC: c.u. stationary bar and vernier plate area
CG, SUPER: arrow appears, scrolls down from the zero on the stationary bar to the zero on the vernier plate, stopping at 11th graduation
CG, SUPER: 11, appears for first part of equation

NARRATION (VO):

TO READ THE VERNIER CALIPER, FIRST INDICATE THE NUMBER OF MILLIMETERS THAT ARE BETWEEN THE ZERO ON THE STATIONARY BAR AND THE ZERO ON THE VERNIER PLATE.

SCENE 55.
continue previous GRAPHIC
CG, SUPER: 2 arrows appear across from each other, scrolling down vernier reading, stopping at .78, top arrow disappears
CG, SUPER: .78, appears for second part of equation

NARRATION (VO):

THEN LOCATE WHERE THE GRADUATION ON THE VERNIER PLATE EXACTLY COINCIDES WITH THE GRADUATION ON THE STATIONARY BAR, AND READING OFF OF THE VERNIER PLATE, NOTE THAT NUMBER'S VALUE IN HUNDREDTHS OF A MILLIMETER.

SCENE 56.
continue previous GRAPHIC
CG, SUPER: 11.78, appears for sum of equation

NARRATION (VO):

ADD THE VERNIER PLATE READING TO THE NUMBER OF MILLIMETERS COUNTED ON THE STATIONARY BAR FOR THE FINAL MEASUREMENT.

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SCENE 57.
tape 544, 08:22:36-08:22:49
vernier height gage being used
tape 544, 08:24:34-08:24:41
vernier depth gage being used

NARRATION (VO):

THIS VERNIER PRINCIPLE HAS ALSO BEEN INCORPORATED INTO VARIOUS MEASUREMENT TOOLS, INCLUDING:

VERNIER HEIGHT GAGES...,

AND VERNIER DEPTH GAGES.

SCENE 58.
CG, SUPER: Micrometer
tape 542, 06:02:13-06:02:23
zoom out, micrometer being used

NARRATION (VO):

THE MICROMETER COMBINES THE DOUBLE-CONTACT OF THE SLIDE CALIPER WITH A PRECISION SCREW ADJUSTMENT, ACHIEVING EVEN GREATER ACCURACY.

SCENE 59.
tape 554, 15:00:40-15:01:40
static of micrometer
CG, SUPER: Frame
CG, SUPER: Anvil
CG, SUPER: Spindle
CG, SUPER: Sleeve
CG, SUPER: Thimble
CG, SUPER: Locking Nut
CG, SUPER: Ratchet Stop

NARRATION (VO):

MOST MICROMETER'S ARE COMPOSED OF A C-SHAPED FRAME,

A STATIONARY ANVIL END THAT CONTACTS ONE POINT ON THE PART BEING MEASURED,

AN OPPOSED THREADED SPINDLE, WHICH MOVES TO CONTACT THE POINT ON THE PART FEATURE OPPOSITE THE ANVIL,

A SLEEVE CONTAINING A GRADUATED SCALE,

A THIMBLE WITH A GRADUATED SCALE, WHICH IS USED TO ADVANCE OR RETRACT THE SPINDLE,

A LOCKING NUT,

AND SOMETIMES A RATCHET STOP.

SCENE 60.
tape 543, 07:21:29-07:21:44
micrometer being used
tape 552, 13:06:40-13:06:50
GRAPHIC: static of micrometer
tape 552, 13:07:10-13:07:20
GRAPHIC: cut away of micrometer showing threaded spindle screw
tape 552, 13:07:40-13:07:50
GRAPHIC: cut away of micrometer

NARRATION (VO):

MICROMETERS ARE PRODUCED IN VARIOUS PRECISIONS, BOTH IN METRIC AND ENGLISH UNITS. IN EVERY CASE IT IS THE THREAD PITCH OF THE SPINDLE SCREW THAT MAKES EACH TYPE DIFFERENT. THE THREAD PITCH IS THE

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showing exploded view of threads
tape 552, 13:08:35-13:08:55
GRAPHIC: cut away of micrometer showing exploded view of threads, lines and arrows appear

DISTANCE BETWEEN TWO ADJACENT THREAD CRESTS.

SCENE 61.
continue previous GRAPHIC
CG, SUPER: 0.5 Millimeters
tape 554, 14:13:26-14:13:34
c.u. metric micrometer thimble being slowly turned

NARRATION (VO):

IN THIS EXAMPLE, THE THREAD PITCH OF THE MICROMETER'S SPINDLE SCREW IS PRECISELY ONE-HALF MILLIMETER. EACH REVOLUTION OF THE THIMBLE MOVES THE MICROMETER SPINDLE ONE HALF MILLIMETER.

SCENE 62.
tape 552, 13:09:35-13:10:25
GRAPHIC: c.u. sleeve and thimble
CG, SUPER: Reading Line
CG, SUPER: arrow appears scrolling down reading line
CG, SUPER: arrow appears scrolling along top millimeter graduations
CG, SUPER: Millimeters
CG, SUPER: arrow appears scrolling along bottom half millimeter graduations
CG, SUPER: Half Millimeters

NARRATION (VO):

THE MICROMETER HAS A READING LINE ON THE SLEEVE. THE VERTICAL GRADUATIONS ON THE TOP OF THE READING LINE EACH REPRESENT A SINGLE MILLIMETER. THE VERTICAL GRADUATIONS BELOW THE READING LINE INDICATE HALF MILLIMETERS.

SCENE 63.
continue previous GRAPHIC
CG, SUPER: arrow appears scrolling along beveled edge of thimble
CG, SUPER: 50 Divisions
tape 554, 14:15:33-14:15:55
zoom out, beveled edge of thimble being turned very slowly
CG, SUPER: Each Thimble Graduation Equals 1/50 Of 0.5 Millimeter Or 0.01 Millimeter
tape 552, 13:10:40-13:10:50
GRAPHIC: micrometer holding part

NARRATION (VO):

THE BEVELED EDGE OF THE THIMBLE IS GRADUATED INTO 50 DIVISIONS. SINCE A SINGLE REVOLUTION OF THE THIMBLE MOVES THE SPINDLE ONE HALF MILLIMETER, EACH THIMBLE GRADUATION EQUALS ONE FIFTIETH OF ONE HALF MILLIMETER, OR ONE HUNDREDTH OF A MILLIMETER. THE THIMBLE IS ROTATED AND THE SPINDLE ADVANCED UNTIL THE FEATURE IS HELD BETWEEN THE ANVIL AND THE SPINDLE FACE.

SCENE 64.
tape 552, 13:11:05-13:11:55
GRAPHIC: c.u. of reading line, sleeve and thimble of micrometer holding part

NARRATION (VO):

TO READ THIS MICROMETER, ADD THE NUMBER OF

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CG, SUPER: arrow, appears pointing out last visible graduation on sleeve
CG, SUPER: 11.5, appears for first part of equation
CG, SUPER: arrow, appears indicating graduation on thimble that coincides with reading line
CG, SUPER: .28, appears for second part of equation
CG, SUPER: 11.78, appears for sum of equation

MILLIMETERS AND HALF MILLIMETERS VISIBLE ON THE SLEEVE TO THE NUMBER OF HUNDREDTHS OF A MILLIMETER INDICATED BY THE THIMBLE GRADUATION WHICH COINCIDES WITH THE READING LINE ON THE MICROMETER'S SLEEVE.

SCENE 65.
tape 543, 07:20:44-07:20:54
zoom out, micrometer in use
tape 540, 04:01:28-04:01:43
zoom in, inside micrometers being used
tape 538, 02:12:09-02:12:16
micrometer depth gage being used
tape 542, 06:28:18-06:28:26
multi-anvil micrometer
tape 542, 06:27:11-06:27:19
disk micrometer
tape 542, 06:27:32-06:27:39
screw thread comparator micrometer
tape 537, 01:24:53-01:25:00
bench micrometer being used

NARRATION (VO):

MICROMETERS ARE AVAILABLE IN A VARIETY OF SIZES AND STYLES, INCLUDING:

INSIDE MICROMETERS - FOR MEASURING INSIDE DIMENSIONS...,

MICROMETER DEPTH GAGES...,

MULTI-ANVIL MICROMETERS...,

DISK MICROMETERS...,

SCREW THREAD COMPARATOR MICROMETERS...,

BENCH MICROMETERS,

AND MANY OTHERS.

--- TOUCH BLACK ---

SCENE 66.
tape 537, 01:12:44-01:12:48
dial indicator being used
tape 541, 05:17:43-05:17:56
electronic digital readout gage being used

NARRATION (VO):

DIAL INDICATORS...,

AND ELECTRONIC DIGITAL READOUT DISPLAYS ARE WIDELY USED ENHANCEMENTS FOR TOOLS TO IMPROVE THE PRECISION OF MEASUREMENT READINGS.

SCENE 67.
CG, SUPER: Dial Indicators
tape 537, 01:23:12-01:23:18
c.u. contact point attached to a spindle on dial indicator, contacting surface, dial moving
tape 538, 02:04:24-02:04:42

NARRATION (VO):

DIAL INDICATORS HAVE A CONTACT POINT WHICH IS ATTACHED TO A SPINDLE OR RACK. WHEN THIS SPINDLE

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c.u. dial indicator face as hand moves, dial turned around showing gears moving
tape 537, 01:23:44-01:23:56
c.u. dial indicator, dial moving

OR RACK IS MOVED, IT TRANSMITS THAT MOVEMENT TO A PINION AND THEN THROUGH A TRAIN OF GEARS. THESE GEARS MAGNIFY THE MOVEMENT, WHICH IS THEN READ OFF THE HAND ON THE DIAL FACE OF THE INDICATOR.

SCENE 68.
tape 543, 07:18:25-07:18:40
dial calipers being used
tape 552, 13:12:10-13:12:20
GRAPHIC: wide, dial calipers with reading
tape 552, 13:12:40-13:13:20
GRAPHIC: c.u. dial calipers with reading
CG, SUPER: arrow, appears pointing out last visible graduation on stationary bar
CG, SUPER: 11, appears for first part of equation
CG, SUPER: arrow, appears pointing out graduation on dial face
CG, SUPER: .78, appears for second part of equation
CG, SUPER: 11.78, appears for sum of equation

NARRATION (VO):

ONE OF THE MOST WIDELY USED COMPARATIVE MEASUREMENT TOOLS USING A DIAL INDICATOR IS THE DIAL CALIPER. TO READ THE DIAL CALIPER IN THIS EXAMPLE, FIRST NOTE THE LAST VISIBLE MILLIMETER GRADUATION ON THE CALIPER'S STATIONARY BAR. ADD THIS NUMBER TO THE TWO-ONE HUNDREDTHS OF A MILLIMETER GRADUATION INDICATED BY THE DIAL FACE HAND FOR THE MEASUREMENT READING.

SCENE 69.
tape 537, 01:23:29-01:23:56
zoom out, dial comparator being used
tape 540, 04:20:18-04:20:23
dial depth gage being used
tape 540, 04:19:20-04:19:26
dial height gage being used
tape 545, 09:06:23-09:06:28
dial indicator hole gage being used
tape 545, 09:04:55-09:05:00
dial indicator internal groove gage being used
tape 545, 09:13:39-09:13:45
zoom out, dial comparator being used

NARRATION (VO):

BECAUSE THE PRINCIPLE OF DIRECT READING FROM A GRADUATED DIAL FACE PROVIDES BOTH ACCURACY AND SPEED OF READING, THE DIAL INDICATOR HAS BEEN INCORPORATED INTO MANY OTHER TYPES OF GAGING EQUIPMENT, INCLUDING:

DIAL DEPTH GAGES...,

DIAL HEIGHT GAGES...,

DIAL INDICATOR HOLE GAGES...,

DIAL INDICATOR INTERNAL GROOVE GAGES...,

AND DIAL COMPARATORS.

--- TOUCH BLACK ---

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SCENE 70.
CG, SUPER: Electronic Digital Readout
tape 540, 04:06:30-04:06:40
electronic digital micrometer being used
tape 540, 04:05:00-04:05:12
electronic digital readout
tape 540, 04:08:58-04:09:04
electronic digital slide calipers being used
tape 540, 04:18:47-04:18:52
electronic digital micrometer being used
tape 540, 04:16:18-04:16:23
electronic digital depth gage being used
tape 540, 04:13:58-04:14:06
electronic digital height gage being used
tape 540, 04:10:27-04:10:32
digital electronic indicators being used
tape 540, 04:15:38-04:15:50
digital electronic internal groove gage being used

NARRATION (VO):

THE ELECTRONIC DIGITAL READOUT, LIKE THE DIAL INDICATOR, HAS THE ADVANTAGE OF BEING DIRECTLY READ, AND IS USED IN MANY TYPES OF GAGING EQUIPMENT, INCLUDING:

ELECTRONIC DIGITAL SLIDE CALIPERS...,

MICROMETERS...,

DEPTH GAGES...,

HEIGHT GAGES...,

ELECTRONIC DIGITAL INDICATORS...,

AND ELECTRONIC INTERNAL GROOVE GAGES.

SCENE 71.
continue previous shot
tape 552, 12:01:00-12:02:00
blue background
CG: Reduce Interpretation Errors
Provide Instantaneous Readings
Quick Conversion To & From English Or Metric Units
Zeroed Out At Any Point
Provide Out-Of-Tolerance Alerts
Collecting & Analyzing Data For Statistical Process Control

NARRATION (VO):

ELECTRONIC DIGITAL READOUT TOOLS REDUCE INTERPRETATION ERRORS THAT MAY OCCUR WHEN A GRADUATED SCALE OR A DIAL INDICATOR IS READ,

THEY PROVIDE INSTANTANEOUS READINGS,

THEY HAVE QUICK CONVERSION TO AND FROM ENGLISH OR METRIC UNITS,

THEY CAN BE ZEROED OUT AT ANY POINT,

PROVIDE OUT-OF-TOLERANCE ALERTS,

AND CAN BE USED FOR COLLECTING AND ANALYZING DATA FOR STATISTICAL PROCESS CONTROL.

--- TOUCH BLACK ---

SCENE 72.
tape 541, 05:25:00-05:25:14
optical measuring projector

NARRATION (VO):

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displaying part
tape 552, 12:01:00-12:02:00
blue background
CG: Optical Measuring Projectors
Vision Systems
Coordinate Measuring Machines

SOME MEASURING DEVICES WORK BY COMPARING THE PHYSICAL PART WITH AN IMAGE OR MODEL OF THE PART'S DESIGN CHARACTERISTICS. THESE DEVICES INCLUDE:

OPTICAL MEASURING PROJECTORS,

VISION SYSTEMS,

AND COORDINATE MEASURING MACHINES.

SCENE 73.
CG, SUPER: Optical Measuring Projector
tape 545, 09:18:24-09:18:38
tilt, zoom in, optical measuring projector being used

NARRATION (VO):

THE OPTICAL MEASURING PROJECTOR IS A NON-CONTACT METHOD OF GRAPHICALLY DISPLAYING AND MEASURING PARTS THAT HAVE DIMENSIONS AND SHAPES DIFFICULT TO MEASURE WITH CONVENTIONAL CONTACT GAGING TOOLS.

SCENE 74.
continue previous shot
tape 537, 01:05:14-01:05:30
part being mounted on optical measuring projector stage
tape 537, 01:06:43-01:06:53
pan of optical path
tape 537, 01:07:55-01:08:02
glass removed showing mirror
tape 539, 03:14:34-03:14:52
c.u. silhouette profile on viewing screen, changing to second lighting source turned on to view the part surface

NARRATION (VO):

THE TYPICAL OPTICAL MEASURING PROJECTOR HAS A STAGE WHERE A PART IS MOUNTED. ADDITIONALLY, OPTICAL MEASURING PROJECTORS HAVE AN OPTICAL PATH MADE UP OF A LIGHT SOURCE,

CONDENSING LENS,

MAGNIFYING LENS,

AND REFLECTING MIRROR TO BOUNCE A PRECISELY MAGNIFIED SILHOUETTE PROFILE OF THE PART ONTO A VIEWING SCREEN. A SECOND ILLUMINATION SOURCE IS USED TO VIEW THE PART SURFACE.

SCENE 75.
tape 539, 03:16:37-03:16:53
c.u. silhouette profile on marked to cross hairs
tape 537, 01:01:56-01:02:14
c.u. silhouette profile on viewing screen, overlay chart placed over the screen
tape 539, 03:18:40-03:18:58
c.u. silhouette profile being read with edge detection

NARRATION (VO):

ONCE A PART IS MOUNTED AND VIEWED, IT CAN BE MEASURED BY USING EITHER FINE CROSS HAIRS ETCHED ONTO THE VIEWING SCREEN TO ENTER IN COORDINATES, OR BY USING OVERLAY CHARTS, WHICH ARE DRAWN TO THE

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CORRECT MAGNIFICATION AND PLACED OVER THE SCREEN TO QUICKLY JUDGE THE CONFORMANCE OF THE PART TO THE SPECIFIED TOLERANCES. ADDITIONALLY, MANY PROJECTORS INCORPORATE AUTO EDGE DETECTION SYSTEMS THAT TRIGGER A COORDINATE READING WHEN LIGHT OR DARK EDGES ARE CROSSED.

--- TOUCH BLACK ---

SCENE 76.
tape 539, 03:21:32-03:21:50
CG, SUPER: Vision System
pan of vision system

NARRATION (VO):

IN A VISION SYSTEM, PART INFORMATION FROM VISUAL SENSORS ENABLES MACHINES TO MAKE INTELLIGENT DECISIONS REGARDING THE PART.

SCENE 77.
continue previous shot
tape 552, 12:01:00-12:02:00
blue background
CG: Inspection: For Gaging, Verification & Flaw Detection
Identification: For Symbol, Or Object Recognition
Machine Guidance: For Object Location And Tracking

NARRATION (VO):

THREE MAIN INDUSTRIAL APPLICATIONS FOR VISION SYSTEMS ARE:

INSPECTION: FOR GAGING, VERIFICATION AND FLAW DETECTION,

IDENTIFICATION: FOR SYMBOL, OR OBJECT RECOGNITION,

AND MACHINE GUIDANCE: FOR OBJECT LOCATION AND TRACKING.

SCENE 78.
tape 539, 03:20:38-03:20:50
pan up, video camera capturing image
tape 539, 03:26:57-03:27:24
pan from video camera to computer system

NARRATION (VO):

IN A TYPICAL VISION SYSTEM, A PART'S IMAGE IS CAPTURED, USUALLY WITH A VIDEO CAMERA, TO MEASURE IT'S RELEVANT FEATURES. THIS INFORMATION IS CONVERTED INTO ELECTRICAL SIGNALS WHICH ARE THEN ANALYZED BY A COMPUTER.

SCENE 79.
continue previous shot

NARRATION (VO):

THE COLLECTED IMAGE IS COMPARED TO PRE-DEFINED

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CRITERIA, INCLUDING DESIRED DIMENSIONS AND ALLOWED TOLERANCES. THE IMAGE MAY ALSO BE ANALYZED FOR DEFECTS, SUCH AS CRACKS OR SCRATCHES.

--- TOUCH BLACK ---

SCENE 80.
CG, SUPER: Coordinate Measuring Machine
tape 546, 10:10:15-10:10:36
cmm probing part

NARRATION (VO):

THE COORDINATE MEASURING MACHINE, OR CMM, IS AN EXTREMELY ACCURATE MEASUREMENT INSTRUMENT THAT PROVIDES DETAILED DATA, AND DOCUMENTATION OF MANUFACTURED PARTS.

SCENE 81.
continue previous shot
tape 539, 03:06:50-03:07:05
pan of cmm frame, part on table
tape 539, 03:02:48-03:03:06
probing system probing part
tape 539, 03:09:35-03:09:45
cmm machine controls
tape 539, 03:10:21-03:10:31
cmm computer system, analyzing measurement data

NARRATION (VO):

A TYPICAL CMM SYSTEM CONSISTS OF FOUR ELEMENTS:

A MACHINE FRAME, USUALLY CONSTRUCTED FROM A GRANITE OR OTHER THERMALLY STABLE MATERIAL, FOR SECURING AND SUPPORTING THE PART...,

A PROBING SYSTEM USED TO COLLECT RAW PART DATA...,

MACHINE CONTROLS, WHEN MACHINE MOTION IS MOTOR CONTROLLED...,

AND A COMPUTER SYSTEM AND SOFTWARE TO PROCESS AND ANALYZE THE RAW PART DATA.

SCENE 82.
tape 539, 03:05:00-03:05:56
wide of cmm table, system, continue throughout scene
tape 552, 12:05:40-12:05:50
GRAPHIC: "x" axis, yellow arrows on black showing run from left to right
CG, SUPER: "X" Axis
tape 552, 12:06:10-12:06:20
GRAPHIC: "y" axis, yellow arrows on black showing run from the front to the rear
CG, SUPER: "Y" Axis
tape 552, 12:06:40-12:06:50
GRAPHIC: "z" axis, yellow arrows

NARRATION (VO):

CMM'S ARE DESIGNED TO MOVE AND MEASURE WITHIN THREE COORDINATE AXES:

THE "X" AXIS, WHICH RUNS FROM LEFT TO RIGHT...,

THE "Y" AXIS, WHICH RUNS FROM THE FRONT, TO THE REAR OF THE CMM...,

AND THE "Z" AXIS, WHICH RUNS UP AND DOWN.

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on black showing run up and down
CG, SUPER: "Z" Axis

SCENE 83.
tape 538, 02:24:10-02:24:18
cmm operation, part placed towards the center of the cmm table, secured, dissolve to next shot
tape 538, 02:24:26-02:24:37
moving probe into position

NARRATION (VO):

IN MOST CMM OPERATIONS, A PART IS PLACED ANYWHERE TOWARDS THE CENTER OF THE CMM TABLE. DEPENDING ON THE PART SIZE AND THE TYPE OF PROBE USED, THE PART MAY ALSO NEED TO BE SECURED TO THE MACHINE TABLE.

SCENE 84.
continue previous shot, cut on action to next shot
tape 538, 02:25:02-02:25:13
probe is moved by machine controls, contacting part
tape 546, 10:08:25-10:08:50
c.u. ruby probe moving along part

NARRATION (VO):

ONCE THE PART IS READY, THE CMM'S PROBE IS MOVED, MANUALLY OR BY MACHINE CONTROLS UNTIL CONTACT IS MADE WITH THE PART. PROBES ARE PRIMARILY ELECTRONIC AND USE A RUBY, OR SOMETIMES CERAMIC TIP, TO CONTACT THE PART. PROBES CAN ALSO BE NON-CONTACT IN NATURE.

SCENE 85.
tape 539, 03:10:52-03:11:17
pan from probe to computer interface, shape appearing on screen

NARRATION (VO):

READER HEADS, TRAVELING ON EACH COORDINATE AXIS ALONG BUILT-IN MEASURING SCALES, TRANSFER DATA ON THE MACHINE'S POSITION FROM THE PROBE TO THE COMPUTER INTERFACE. THIS DIMENSIONAL AND GEOMETRIC DATA IS THEN CALCULATED, COMPARED, EVALUATED AND RECORDED.

SCENE 86.
tape 546, 10:05:04-10:05:14
cmm being used
tape 549, 11:14:20-11:14:32
huge cmm system filling entire room

NARRATION (VO):

CMM’S ARE AVAILABLE IN A VARIETY OF STYLES AND SIZES, RANGING UP TO SYSTEMS THAT ARE USED TO INSPECT LARGE AIRCRAFT COMPONENTS.

--- FADE TO BLACK ---

SCENE 87.
CG: Review

MUSIC UP AND UNDER

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white text on black
tape 63, 12:00:15-12:03:49
review music

NARRATION (VO):

LET'S REVIEW THE MATERIAL CONTAINED IN THIS VIDEOTAPE.

SCENE 88.
tape 538, 02:22:08-02:22:15
gaging of shop floor part

NARRATION (VO):

THE MEASUREMENT AND GAGING OF PART DIMENSIONS IS A CORNERSTONE ACTIVITY IN MANUFACTURING.

SCENE 89.
tape 523, 10:02:59-10:03:35
c.u. measurement of part dimension
tape 543, 07:08:17-07:08:27
gaging with telescope gage
tape 538, 02:17:17-02:17:22
gaging with micrometer
tape 537, 01:14:48-01:14:54
gaging with tool having a dial indicator
tape 541, 05:18:29-05:18:38
gaging with tool having a electronic digital readout
tape 545, 09:18:59-09:19:10
optical measurement projector with part
tape 539, 03:21:57-03:22:03
vision system, scanning parts
tape 546, 10:13:21-10:13:30
coordinate measurement machine

NARRATION (VO):

THESE PART DIMENSIONS ARE GAUGED USING MEASUREMENT TOOLS, WHICH RANGE IN COMPLEXITY FROM NONGRADUATED MEASURING TOOLS AND GAGES,
TO GRADUATED MEASURING TOOLS AND GAGES,
WHICH ARE ENHANCED BY INCORPORATING DIAL INDICATORS...,
AND ELECTRONIC DIGITAL READOUT DISPLAYS.
ADDITIONAL MEASUREMENT TOOLS INCLUDE:
OPTICAL MEASUREMENT PROJECTORS...,
VISION SYSTEMS...,
COORDINATE MEASUREMENT MACHINES AND OTHERS.

SCENE 90.
CG, SUPER: Nongraduated Measuring Tools & Gages
tape 543, 07:04:14-07:04:22
c.u. calipers taking inside reading
tape 543, 07:05:09-07:05:18
calipers used to take outside measurement
tape 551, 06:06:07-06:06:23
go-no-go gage being used

NARRATION (VO):

NONGRADUATED MEASURING TOOLS AND GAGES DO NOT HAVE LINEAR OR ANGULAR GRADUATIONS MARKED ON THE TOOL.
THESE TOOLS ARE GENERALLY USED TO TRANSFER MEASUREMENTS TO OR FROM A GRADUATED MEASURING TOOL, OR AS A PASS/FAIL CHECK COMPARISON TO A STANDARD.

SCENE 91.
tape 538, 02:02:30-02:02:37
c.u. "go" end fitting into hole, and the "no-go" not fitting

NARRATION (VO):

THE PRIMARY TYPES OF NONGRADUATED TOOLS AND GAGES

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tape 543, 07:14:03-07:14:11
dividers used for transferring lengths taken from a graduated rule, then being used for scribing circle
CG, SUPER: Dividers
tape 543, 07:03:41-07:03:47
calipers compared with a vernier calipers
CG, SUPER: Calipers
tape 543, 07:05:37-07:05:55
telescope gage measuring inside diameter, taken out and distance measured
CG, SUPER: Telescope Gages
tape 543, 07:11:57-07:12:11
small hole gage measuring hole
CG, SUPER: Small hole Gages
tape 543, 07:12:53-07:13:01
square used for the measuring right angle
CG, SUPER: Squares
tape 543, 07:13:33-07:13:40
steel straightedge used for scribing straight line
CG, SUPER: Straightedges
tape 544, 08:03:43-08:03:57
adjustable parallels placed in slot, measured with micrometers
CG, SUPER: Adjustable Parallels
tape 543, 07:18:59-07:19:26
"go", no-go" gage being used
CG, SUPER: Go-No-Go Gages

INCLUDE:

DIVIDERS...,

CALIPERS...,

TELESCOPE GAGES...,

SMALL HOLE GAGES...,

SQUARES...,

STRAIGHTEDGES...,

ADJUSTABLE PARALLELS...,

AND GO-NO-GO GAGES.

SCENE 92.
CG, SUPER: Graduated Measuring Tools & Gages
tape 544, 08:08:37-08:08:47
combination square being used
tape 538, 02:04:53-02:04:58
micrometers being used
tape 538, 02:02:55-02:02:59
dial calipers being used

NARRATION (VO):

GRADUATED MEASURING TOOLS AND GAGES HAVE EITHER LINEAR OR ANGULAR GRADUATIONS AS PART OF THE TOOL, AND ARE AVAILABLE IN BOTH ENGLISH AND METRIC UNITS.

SCENE 93.
tape 543, 07:21:29-07:21:44
micrometer being used
tape 544, 08:10:36-08:10:41
tapered end rule used on hole
CG, SUPER: Rules
tape 544, 08:07:40-08:07:45
combination squares being used for layout of 45 degree
CG, SUPER: Combination Squares
tape 544, 08:18:44-08:18:50
slide calipers being used to

NARRATION (VO):

THERE ARE VARIOUS TYPES OF GRADUATED TOOLS AND GAGES, INCLUDING:

RULES...,

COMBINATION SQUARES...,

SLIDE CALIPERS...,

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gage outside surface
CG, SUPER: Slide Calipers
tape 554, 14:11:16-14:11:24
vernier calipers being used for outside reading
CG, SUPER: Vernier Calipers
tape 542, 06:02:13-06:02:23
zoom out, micrometer being used
CG, SUPER: Micrometers

VERNIER CALIPERS...,

AND MICROMETERS.

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SCENE 94.
CG, ROLL: credits
white text on black, fade up mid-screen

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SCENE 95.
CG: 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.

--- TOUCH BLACK ---

SCENE 96.
tape 40, 01:00:00-01:00:12
SME logo, with music
CG, SUPER: www.sme.org