Understanding and Using an Inch Micrometer

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Overall Program Description

The outside inch micrometer is a measurement device that incorporates a calibrated screw to record accurate measurements of components in the mechanical engineering and machining trades. While the caliper can take multiple measurements, including outside, inside, height or depth, the outside inch micrometer can only be used to determine measurements outside an object. Micrometers can measure up to 1000^{th} of an inch, allowing for precision when used by a skilled operator. Therefore, accurately reading an outside inch micrometer is an essential skill for any technical trade. Digital outside micrometers are typical in the workforce, but this is no replacement for understanding the fundamental steps required to take an accurate reading using a dial inch micrometer. Micrometers may vary in scale, including metric micrometers and sizes ranging from 1-2 inches to 20-25 inches.

The *Understanding and Using an Inch Micrometer* Virtual Reality learning experience will consist of four modules, 15 minutes in length that may be experienced and completed using the Meta Quest 2 headset with track controllers. The target is young adults, approximately 15 years to 30, with no previous experience. The five modules may be viewed in linear order or independently to repeat the content and related knowledge checks. There is one final assessment, which includes a hands-on inch micrometer reading simulation. The user may share their results on an LMS for easy grading or social media using the provided user interface controls and record screen feature native to Meta Quest. The terminal program objective is:

- Given a series of videos, demonstrations, vocabulary, and hands-on exercises, participants will be able to record measurements using an outside inch micrometer accurately.

Planned Structure and Learning Objectives

Module 1 – What is a Micrometer

Module 1 shares basic information in a virtual reality video about what a micrometer is and how it functions:

- Given access to a video in the VR headset, the participant will learn the purpose of a micrometer, its role in mechanical engineering, and the difference between a caliper and a micrometer
- The participant will understand the purpose of learning to read a dial inch micrometer when digital micrometers are typical and develop the ability to differentiate from a metric micrometer.

The video is available to participants as a kick-off to the experience and to be viewed again using the "Repeat a Module" pathway. Results are measured according to Kirkpatrick's Model of Evaluation Level 2 using a knowledge check at the end of the video to support recall and learning (Hodell, 2016). Students are also provided with a survey at the end of this unit to record previous experience with calipers and micrometers using Kirkpatrick's Model of Evaluation Level 1 to assess opinions and performance by the end of the unit (Hodell, 2016).

Module 2 – Micrometer Video Tour

Module 2 provides the end-user with a 3D tour of a micrometer and details key elements:

- Given a 3D tour of the micrometer, students will understand and articulate the key parts of a micrometer, including the spindle, thimble, barrel, anvil, hatch marks, and frame.

The video is available to participants in sequence with the experience and to be viewed again using the “Repeat a Module” pathway. Results are measured according to Kirkpatrick’s Model of Evaluation Level 2 using a knowledge check at the end of the video to support recall and learning using drag and drop vocabulary words featured in the video tour (Hodell, 2016).

Module 3 – Units of Measurement

Module 3 provides the end-user with a detailed explanation of the hatch marks and system of measurement on the inch micrometer:

- Given a close-up view of an inch micrometer barrel and thimble, students will understand and articulate the meaning of the hatch marks on the barrel, thimble, and vernier scale.
- Students will understand how to read up to .0001” and add the different units of measurement together.

The module is available to participants in sequence with the experience and to be viewed again using the “Repeat a Module” pathway. Results are measured according to Kirkpatrick’s Model of Evaluation Level 2 using a knowledge check at the end of the video to support recall and learning (Hodell, 2016).

Module 4 – Reading the Micrometer

Module 4 provides the end-user with an opportunity to see a complete reading of the micrometer and move around the space using the Meta Quest controllers:

- Students will understand and articulate how to use an inch micrometer to take a reading of different objects provided in the VR scene.

- Students will understand common mistakes, including a failure to calibrate and zero out the micrometer before starting, mistaking the thimble for the barrel as required, not using the lowest hatch mark value on the thimble, or adding on the final vernier reading in the wrong decimal position (de Haro, 2017).

The module is available to participants in sequence with the experience and to be viewed again using the "Repeat a Module" pathway. Results are measured according to Kirkpatrick's Model of Evaluation Level 2 and 3 using hands-on practice in the knowledge check at the end of the video to determine when objectives have been met, and the desired behavior is observed (Hodell, 2016).

Formative Evaluation

The formative evaluation will examine the terminal objective and assess what was accomplished analogously to Kirkpatrick's level 4 evaluation (Hodell, 2016). According to the program objective, participants will be able to record measurements using an inch micrometer accurately. Students will be presented with a series of 10 close-up, randomized micrometer readings and use the Meta Quest controllers to move the device around in 3D space to observe the three hatch mark readings accurately and record them on the calculator, "tacking on" the vernier reading. Students will be able to record their screen actions and share them with LMS for final grading by the CTE instructor. Additionally, the module will reject readings where mistakes are noted in the data entered on the calculator, requiring the student to revisit previous modules and make additional attempts in the final assessment before completing. Students will be able to share screen recordings of failed attempts for further scaffolding by the instructor.

One final survey using Kirkpatrick's Level 1 assessment will be conducted to measure participants' reactions to the overall experience of program resources. The program's success will be measured using Kirkpatrick's Level 4 evaluation in the real world, where instructors and colleagues should be able to observe the student successfully reading the inch micrometer in practice (Kirkpatrick & Kirkpatrick, 2016).

Additional Considerations

Understanding and Using the Inch Micrometer satisfies the Career Technical Education Manufacturing and Product Development Pathway Knowledge and Performance Anchor Standards 10.1 Technical Knowledge and Skills, "Interpret and explain terminology and practices specific to the Manufacturing and Product Design sector" (California Department of Education, 2012, p.13). The course fulfills the Pathway Standard B2.2 "Describe and demonstrates… using a micrometer" (California Department of Education, 2012, p.18)

The mistakes that learners are expected to make include a failure to calibrate the micrometer, adding up the hatch marks with the final vernier reading in the wrong location, mistaking the thimble for the barrel as required, and confusion over using the lowest hatch mark to calculate the task. These concerns are addressed in Module 3 content, and if the student attempts to misread the micrometer in Module 4, the knowledge check will return feedback detailing the mistake. Subsequently, the student will be prompted to repeat the exercise and correct the behavior. Secondly, the calculations display in Module 4 will adopt a "tack it on" interactive approach when adding in the final vernier number. For example, rather than adding .0005 to the previous calculations of .595, the user will be instructed to "tack five onto .595 through the onscreen interaction. This avoids the common problem of the user reading the vernier number as .005 when it is .0005 and recording an incorrect reading. Lastly, students may require some time to acclimate to the track controllers and how it adjusts the micrometer in 3D

space. In these cases, students should be supported by the onsite coordinator of the VR equipment at the location where it is made available.

Enabling social share features native to Meta Quest and Facebook is suggested to evangelize the course and behavioral results at mastering an impressive technical skill using reels and platform extensions. Additionally, social sharing inspires community learning around virtual reality workforce content.

References:

California Department of Education. (2012). *California Career Technical Education Model Curriculum Standards: Manufacturing and Product Development*. https://www.cde.ca.gov/ci/ct/sf/documents/manproddev.pdf

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Kirkpatrick, J., & Kirkpatrick, W. (2016, November). Evaluation Blunders & Missteps to Avoid. *T + D Magazine*. Retrieved September 3, 2022, from https://courses.pepperdine.edu/access/content/group/msed604.21HY_2222/Documents/Kirkpatrick%20_%20Kirkpatrick_2016.pdf