

# Enhancing Nanoscience Education

- Teaching nanoscience difficult:  
OBJECTS CANNOT BE EASILY SEEN
- Student access to modern tools (SEM, AFM, STM)?  
NOT VERY PRACTICAL
- Possible answer:  
SIMULATE USING HANDS-ON ACTIVITIES

# Lesson: Seeing the Invisible World

[show picture of fly]

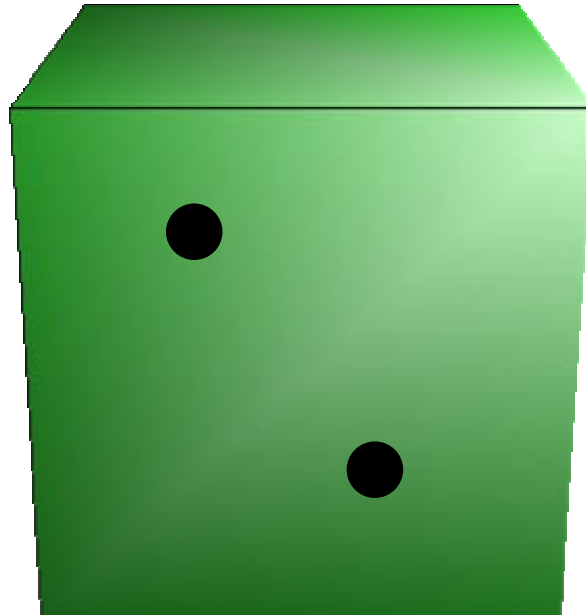
[show picture of transistor device]

[show picture of magnetic bits]

All of these images are less than 0.1 mm across.  
How were they produced?

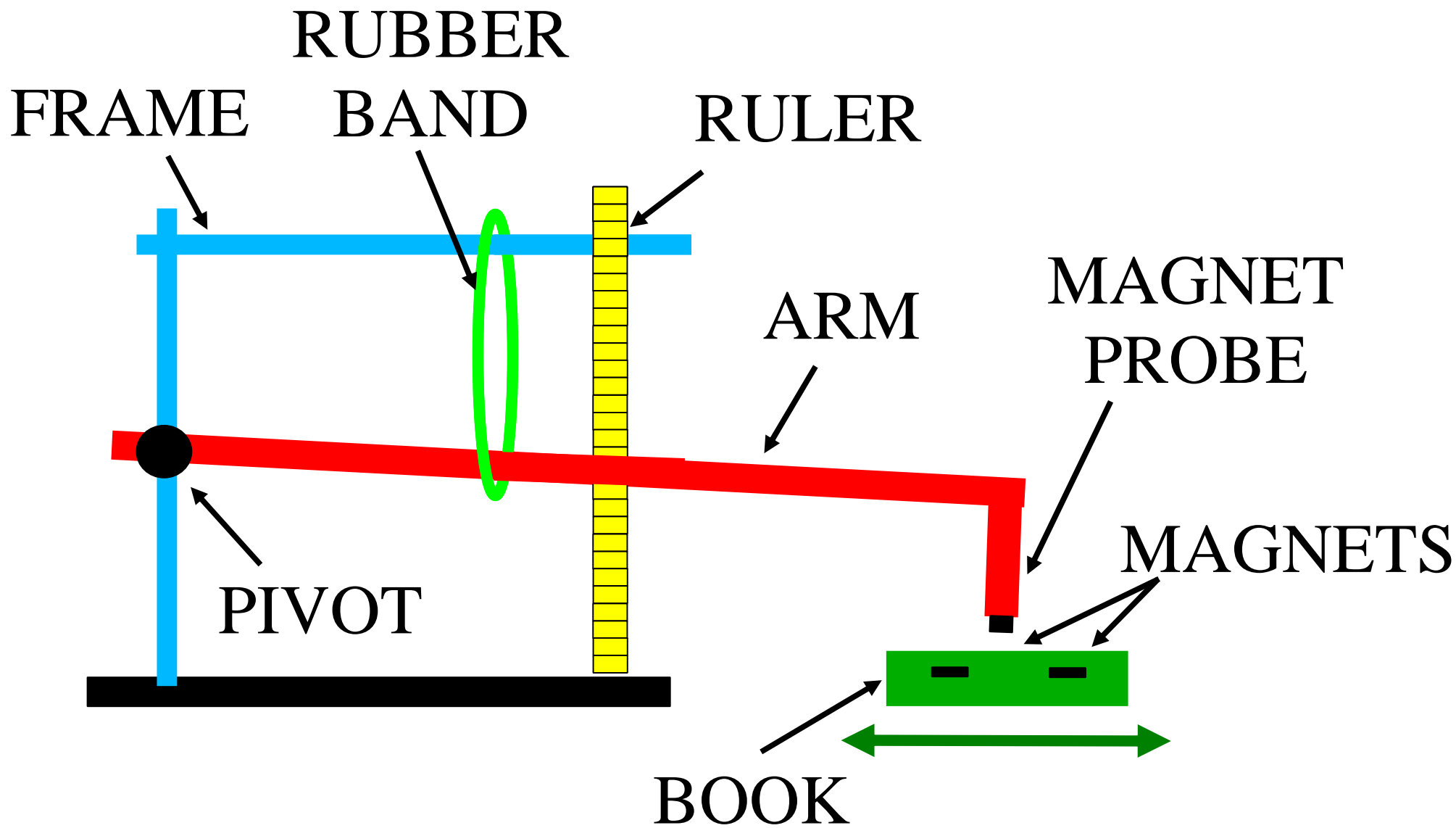
# ACTIVITIES WITHOUT INSTRUMENTS

- Students groups of 3-4.
- Groups given a book, taped shut, with magnets inside.
- Task: Describe number and location of magnets inside book.
- Message: Accuracy limited without instruments.



# ACTIVITIES WITH INSTRUMENTS

- Groups are told the mass of a book and the mass of a magnets.
- Groups are told to use scales to refine their answers.  
(Scales are accurate enough to determine number of magnets.)
- Groups are given materials and instructions for building an MFM.
- MFM includes a frame, a meter stick, a rubber band, and a magnet sensor.



# DATA TAKING USING MFM

- Students are guided to perform rastering motions and record vertical position of meter stick.
- Students use Excel to plot one-dimensional and two-dimensional images.

## ALTERNATIVE:

- An electronic magnetic field sensor can be placed on the arm. As the sample is rastered, field data is recorded, allowing images to be created.

# REVIEW QUESTIONS

- Students are asked to describe the experience of using the instruments compared to simply examining the book.
- Students are asked how to modify the instruments discussed so that they will be useful for smaller objects.
- Students are asked to describe any other techniques that could examine very small objects.

# WRAP-UP

- Teacher discusses and shows images and diagrams of state of nanoscience instruments (AFM, MFM, SEM, etc.).
- Teacher shows images of small objects produced using these instruments (insects, microelectronics, gears, magnetic bits, etc.).
- Teacher asks students to describe other possible uses of these tools.

## BIBLIOGRAPHY

-The only other MFM device I could find on the web was built with LEGO's by people at the University of Madison. A file describing it is attached.

[mrsec.wisc.edu/Edetc/LEGOInst/MFM](http://mrsec.wisc.edu/Edetc/LEGOInst/MFM)