Unit: Exponential Functions **Lesson: Moore's Law**

Disclaimer: This activity is untested. I will use it in Spring 2014 for the first time.

Activity overview:

Students will explore the validity of Moore's Law. Students will use published data to model the rates of change in different aspects of the semiconductor and computer industry and then use their models to make predictions. Exponential and linear models will be needed. To bring Varian into the picture I'd like to get data to explore Rock's Law which says that the cost of capital equipment (ie implanters) to build semiconductors will double every four years.

This activity will be used in a unit in Algebra 1 on Exponential Functions. It will follow activities intended to compare linear versus exponential growth. Students will have explored the choice between collecting a set amount or putting a penny on the first square of the checkerboard and doubling the amount on each successive square and the choice between an allowance that starts at a set amount and goes up a fixed amount each year or doubles every year.

Standards:
A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.★
F.BF.1 Write a function that describes a relationship between two quantities.★
F.LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.

- b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
- c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F.LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
F.LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
F.LE.5 Interpret parameters in a linear or exponential function in terms of a context.
S.ID.6a Fit a function to the data; use functions fitted to data to solve problems in the context of the data.★
S.ID.6b Informally assess the fit of a function by plotting and analyzing residuals.

Prior Knowledge:

- Students should be able to construct scatter plots and graph equations on a TI83.

Materials:

- Data on circuits per 1 inch diameter wafer, processing speed, cost of memory etc over time.
- video, visuals, handouts about the industry (in particular Varian and other AMP industries in the area)

Setup/Hook

Review a brief history of the computer focusing on semiconductors and highlighting Varian. Mention Moore's Law which states that the evolution of the processing power of computers is exponential. In general, it means that the number of transistors on a 1-inch diameter of silicon wafer doubles every x months, where x is 18-24 months. It has also been interpreted to mean that processing power doubles every 18-24 months.

Possible videos to share:
A present and future enabled by Moore's Law
http://www.intel.com/content/www/us/en/company-overview/future-enabled-by-moores-law-video.html
George Moore at Intel and what Moore's law means to Intel and "you"
http://www.intel.com/content/www/us/en/silicon-innovations/moores-law-technology.html
Intel uses Varian's implanters at its fab (silicon chip fabrication plants)

What will happen in 5 or 10 years? How can we use data from the past to make a prediction about the future? Will the pattern continue? Can the pattern continue?

Activity

1. Give students real historical data. "How can we make predictions from this data?" Guide towards making a graph to determine function family.
Students will use real data and graphing calculators to perform regression. Using the models predict the values in 5 or 10 years.

2. Review use of residuals to determine goodness of fit. Students will make residual plots and evaluate the function found in step 1.

Conclusion

Is Moore's Law predictive or a goal to be attained? Can it continue? Discuss the physical limitations of building transistors on silicon wafers and then show the clip about the new 3D designs at
http://www.intel.com/content/www/us/en/silicon-innovations/standards-22nm-explained-video.html
This is happening here as well as in California. Showcase Integrated Circuit AMP presence in the area in particular Varian

Data Sources:

On Core Algebra 1, Houghton Mifflin Harcourt
http://www.tomshardware.com/forum/id-1631024/data-demonstrate-moore-law.html#.
http://www-users.cs.york.ac.uk/pcc/pc_history/index.html
http://www.intel.com/pressroom/kits/quickreffam.htm
http://en.wikipedia.org/wiki/32_nanometer

This table shows the number of internet hosts from 2001 to 2007.

Years since 2001	0	1	2	3	4	5	6
Number in millions	110	147	172	233	318	395	490

1. Enter the data from the table into a graphing calculator. Set up a scatterplot of the data and graph it.

2. Make a sketch of the graph.

3. What type of function might fit the data? Explain your reasoning.

4. Use regression to find the function of best fit.

   Function y= Correlation coefficient r =

5. How well does the function fit the data? Use the correlation coefficient to support your answer.

6. Use your model to predict the number of internet hosts in

   2014: 2019: 2024:

7. Are these predictions likely to be accurate? Explain.

8. Does the growth in internet hosts obey Moore's Law? Explain.

Data Source: On Core Algebra 1 Houghton Mifflin Harcourt

This table shows the node size of the memory cells or chips. The smaller the node size the more circuits can fit on a silicon wafer and in electronic devices.

Years since 2001	1	3	5	7
nanometers	130	90	65	45

1. Enter the data from the table into a graphing calculator. Set up a scatterplot of the data and graph it.

2. Make a sketch of the graph.

3. What type of function might fit the data? Explain your reasoning.

4. Use regression to find the function of best fit.

Function y= Correlation coefficient r =

5. How well does the function fit the data? Use the correlation coefficient to support your answer.

6. Use your model to predict the node size in

2014: 2019: 2024:

7. Are these predictions likely to be accurate? Explain.

8. Does the decline in node host size obey Moore's Law? Explain.

Data Source: http://en.wikipedia.org/wiki/32_nanometer