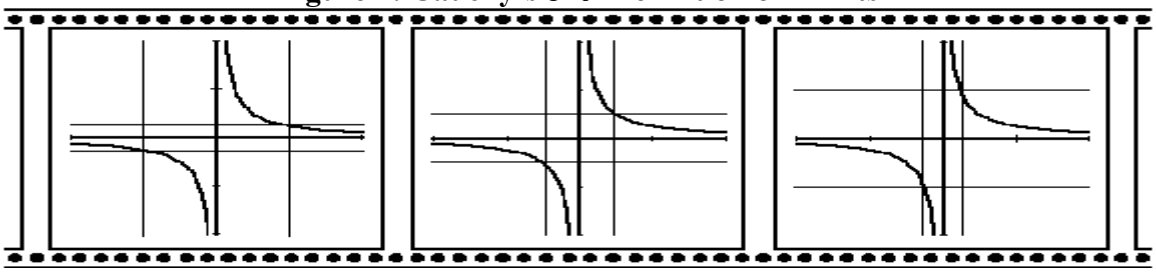
CALCULATOR ANIMATIONS FOR STUDENTS' MATHEMATICS RESEARCH

Sher, Lawrence, lawsher@yahoo.com
Wilkinson, Patricia, pbwilk@aol.com
Borough of Manhattan Community College
199 Chambers Street
New York, NY 10007
Phone: (212) 220-1335
Fax: (212) 220-8550

One of our most exciting student research projects was a calculator animation of the ε–δ definition of the limit of a function. When Ms. Niang presented her Calculus III project to an honors committee in December, 1998, the mathematics teachers present felt her animations would make Cauchy's definition more accessible to beginning calculus classes.

Ms. Niang is now putting her animation into a classroom type format for student use. She was one of our original MAA-Tensor women's grant research fellows, and was a biology major. She intended to end her mathematics after Calculus I, but now, after her A grade in Calculus III, is committed to a joint Mathematics-Biology major.

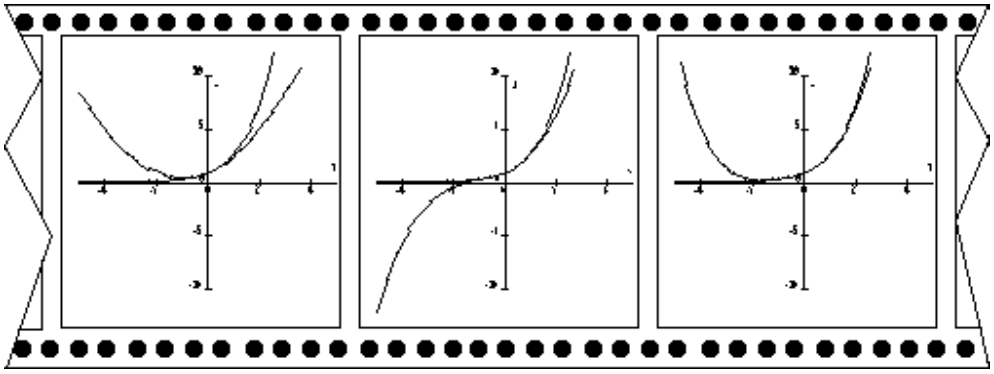
Figure 1: Cauchy's ε–δ Definition of Limits



For 1/x near 0, as δ decreases, ε increases.
Thus, there is no limit at 0.

Ms. Niang's animations are just the latest exciting example of BMCC mathematical computer animations that have been a major field of research opportunities for our students. Donald Stennett's research, "Animations of Series Approximations of Trigonometric Functions," won **First Place** at the 4th Annual National Science Foundation-Alliance for Minority Participation (AMP) Student Research Conference, "Education and Research: Parallel Paths to Excellence" in Tallahassee, Florida, on July 22, 1996.

Figure 2: Animation of MacLaurin Series of e^x



The tail wags on the left side only.

Presentation is a major feature of our student research program. Calculator animations easily create effective presentations. The style of animation is early Disney or "flipbook." A series of pictures are created and saved. They are then shown at a rapid speed in order. The **CyclePic** command on the TI-89 or TI-92 easily controls the presentation (e.g. **CyclePic"e",5,.4,3,-1**). The **e** indicates which set of pictures are used. The **5** states that the first five pictures of set **e** will be shown. The **.4** says that each frame will be shown for four-tenths of a second. The sequence will be shown **3** times. The **–1** runs the animation backwards after it is run forward. Presentations are often shown slowly at first (i.e. 2 seconds per frame) when the concept is explained; then more quickly (i.e. 1/2 seconds per frame) to show the motion.

BMCC's NSF grant "Women's Animated Research in Mathematics," has shown that one of the best ways to attract and retain women to the field is to get them involved in a research project under the direction of a competent mentor. The research projects involve more than study. Students are taught that a proper presentation of results, both written and oral, is a major component of research. When an outside evaluator of our mathematics courses asked to visit the Calculus lab, one of our students, Ms. Seifullah, was working on an animation project in polar coordinates. By using the software *MAPLE*, a computer algebra system, she was creating moving images on the screen that showed how the graph changed as she changed variables in her equations, She is an Alliance for Minority Participation (AMP) research fellow and this was her culminating project. The evaluator asked her to explain what she was doing and was amazed by her response. She said "What level of explanation do you want? Should I start by explaining what polar coordinates are? Do you want to know about the software that allows me to graph my equations? Would you like to know about the program I wrote that allows me to animate my equations? Do you want to hear what I am concluding based on my animations?" Her grasp of the various levels of knowledge and skills she was using and her articulateness in explaining what she was doing made it clear she was functioning as a working mathematician. She is typical of many students in the program they are not just "learning" mathematics they are "doing mathematics" which is what a working mathematician does. Her articulateness was honed by making calculator animation presentations at the MAA metropolitan area conference, and her presentation, "Animation of Polar Functions," at the 1997 National Science Foundation-Alliance for

Minority Participation Student Research Conference in Arizona resulted in an invitation to speak at a National Aeronautics and Space Administration conference.

The BMCC Mathematics Animation Program won a national award: **First Place**, "Student Created Computer Calculus Movies," *Student Success Strategies, Applying Technology to Teaching and Learning*, National Council of Instructional Administrators, American Association of Community Colleges, Minneapolis, Minnesota, April, 1995.

The work of this presentation was supported by the following NSF grants:
1.“Portfolios to Increase the Number of Women in Mathematics,” HRD 9710273
2. “Women’s Animated Research in Mathematics,” HRD 9908658
3. “Multimedia based Calculus with e-folios,” 0125637
and this FIPSE grant:
4. “Student's Business Skill's through Creating Mathematics Movies” P116B980071