**Function Project**

**Summary**

**Target audience:** Pre-calculus students (grades 10-12)

**Time required:** 90 min (there is a natural break for two 45 min classes)

**Objectives:** Students will apply their knowledge of different families of functions to create a picture of their choosing and will create an application on their TI-83/84 calculators, using the TI-BASIC programming language, to display their picture.

**Materials:**
- Graph paper
- TI-83/84 graphing calculator

**Introduction** (5 min)
The different functions studied in Algebra 2, Trigonometry, and Pre-calculus can be combined to create intricate pictures. Using basic transformations and domain restrictions, virtually any image can be generated. The students’ task is to design a picture that uses at least five different functions and demonstrates an understanding of the basic transformations. The picture may be anything appropriate. The students must calculate the transformations needed to generate the picture, the points of intersections, and the domain restrictions for each function. The resulting equations will be programmed into the students’ calculators to create an application that generates the picture with a single function call. The power point may also be used to show some examples of past projects.

**Creating an image** (20 min)
Students should start by sketching out an idea for their image. They should then choose a domain and range and redraw their picture on graph paper using the chosen domain and range. While transferring the image to graph paper, encourage students to choose clear intersection points and simplify the drawing somewhat. On the TI-83/84 a good domain and range is \(-4.7 \leq x \leq 4.7\) and \(-3.1 \leq y \leq 3.1\) or some scaled equivalent of these numbers. These numbers account for the rectangular shape of the screen and provide a cleaner image. The deliverable for this part is a clear picture on graph paper.

**Writing Equations** (20 min)
Students should then identify functions to represent each section of their picture (changing the image slightly if necessary) and write the accompanying equations and domain restrictions. The deliverable for this section is a list of equations, each corresponding to a section of the picture on graph paper. It helps to have students label each section on the picture and then label the equations to match. For a two-day version of the project, this is a good stopping place for the first day.
Programming (30 min)

These directions are for a TI-83/84 graphing calculator.

1) Hit the PRGM button
2) Scroll over to NEW, select Create New
3) Type in a name for your program, hit ENTER
4) Type in the functions you want
   a. Hit 2nd PRGM to access the DRAW menu
   b. Select DrawF and enter your function in parentheses
   c. Each function should have its own line and its own DrawF call
5) Controlling the domain
   a. The domain can be controlled by dividing the DrawF function by a test condition, e.g. (X < 5). The symbols can be found under the TEST menu by hitting 2nd MATH.
   b. Rookie mistake: not putting multiple domain restrictions in an outer set of parentheses.
6) Full example: \( \text{DrawF}\left(\frac{X^2 - 3}{(X < 5)\,(X > -1)}\right) \)

For the Pros:

1) Start your program with the following commands to set up a primo canvas for your work:
   a. ClrDraw, hit 2nd PRGM
   b. AxesOff, hit 2nd ZOOM
   c. FnOff, hit VARS, scroll to Y-VARS, choose, On/Off...
   d. -4.7 -> Xmin : 4.7 -> Xmax, hit VARS, choose Window...
   e. -3.1 -> Ymin : 3.1 -> Ymax, hit VARS, choose Window...
   f. Note: the arrow above in the window ranges is the key STO, which stores a value in variable (look by the ON key). These values for X and Y maintain the aspect ratio of your calculator screen. This means that the rectangular shape of the screen will not skew your functions, or show gaps between function intersections. If you need a bigger or smaller screen multiply the above numbers by a constant. For example, if you multiply these values by 2, you will get the values \( Xmin = -9.4, Xmax = 9.4, Ymin = -6.2, \) and \( Ymax = 6.2. \)

2) End your program with the following commands to restore the previous user interface:
   a. Pause, while editing your program, hit the PRGM button, then scroll down to choice #8
   b. ZoomRcl, hit ZOOM, then scroll over to MEMORY
   c. AxesOn, hit 2nd ZOOM
   d. FnOn, hit VARS, scroll to Y-VARS, choose, On/Off...
   e. Also check out the DRAW menu for other useful commands including vertical lines and text options, e.g. Text(40,20,"some_text").
Conclusion (15 min)
A nice conclusion is to have students demonstrate their programs for the class. This is best done under a document camera, but an overhead calculator can also be used. If a document camera is used, have students all run their program and then just bring it up already completed to avoid waiting for programs to draw. If using an overhead calculator, students can send their program to the overhead calculator using the *link* command as described below.

1. Connect both calculators using a link cable and make sure both calculators are on.
2. On the calculator receiving the program, hit the *LINK* button (to the right of the *ALPHA* key) and then choose *RECEIVE*.
3. Next on the calculator with the program, hit the *LINK* button, choose *Prgm*..., scroll to the program name, hit *ENTER* when the program name is highlighted, then hit the right arrow key to choose *TRANSMIT* and hit *ENTER*.

If you don't have access to either a document camera or overhead calculator, students can just pass their calculators around.