

## **The Infinity Project Curriculum for Pre-Engineering Students**

**Arun Kulkarni and Kay Pleasant**

Computer Science Department  
The University of Texas at Tyler, Tyler, TX 75799

### **Abstract**

The Infinity Project curriculum helps students understand the real world relevance of engineering, science, and math and exposes them to high tech career opportunities. The program is a nationally recognized partnership between leading research universities, industry, government and K-12 educators. It helps school districts and universities incorporate modern engineering and technology in their curricula. The Infinity Project provides new innovative educational approaches to modern engineering in the communications and information age that are both fundamental and fun. It is a hands-on curriculum. We have been offering the Infinity project curriculum for freshman students at the University of Texas Tyler for the last three years. In this paper, we present student projects that deal with engineering and scientific applications. Our experiment demonstrates that the Infinity Project curriculum has helped us to retain and attract more students to our computer science and engineering programs.

### **Introduction**

The Infinity Project is the first in the country to help school districts incorporate state-of-the-art engineering, computer science, and advanced technology into standard high school curricula. The program helps students understand the real world relevance of engineering, science, and math and expose them to the digital world. The Infinity Project curriculum provides a pre-engineering class to high school students who have completed Algebra-II and one science course. The class focuses on the math and science fundamentals and teaches students how engineers create and design the technology

around them. The curriculum and associated technology are developed by the country's leading college engineering professors in co-operation with K-12 educational experts. The curriculum is not just theoretical. It is not solving problems on a blackboard. It is a hands-on curriculum, where students learn math concepts while developing real life applications. Using the Infinity textbook [1] and the specially designed technology kit coupled with computer lab facilities student explore engineering through a variety of modern technologies. Students innovate, create, design, experiment and learn all along the way. The Infinity Project technology kit components are easy to use and install on existing classroom PCs.

The Infinity Project software is developed using the Visual Application Builder (VAB) tool. Applications in the VAB can be created with a lot of ease. Most of the actions performed to generate an application are comprised of mouse clicking events. The VAB provides different sets of blocks belonging to different groups that form distinct libraries. Each block represents a several lines of code. The libraries correspond to different fields. One can create an application by pulling predefined blocks on the screen and by connecting them with graphic lines. Students can create a real life application with a few mouse clicks rather than writing a large number of lines of code. The functionality of applications is nothing but the integrated result of functions of individual blocks.

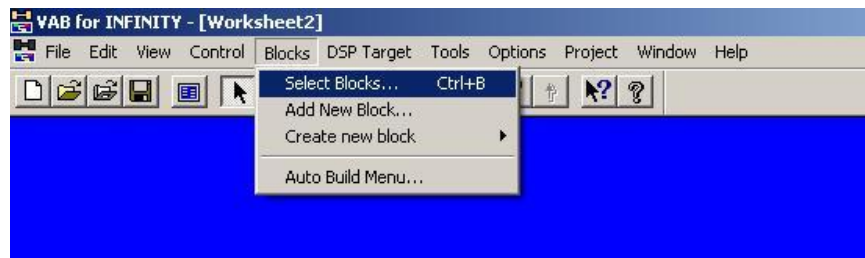
## **Student Projects**

Numerous applications can be developed in different areas of math, science and engineering. Here, we present some applications developed by high school students as a part of Infinity Project. With the Infinity Project curriculum, math and science concepts are not taught by traditional classroom methods but are taught using hands-on techniques. This generates interest in students about what they are learning, and it encourages them to try new things. It also provides them an environment to experiment with the various topics.

In order to create an application the students need to add the required blocks on the worksheet and link them together. Each block contains lines of code that implements a function, and the chain of blocks implements a program. Some times students are asked to provide some information to the blocks. This information includes filenames, values to the variables used in the application, etc. Apart from using the existing blocks, students can also create new blocks of their own using the Block Wizard. The wizard guides

through all the steps and generates a template along with the code. Students are then required to provide the operational code equivalent to the algorithm, so that the block can work as per the logic and give correct results. Blocks can be created in the existing library, or one can create a new library and add a block in the new library.

The steps for building an application are clearly explained in the help tool. A basic application can be built using the built-in functions of the VAB in the worksheet. The functions are divided into different groups and further into different libraries depending on the manner in which the functions are used. There are libraries such as Simulation Library, Real-Time Library, Native Library, etc. A block can be selected using the “Blocks” option on the menu bar as shown in Figure 1. The steps involved in developing an application include the selection of a library, adding blocks to the work sheet, and providing the connectivity and properties.



**Figure 1: Selection of Blocks**

For example, to add a function from a Real-Time Library, we select a RT-DSK Hardware functions Group then select the function, as shown in Figure 2.

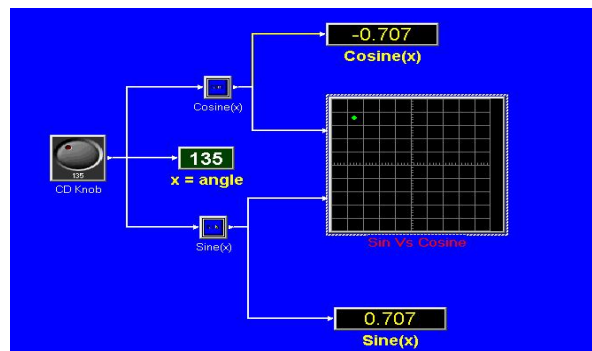


**Figure 2: Selection of Library, Group and Function**

A list of functions present in that group is shown, from which the desired function is selected and added to the worksheet. After adding desired functional blocks to the worksheet, we connect them properly using one of the three types of connectors. The connectors provide flow of functional processing from one block to another. Some of the areas in which Infinity Project is used are described below.

### Mathematical Applications

Mathematics is a very interesting subject. At the same time, it can be confusing if it is not taught in a proper manner. Mathematics includes topics such as co-ordinate geometry, statistics, trigonometry, calculus, etc. Applications that deal with mathematical concepts can be created very easily using VAB blocks. These applications assist students in learning. For example, we can create an application to display sine and cosine functions of desired amplitude and frequency. The graphical display of these functions helps students to understand the functions clearly.



**Figure 3: Plot of Sine Vs Cosine**

Figure 3 shows the plot of sine and cosine values for a given input angle, which is fed to the respective blocks using a knob. The angle can be changed by rotating the knob using the mouse. The plot shows the quadrant into which the value of sine and cosine for the given angle falls.

We can also plot a polynomial function using a built-in block by providing it the corresponding parameters. We can create an application that generates and displays a Fourier transform. Similarly, there are blocks that help creating applications such as spectrum analysis, display graphs for a particular statistical set of data, and compute the results of differentiation and integration equations. There are some blocks that implement logical operators such as AND, OR, and NOT. The binary operations such as rotational

encoding and bit masking can be simulated. If there is no block that that exists to perform the desired function, then we can develop a new block with the desired functions, and add it to the library. Blocks that perform matrix operations such as the addition, multiplication, and inverse are also available.

### Scientific Applications

The Infinity Project curriculum also helps to develop applications in the field of sciences. Scientific processes such as the modulation and demodulation can be visualized using the VAB tool. There are built-in blocks that serve for this purpose. The analysis of sound waves can also be done. Many scientific topics require some visualization in addition to the normal explanation. Applications like band-pass filtering that include low-pass and high-pass can be easily developed using built-in filters provided by the VAB tool, which also provides blocks that are capable of generating a continuous wave of specified frequency and amplitude. We can also develop applications that perform classification or clustering tasks. The VAB tool also supports external sound devices such as the MIDI devices. Another interesting application is visualizing a sound. Here a signal generator is used to generate a sinusoidal waveform that is displayed on the screen and passed through the loudspeaker so that the corresponding sound can be heard. The application is shown in Figure 4.

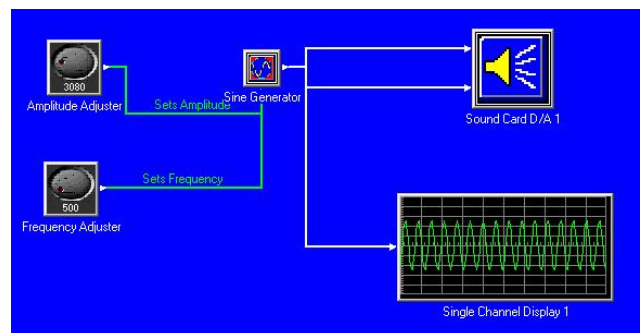
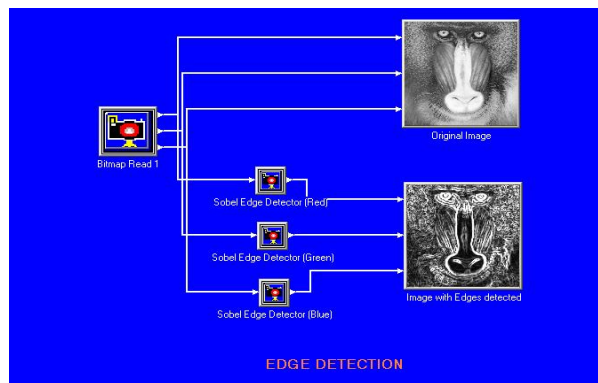


Figure 4. Visualizing the sound

### Image Processing Applications

These applications include image-editing methods such as sharpening, smoothing, edge detections, and image classification [2]. The VAB provides a separate image-processing library with blocks that perform various mathematical operations on an image or set of images. For example, there are blocks that implement various edge detection algorithms. Each of these blocks contains the code that corresponds to the given edge

detection algorithm, and it can be generated easily. There are built-in blocks that read input images from files on the disk and can display images on to the screen. The Image Read block reads the input file from the disk and the output of the Image Read Block can be fed as the input to another block that implants an image-processing task such as edge detection, image filtering, noise filtering, histogram equalization, image addition, subtraction etc. There are built-in blocks that deal with a sequence of images. Such blocks are useful in developing real-time applications. In designing a security system, a given scene is captured in to two images obtained at consecutive time instants. In order to detect any motion in the scene the second image is subtracted from the first image. The resultant image shows the change, if there is any. The other applications in this field include identification of tumors in x-ray samples, identification of geographic locations in multispectral satellite images. These applications can be built with image processing blocks such as image pattern generators, filtering methods, fractal generators etc. An application that implements various edge detection techniques is shown in Figure 5.



**Figure 5: Edge Detection**

## Conclusions

The Infinity Project provides an innovative hands-on tool to teach math, science and engineering concepts. Students are challenged to participate in the learning process. Many high schools and universities have already introduced the Infinity Project in their curricula. The statistics supplied by the Infinity Project team shows that sixty-five percent of students completing the Infinity curriculum report a strong interest in pursuing career in Engineering or Computer Science. The computer science department at UT Tyler is small department with about 173 undergraduate students and 30 graduate students. We

have been offering the Infinity Project Curriculum as Freshman Seminar course (UNIV 1300-03) on a regular basis for the last three years. We have setup an Infinity project lab with sixteen workstations. The classroom lectures and hands-on labs were interleaved during the semester. Student evaluations indicate that they enjoyed learning math concepts with hands-on labs. Students indicate that the best feature of the course is hands-on labs. The Infinity Project has increased the freshman retention rate in engineering students. [3, 4, 5]

## Acknowledgement

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## References

1. Geoffrey C. Orsak, Sally L. Wood, Scott C. Douglas, David C. Munson Jr., Ravindra Athale, and Mark A. Yoder, 2002, *ENGINEERING: Our Digital Future*; Prentice Hall, Upper Saddle River, NJ.
2. Kulkarni, A. D., 2001, *Computer Vision and Fuzzy Neural Networks*, Prentice Hall, Upper Saddle River, NJ.
3. Information from Infinity Project official website – <http://www.infinity-project.org/>
4. Support and contents from Hyperception group that designs VAB tool – <http://www.hyperception.com/VAB>
5. Statistics from Texas Instruments and Infinity Team - <http://www.ti.com/corp/docs/company/citizen/factsheets/infinity.shtml>

### ARUN D. KULKARNI

Dr. Kulkarni currently serves as a Professor of Computer Science at The University of Texas at Tyler. His research interests include data mining, fuzzy neural systems, computer vision, and knowledge discovery from databases. Dr. Kulkarni has authored two books and published more than sixty refereed papers in journals and proceedings. Dr. Kulkarni is serving as the Principal Investigator (PI) for the Infinity Project grant.

### KAY PLEASANT

Ms. Pleasant serves as a Senior Lecturer and Advisor for the Computer Science Department. Her areas of interest include Computer Science Education, Women in Computer Science, and Recruiting and Retention of Computer Science Students. Ms. Pleasant is serving as the Co-PI for the Infinity Project grant.