Basic Software for Space Explorers

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A few words about the software used in our activities:
We have chosen to emphasize professional software titles that have several characteristics:

- They are free of cost
- They run on multiple operating systems
- They are actively being maintained
- They are of uniformly high quality

Using free software means that students can use the same software at home they are using in school, without having to spend any money. Also, because student computers at home may be of a different platform than those used at school (e.g., Windows, Linux, Macintosh), it is important that students are able to use the same software in all locations so they don't have to learn different sets of commands, or worry about not being able to open files created at one location on a different computer system located elsewhere. Because we have (when possible) focused on titles that are popular, they are actively maintained, meaning that bugs are quickly identified and fixed. This results in software that is of sufficiently high quality that it is used in the professional workplace.

Because Linux is used as the operating systems for many NASA activities, as well as in many schools worldwide, we have insured that support for this operating system is included. The accompanying CD contains installers for all the Windows and Macintosh software, and for

those Linux titles that are not likely to be found in default installations. The web sites listed below should be checked for upgrades and for detailed instructions on how to install the software on your computers.

You are encouraged to make copies of the software distribution CD and give them to your Space Explorers to install on their computers at home.

Software (and sources):

- Concept mapping tool: Cmap (cmap.ihmc.us)
- Office Suite: OpenOffice (www.openoffice.org)
- Image editor: GIMP (www.gimp.org)
- Slide show web page generator Jalbum (jalbum.net)
- Earth map: GoogleEarth (earth.google.com)
- Orbit and other simulators: PhET (phet.colorado.edu)
- Math modeling and plotting software: MathTrax (learn.arc.nasa.gov/mathtrax)

Title: Cmap

Function: Building concept and causal maps

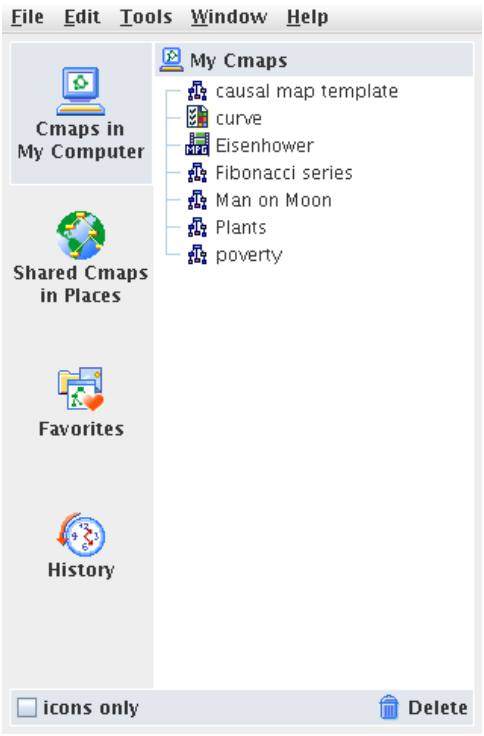
Features: Supports easy construction and organization of concept maps, facilitates links to external resources, has the ability to provide online assistance in map creation, among many others.

Basic operations:
Concept mapping is a powerful tool for representing student knowledge developed by Novak and Gowin (1984) as a tool for science educators. The idea behind it is easy to learn: a body of knowledge about a topic has some nouns or noun phrases associated with it, and some of these may connect to others through verbs or verb phrases. The nouns are called "concepts" and the verbs are called "linking phrases." The complete statement (concept – linking phrase – concept) is called a "proposition."

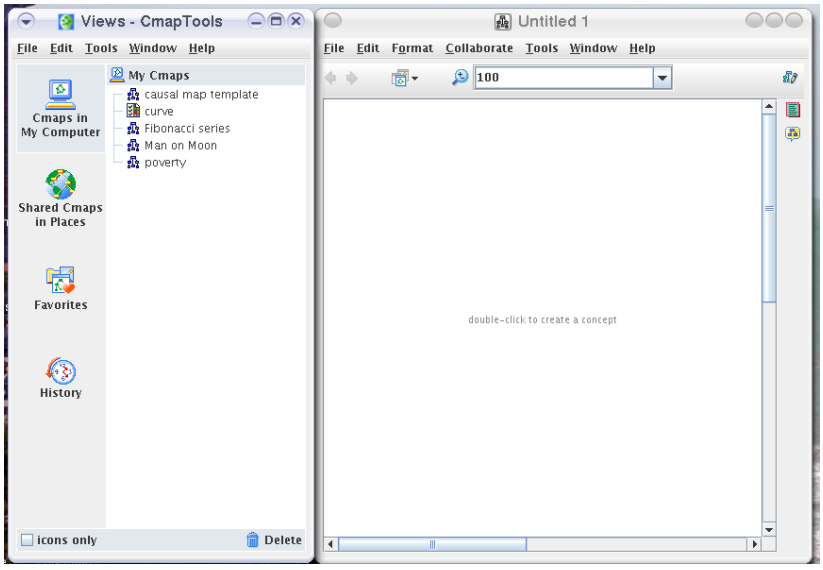
For example, a student studying plants might observe that plants are associated with concepts like root, stem, leaf, flower, seed, photosynthesis, petal, pollen, color, green, and so on. Furthermore, the student may know that flowers have petals, so the word "have" connects those two concepts. A two-dimensional graphical map of these relationships is called a concept map, and it provides a snapshot of student understanding both in terms of the accuracy of the connections, and their scope.

Traditionally, students would create concept maps on a topic of study both before and after the learning experience so they could see the extent of their prior knowledge, and identify misconceptions and make other observations of their actual learning. This makes concept mapping a powerful tool for self-assessment.

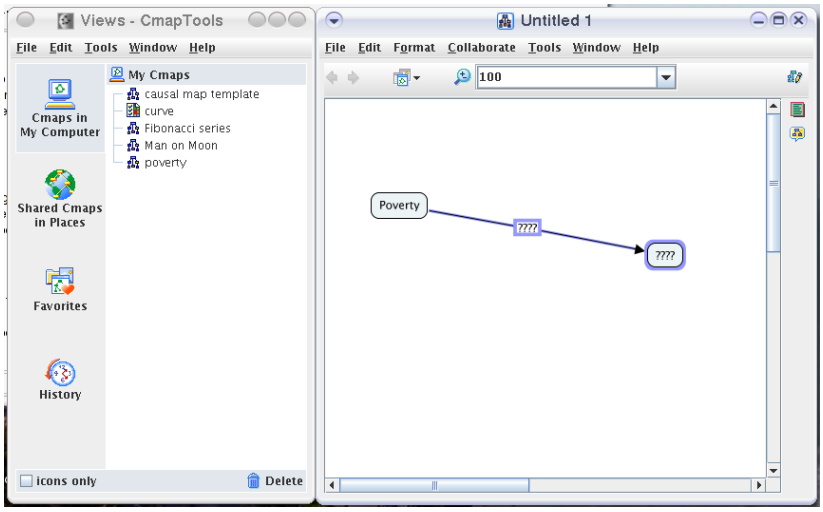
When the program is first opened the user sees a window with access to existing maps, either on your own computer, or distributed globally through a special network. (You won't be able to navigate through the global maps unless you are on-line.) To build a new ***CMap***, just choose that option from the File menu.



A window opens on the right and this is where maps are built and edited.

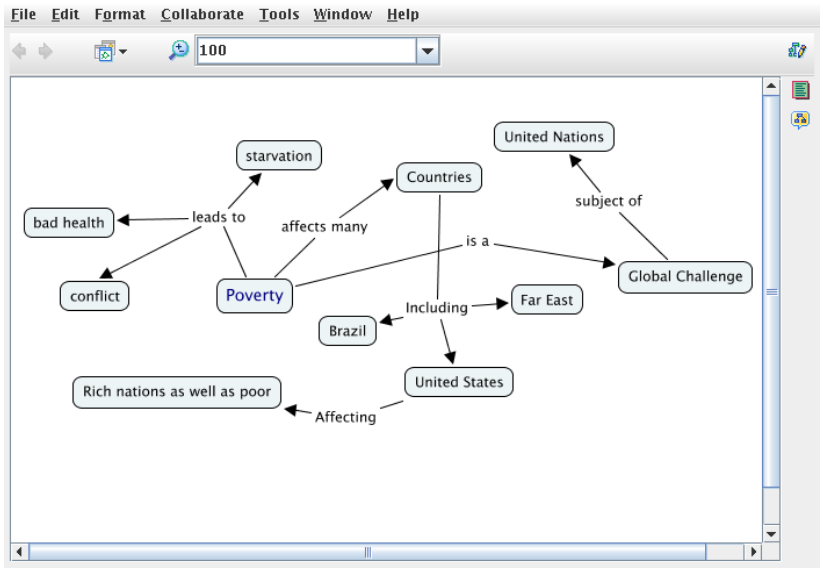


You can set the topic concept for your map by double-clicking the mouse anywhere in the right window, and then start building propositions by dragging a connection line a short distance and letting go of the mouse button. This creates a new concept with the ability to add text to the concept box and to the link connecting the two concepts.

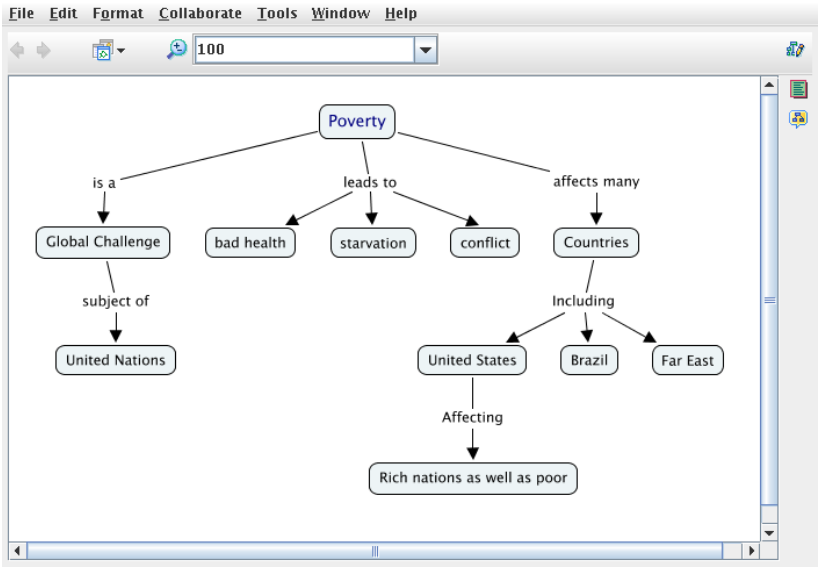


Labels can then be added, with the concepts going in the boxes and linking phrases going on the lines. If the same concept and linking phrase connects to several other concepts, lines can be drawn from the linking phrase itself to make a prettier (and easier to read) map.

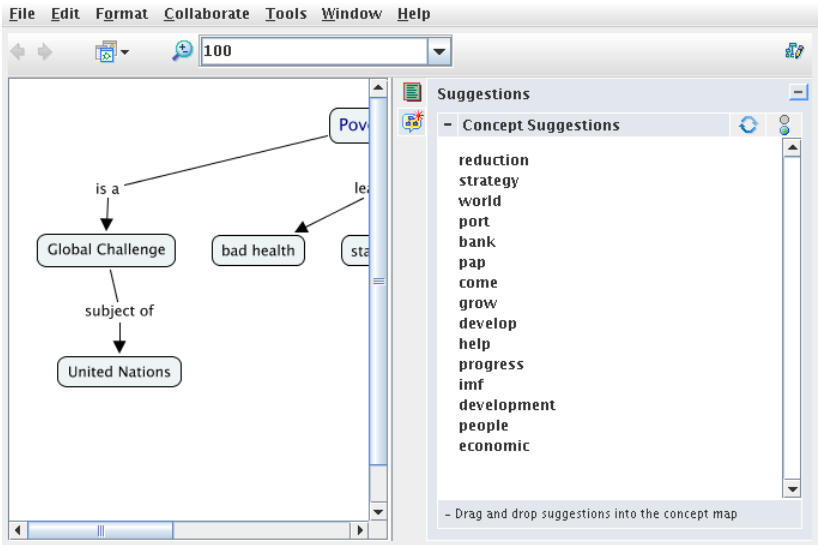
As shown below, after creating a few propositions, your map may start to get messy.



This can be fixed with the Autolayout tool from the Format menu on the ***CMap*** window.



Once you start working with this tool, you'll find some amazing capabilities. For example, if you're building a map but are stuck thinking of new concepts to explore, ***CMap*** has a *Suggest* option that will go on-line to look at other maps and find possible concepts related to yours that you might want to consider. Once you ask for suggestions, your map will be analyzed and new concepts will be offered for your consideration based on an online search looking for topics similar to the one you are exploring.

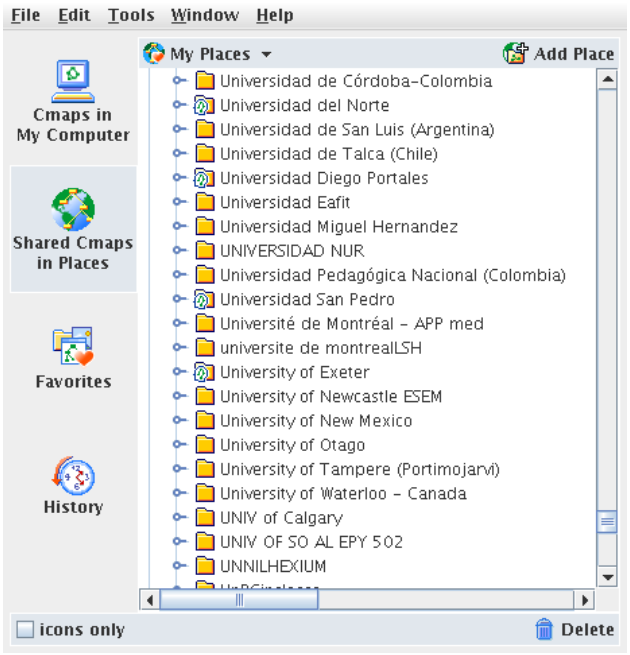


Suggestion window showing possible new concepts.

You can also add links to any concept that will do almost anything you wish, from playing a sound file or movie to opening a web site.

While your maps should always be stored on your computer, they can also be shared by posting them on a ***CMap*** server where others can see your work, comment on it, or even make changes and additions to it. The goal of this program is build collaborative environments for constructing knowledge. Of course, you don't have to unlock a map to allow collaboration unless you want to. The choice is yours to make.

As the following illustration shows, the number of ***Cmap*** servers worldwide is large and growing, and this doesn't count the private servers located behind school firewalls.

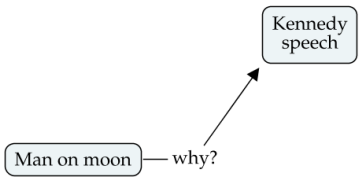


For classroom use, students and teachers can build presentations like a slide show based on maps they have created. These slide shows can be used to illustrate student understanding of the topic being explored. Any external links used in your map remain active in the presentation mode.

Before leaving this product, I want to illustrate another kind of map that can easily be built using ***CMap***: causal maps. The causal mapping process was developed by John and Ruthmary Cradler as a tool for building in-depth understanding of a topic. These maps are usually horizontal, although the direction of the map is not critical.

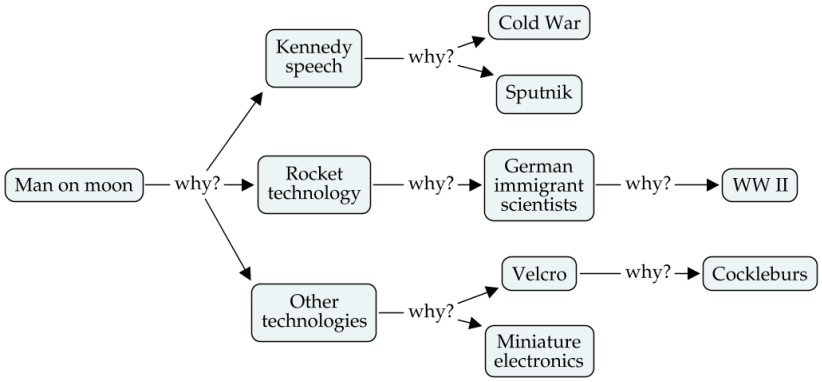
To make one of these maps, you start with a topic you want to understand in some depth. Next you ask yourself "Why?" (this becomes the connecting question) and then create a new concept that describes one answer to this question. For example, if the topic is "Man's

landing on the moon," one response to "Why?" is "Kennedy's speech." Another answer might be "Rocket technology."



After creating a few entries for the first level, you then move to each of the new causes and ask the question again. For example, Kennedy was dealing with the advances of Russian spacecraft.

You keep working on the causes of the causes as many levels deep as you wish, until you run out. The beauty of this kind of map is that the deeper you go in identifying causes, the greater your understanding of the original topic! Causal mapping is a tremendously powerful addition to concept mapping as a tool for helping students develop and demonstrate their deep grasp of virtually any topic under study.



As you get familiar with ***CMap***, you'll want to build hyperlinks to concepts, add background images, and do many other things to increase the value of this tool in almost any project.

Title: Open Office

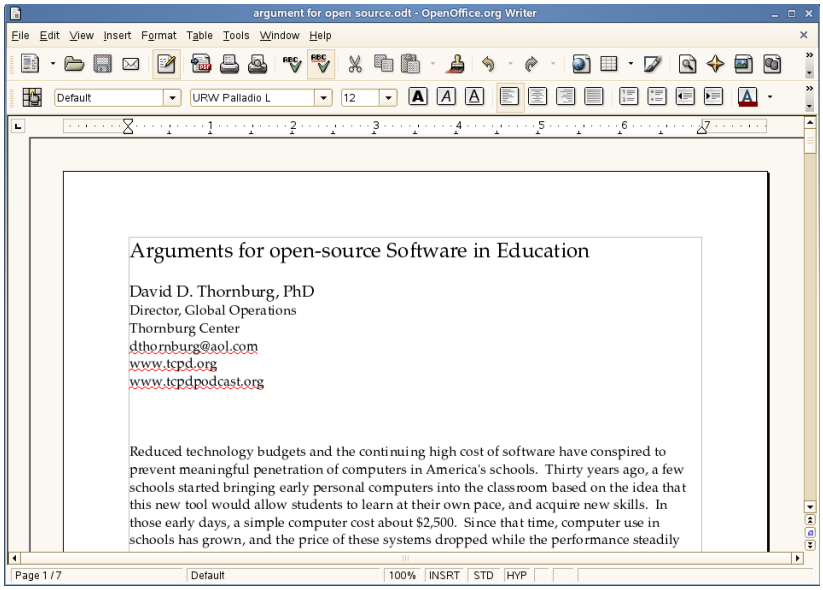
Function: Full office suite including word processing, spreadsheet, database, presentation, equation editor, and other powerful tools

Features: Provides excellent tools for creation of documents and presentations. The math equation editor provides the ability to build professionally perfect equations of almost any complexity.

Basic operations:
While we need to look beyond the use of student computers as tools for document creation, a good basic suite of applications for word processing, spreadsheet, presentations, chart drawing, and databases is essential. Nearly every student computer I've ever seen has some software in this category present, ranging from Microsoft *Works* to Microsoft *Office* or any of the other popular titles.

OpenOffice.org (http://www.openoffice.org) is free for everyone, and the release of updated versions cements this program as a great choice for educational use.

The ***OpenOffice.org*** user interface is clean and intuitive. If you are already using any other word processor, you should have no problem mastering this product.



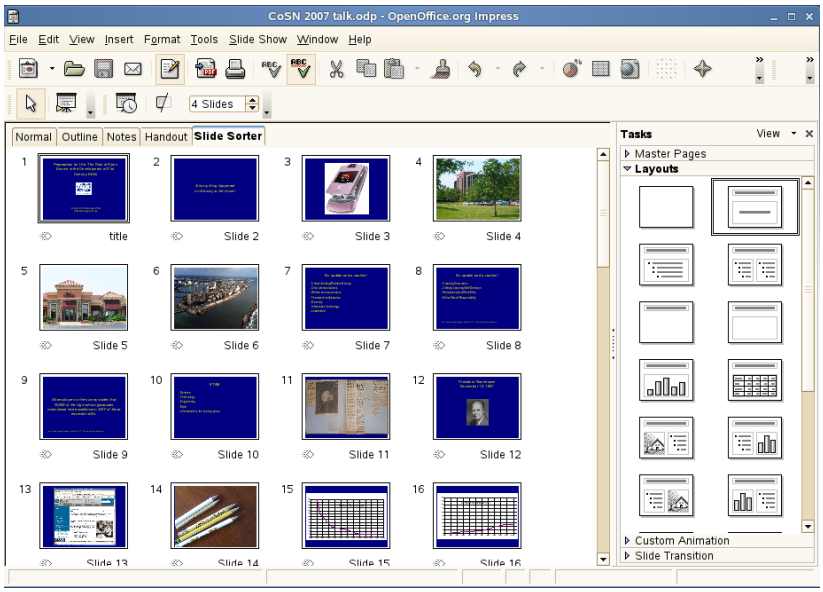
In addition to being able to open and save documents in a variety of formats compatible with other word processors (including Microsoft ***Word***), ***OpenOffice.org*** uses its own file format

which allows it to have a few new features not supported uniformly in other programs. This ability to work with "legacy" systems (to "play well with others") is essential, especially if you are e-mailing a project to someone who doesn't want to download ***OpenOffice.org***. One nice feature is the ability to export any document as an Adobe Portable Document Format (pdf) file which can be opened by Adobe's ***Acrobat Reader*** (www.adobe.com).

This is an important feature because the free ***Acrobat Reader*** is available for Mac, Windows and Linux, so you can share your beautifully formatted documents (with original fonts) with all your friends.

As with most good word processors, the one in ***OpenOffice.org*** supports tables and embedded graphics along with a variety of formatting and document checking tools to help ease the process of creating nice looking documents.

The presentation tool for ***OpenOffice.org*** (***Impress***) looks a lot like ***PowerPoint***, and can, in fact, export presentations in that format if you choose.



As with ***OpenOffice.org***'s word processor, the learning curve for ***Impress*** is easy to handle, especially if you already use a traditional presentation program like ***Powerpoint***.

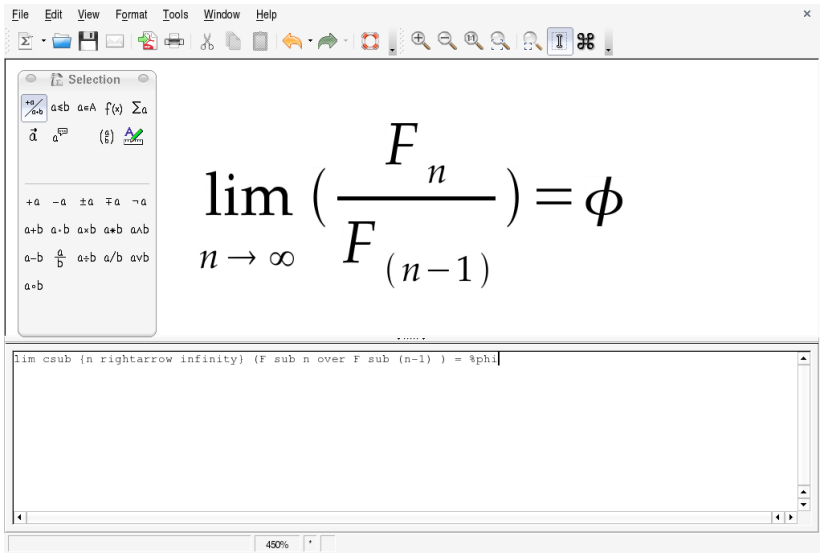
One of the truly clever features of ***OpenOffice.org*** is the ease with which it lets users create nicely formatted mathematical equations.

$$\lim_{n\to\infty}\left(\frac{F_n}{F_{(n-1)}}\right)=\phi$$

This elegant equation showing the relationship between Fibonacci numbers and the golden mean, was created from the following formula script:

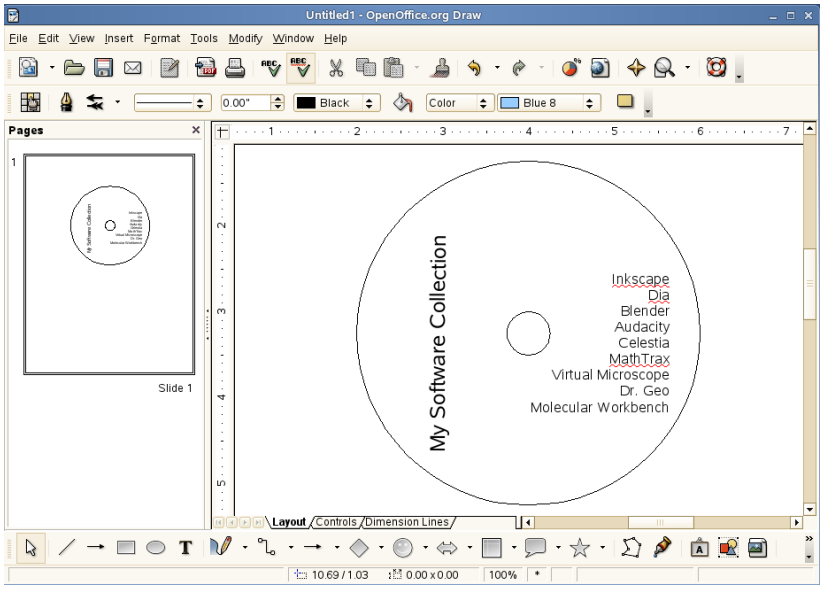
```
lim csub {n rightarrow infinity}( F sub n over F sub (n-1) ) = %phi
```

This fairly non-intuitive formula description was made using some of the helper tools built into the formula generator.

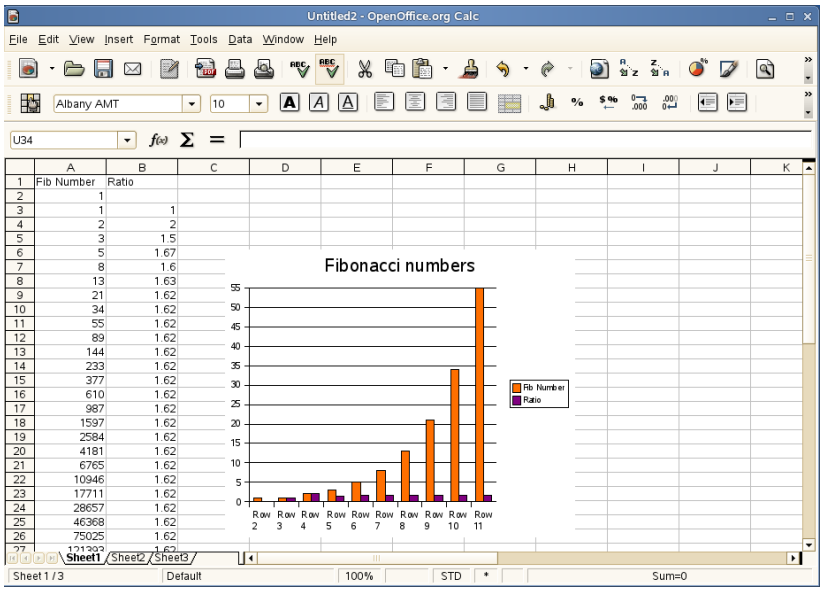


The neat thing is that, once you start building formulas with this tool, you'll quickly memorize the most common commands and the process will get faster and faster. I can't imagine anyone in the space exploration project who wouldn't want to use something like this to generate elegant-looking formulas. Note however, that even though your formulas may look pretty on the screen, their accuracy is still in your hands!

The drawing tool included as part of ***OpenOffice.org*** is not designed to replace a full graphics program, but is more than adequate for creating line drawings, charts, *etc.* We will explore another graphics program later, but here's a view of a project in the ***OpenOffice.org*** drawing tool:



The ***OpenOffice.org*** spreadsheet is as powerful as commercial offerings, and includes its own graphing capabilities.



In addition to a database program, OpenOffice.org also lets you print labels, make simple web pages, and create business cards. All in all, it is quite a versatile program that is likely to meet any traditional document generation needs for you and your students.

Title: GIMP

Function: Photo image editor (similar to Photoshop)

Features: Provides rich editing tools for creating and modifying images. Can open and save images in numerous formats for use in other projects. Online documentation and tutorials are available.

Basic operations:
In the history of personal computing, it wasn't that many years ago when ordinary folk developed the need to edit high-quality color images. This task used to lay in the hands of graphics professionals who were using digital images for advertising layouts, brochures, and occasional forays into the world of fine arts. As a result, professional image editing software (like Adobe's ***Photoshop***) had a dominant position in the market which it maintained through continual improvement, and the development of slightly less-powerful (and less expensive) versions for the home market, such as the popular program ***Photoshop Elements***.

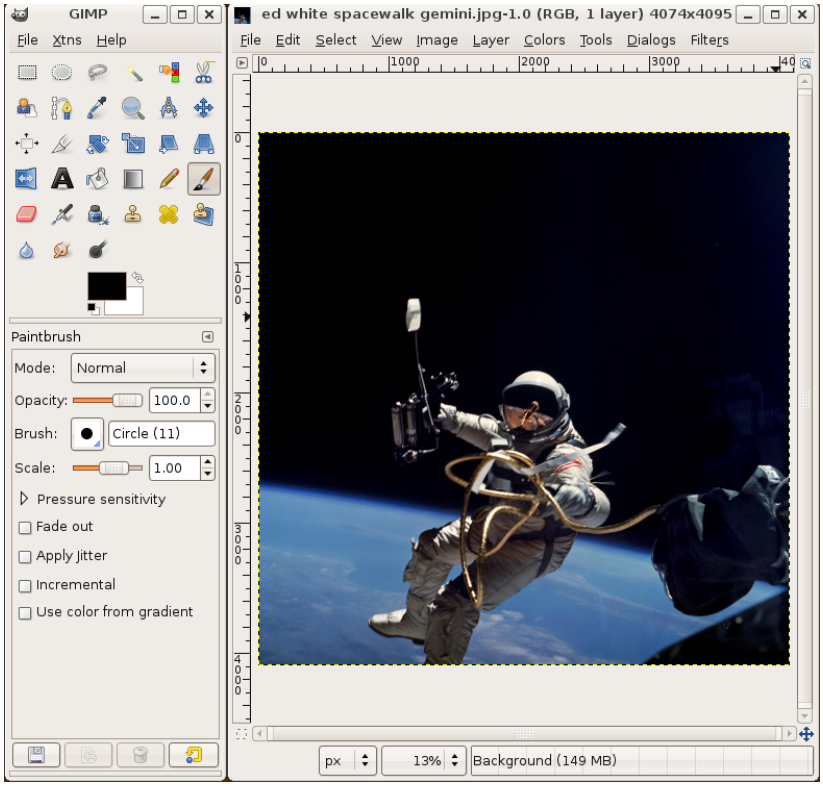
The rapid growth of digital photography has increased the demand for powerful image editing software now that "darkrooms" have moved onto computer screens. As with other popular kinds of Open Source software, image editors have entered the mainstream, with ***GIMP*** leading the pack. ***GIMP*** (http://www.gimp.org) is formally known as the *GNU Image Manipulation Program*.

Like Adobe's *Photoshop*, ***GIMP*** undergoes constant improvement, and is so rich in features that several books are devoted to this one piece of software. The ***GIMP*** web site is a great place to learn about these resources.

As with the other programs we're exploring in this book, we'll just touch on some of the highlights of this program and leave the in-depth exploration up to you.

There are numerous projects in the space exploration project that lead to tremendous images. Some of these will have been taken by professionals and astronauts, and others may be taken by you! No matter where the images come from, you may find that you only want to use a portion of the image, or to change the image size to be more compact if you are placing it in a web page. One note of caution: Be sure you have the right to use any images you find on the Internet, and that you give credit for any image you use that you didn't take yourself!

While you can start ***GIMP*** with a blank screen on which you create your own image, you'll most likely start with an image you've taken with a digital camera, or have brought into your computer from another source.



GIMP screen with open image (image: NASA)

Next to the image you'll see a panel with some frequently used tools ready to use. ***GIMP*** lets you undo any changes you make to your original. These "undos" go all the way back to the beginning of your session if you wish! Needless to say, this can be quite handy if you are doing a lot of edits and have decided to change your mind halfway through a project.

One simple task you can do with ***GIMP*** is automatically correct the color balance and contrast of your image if it needs fixing. You can change the resolution of your image which is very handy when creating pictures to be posted on the web. For example, I always take pictures with the highest resolution my camera supports so that, if I have to select just a portion of the final image for some reason, I still have plenty of resolution to display the image without visible loss of quality. Once I'm done editing my image, I can then resize it to fit the final application. If I'm using the image in a slide show, I usually save the final picture at a size about 1024 pixels across. This is high enough resolution to be easily seen, yet produces a small enough file to keep the presentation file compact. Remember, though, that once you

throw resolution away, you can't get it back. For this reason, I only edit copies of images, and leave the original untouched in case I need it later.

When you save images edited in ***GIMP***, you have lots of choices. ***GIMP*** looks to see the extension you've given the file name to determine the image format. For example a picture named Shasta.jpg will be saved as a JPEG (.jpg) file, while if you type Shasta.png, the image will be saved as a Portable Network Graphic (PNG) file. (This format compresses the image without any loss in quality. It was created to replace the GIF format which was proprietary. As part of the design process, the folks who developed PNG made sure the quality of the images was much higher than those associated with GIF – another win for this new format!) The ability of ***GIMP*** to open and save images in a wide variety of file formats adds tremendously to its value.

Advanced users will enjoy the fact that ***GIMP*** lets you create several layers for each image on which various editing effects can be used to create spectacular pictures. These features are covered in books devoted to ***GIMP***. One such book (available for on-line use for free) can be found at the GIMP-Savvy site (http://www.gimp-savvy.com).

Anyone can spend many happy hours applying various filters to images to create some interesting effects. For example, let's start with this picture of Ed White and the first "spacewalk.".

Using one of the many built-in ***GIMP*** filters you can turn this into a n image with a fabric texture:

Alternatively, you can make this picture look as strange as you want, just by experimenting with the built-in filters. Because you can "undo" any changes you make, you should experiment with a lot of filters to see what they do to your images. Different effects can be applied to the starting image, or can be combined one after the other to build quite interesting images.

Note that the filters in ***GIMP*** include many of the same effects found in Adobe's products, but also include some unique offerings you might find interesting. For example, a picture can be wrapped around a sphere and rotated automatically.

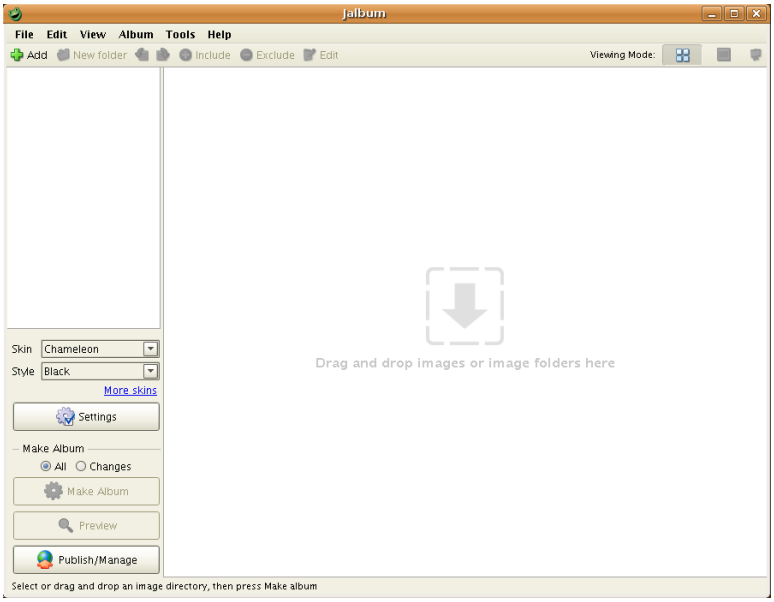
If you are already familiar with ***Photoshop Elements*** or other programs of that kind, ***GIMP*** should be fairly easy to master. In any case, you might want to invest in a book or two to refine your ***GIMP*** skills and work like the pros!

Title: JAlbum

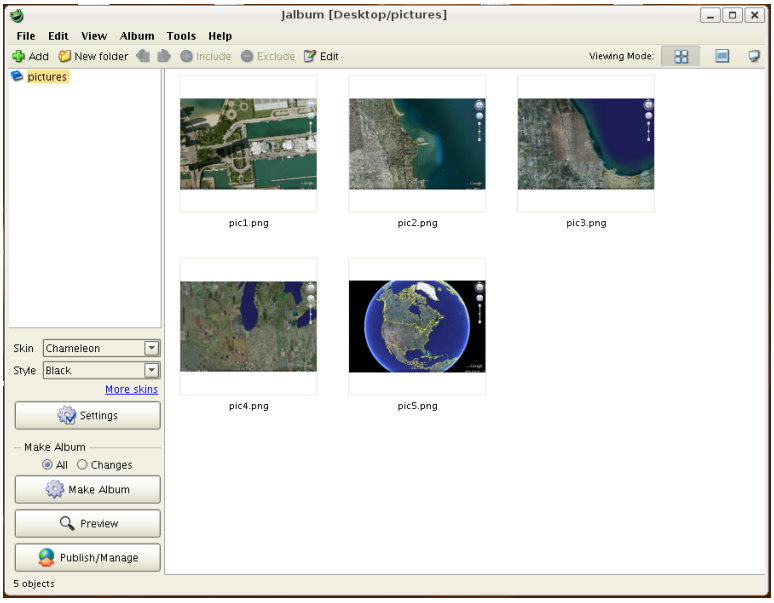
Function: Photo web slide show creator

Features: Makes it very easy to create professional quality image web sites, and even supports the posting of final sites to the Internet. A wide variety of built-in templates allows the creation of sites based on various themes, many of which can be adjusted or modified by the user. The process of site creation is fully automated once the user chooses the template and file containing images to be posted. ***JAlbum*** can even post completed sites to the Internet if you wish.

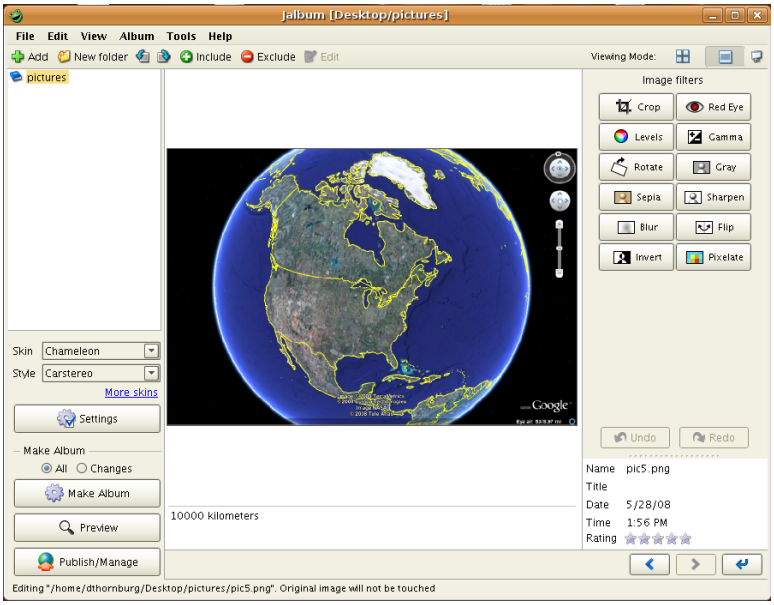
Basic operations: The designers of ***JAlbum*** have made it incredibly easy to build professional picture sites for the Web that even have slide show capabilities built-in. The basic process is quite simple. After launching ***JAlbum***, you'll see a blank area where you can drop a folder containing the pictures you want to include.



After dragging a folder with images to this window, thumbnail images will appear automatically.



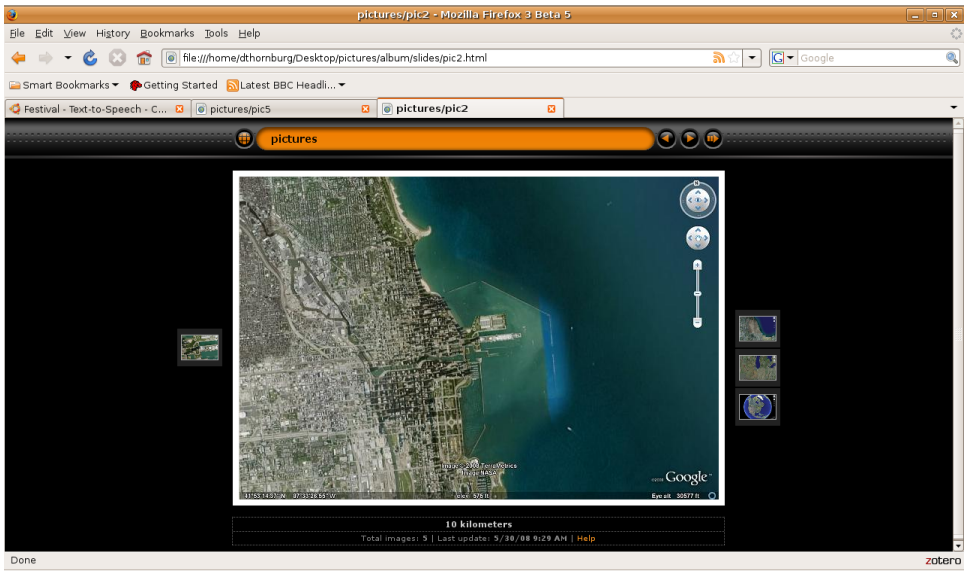
Next, you can choose from a variety of layout templates (be sure to experiment with these), and change some of the properties of the layout to customize it to your liking. If you click on any image, you can see a larger version that can be edited a little bit using the built-in tools for red-eye reduction, rotation, etc. You can also add text to your images to make them more descriptive.



Once you have everything laid out the way you want, just click on the **Make Album** button, and your photo web site will be built automatically and saved on your computer. If you have access to a Web site where your pages can be saved for others to see, you can upload your

completed project directly from *JAlbum* using the **Publish** button. You may have to check with your teacher to find out where your work can be saved.

Your completed Web site will look beautiful, and only requires a short time to create!

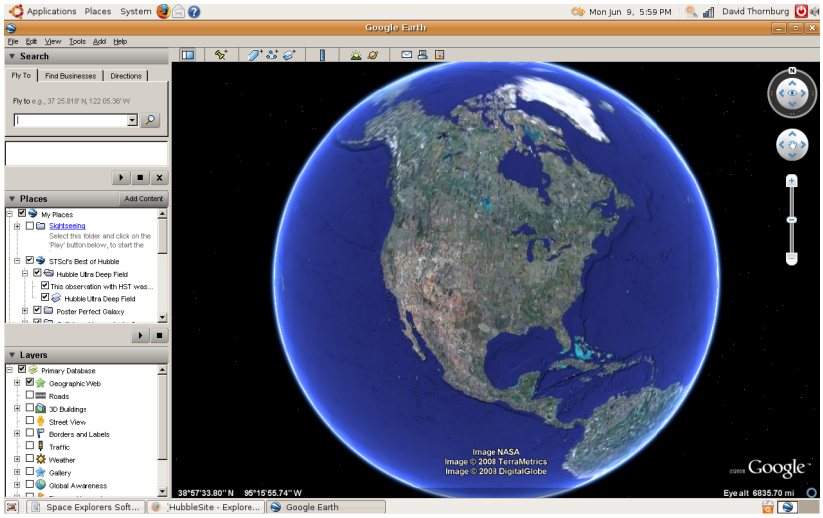


Title: GoogleEarth

Function: Interactive map of Earth and Space

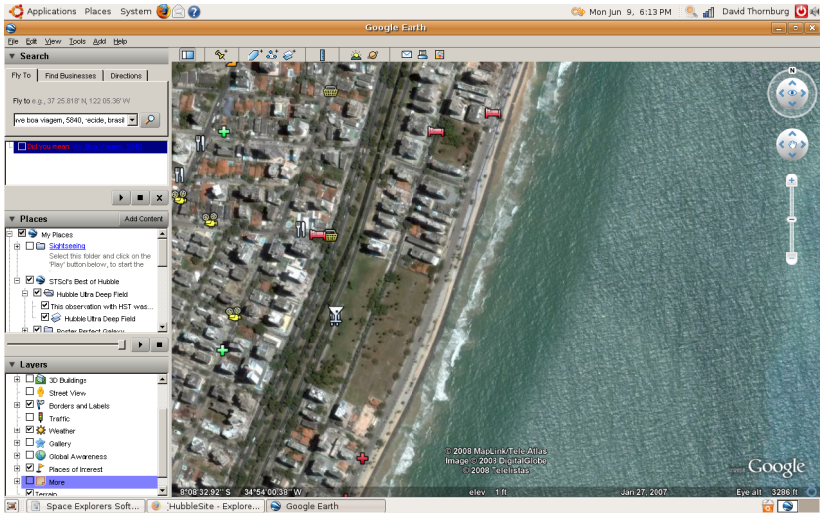
Features: Zooms to any place on Earth through a given address or geographical location. Supports manual pans and zooms and provides celestial maps and navigation as well.

Basic operations:
When you launch ***Google Earth***, you will see a view of the Earth. In order for ***Google Earth*** to work properly, you must be connected to the internet so the software can download detailed maps and other resources as needed.



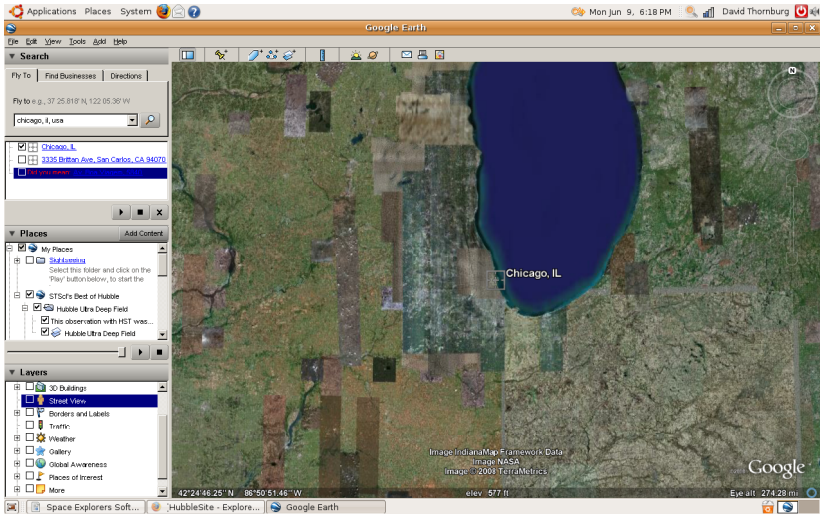
The view shows the entire planet as if it were bathed in sunlight. To get a more realistic view, you can click on the sunlight icon on the bar just above the Earth image. This view also provides a slider that lets you change time and see how the transition from day to night moves across the Earth.

One of the truly amazing features of ***Google Earth*** is the ability to zoom into a specific address pretty much anywhere in the world. For example, I can zoom in to see my apartment building in Recife, Brazil:

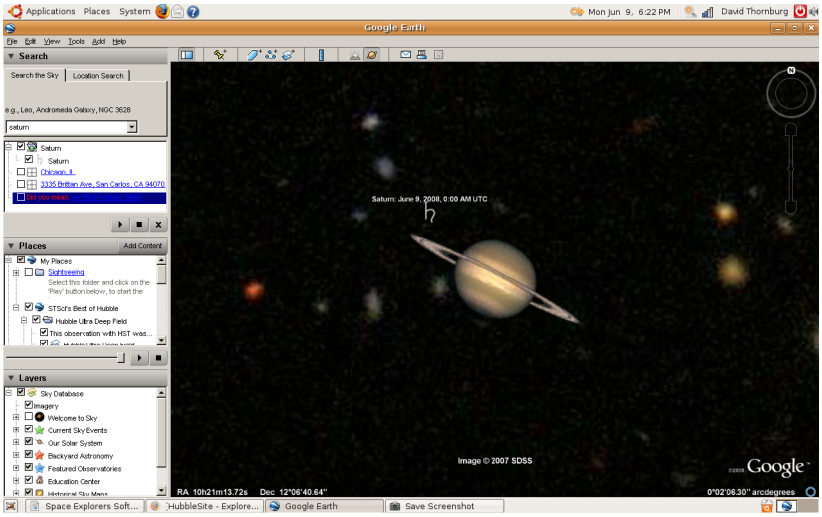


This ability is amazing. You should type in your address and see how close ***Google Earth*** comes to showing exactly where you live. You can add layers to your image to show the location of shops, or even of photographs of the area you or others have taken!

In addition to allowing you to navigate through addresses, you can also fly over the planet at any altitude and zoom in on areas of interest to you.



If you tire of looking at the Earth, just click on the planet icon at the top of the image and you will switch to the sky view of ***Google Earth***.



This view lets you navigate to planets and beyond. You can even add more celestial images to your sky database from the Hubble Space Telescope by visiting http://hubblesite.org/explore_astronomy/gsky/ and choosing the datasets you want to add.

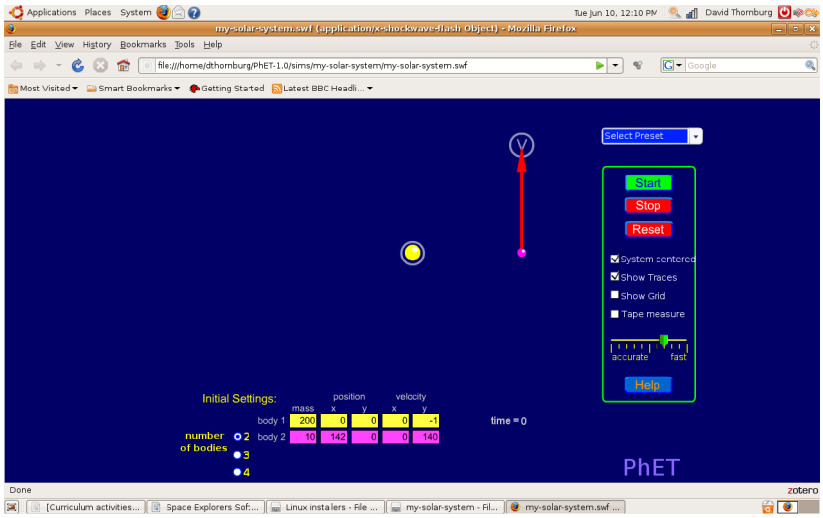
Title: PhET

Function: Orbit and other physics simulations

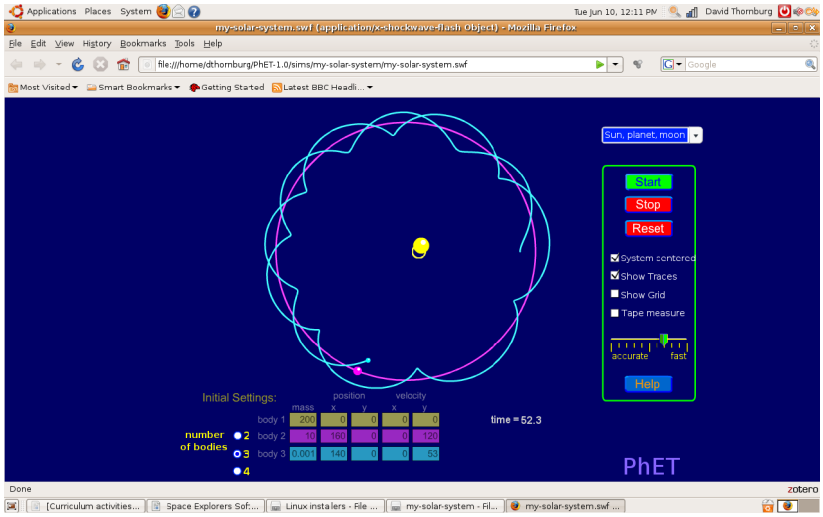
Features: Provides a series of small programs for modeling various physical phenomena, including the graphing of orbits of multiple objects around each other. Helps provide a concrete understanding of abstract concepts.

Basic operations:
The PhET software can be run from your web browser, or can be downloaded to run on your computer when you are not connected to the internet. This collection of over 50 small programs let you explore a variety of scientific topics through using models created as Java or Flash applications. If you have trouble running these programs from your computer when not connected to the Internet, it is better to run them when you are online. Just go to phet.colorado.edu to run or download the applications.

One application of particular interest to the first-year of the space explorers program is called ***my-solar-system***.

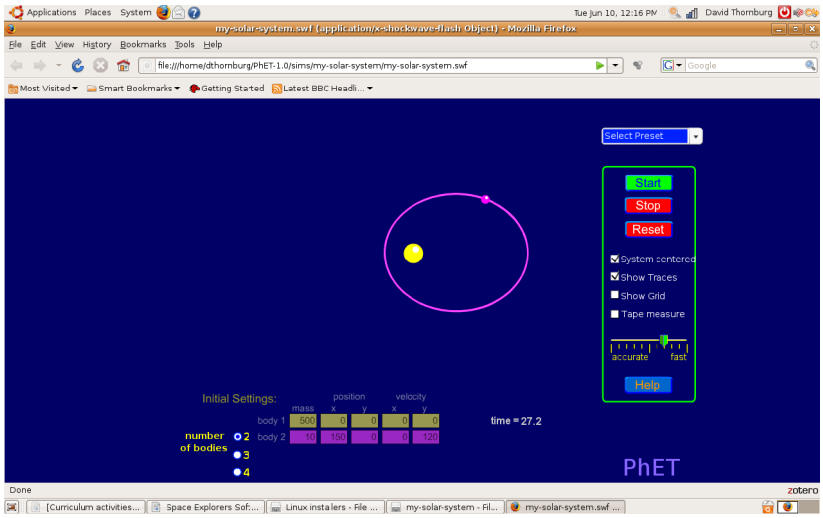


This application lets you experiment with orbits of objects rotating around each other. This application comes with some presets. For example, there is a preset for a planet with a moon rotating around a massive sun.



The lines show the paths taken by each of the objects. The sun, for example, has movement because of the gravitational attraction of the planet and moon. The moon rotates around the planet, but, since the planet is orbiting around the sun, the moon's path looks pretty complicated.

You can build your own models by changing the mass, starting position and direction of movement, and initial velocity. For example, if we increase the mass of the sun we can see a circular orbit turn into an elliptical one.



The beauty of this application is that it lets you experiment with various orbits so you can develop a feel for the interaction of various components of the system. The other applications in the series do a similarly great job of helping make abstract physics concepts easier to grasp.

Title: MathTrax

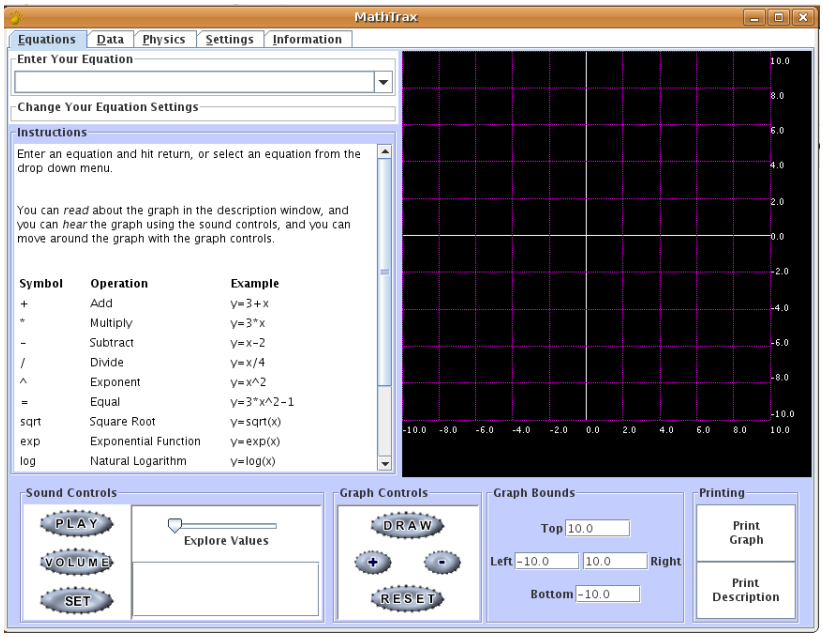
Function: Plots and describes algebraic equations in Cartesian and polar coordinates.

Features: Provides a written description of any equation entered in the system. Also provides plotting tools for rocket launches based on various data provided by the user.

Basic operations:
Algebra is essential for understanding lots of concepts related to space exploration, from the trajectory of rocket launches to the mathematics of orbits, algebra gets a workout in just about anything you study in this area!

The problem is that some algebraic ideas are tricky to understand. Graphs can be very helpful since they show, visually, what your equations are describing. ***MathTrax*** is one of the most powerful algebra programs I've found, and it can help you understand complex ideas!

When you first launch this program, you will see several windows:



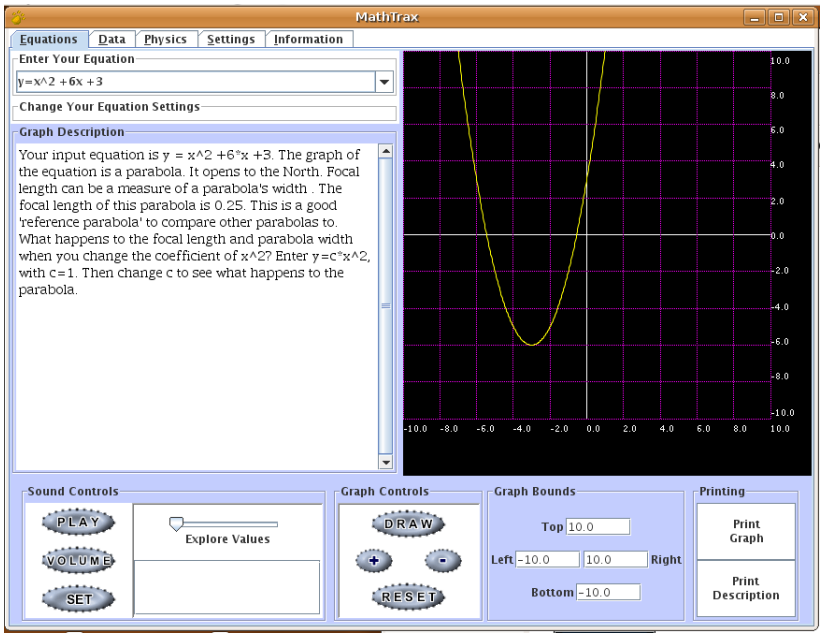
The window in the upper left of the screen is where you will type the equation you want to plot. For example, if you wanted to plot:

$$y = x^2 - 6x + 3$$

You would type:

y = x^2 -6x +3

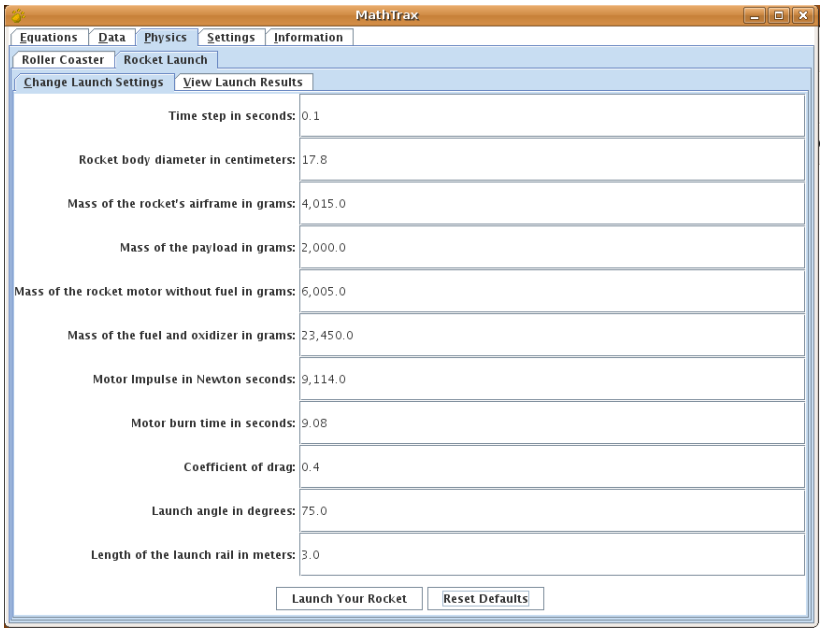
In this equation the use of the carat (^) indicates that the following symbol (2) is an exponent. As soon as we press the *Enter* key, we see two things happen. First, we notice the graph on the right side of the screen and, second, the text which appears the the box labeled *Graph Description*. This text tells us, in words, what the equation is all about! It is generated automatically by ***MathTrax***, and this feature is not found in any other algebra program I know about!



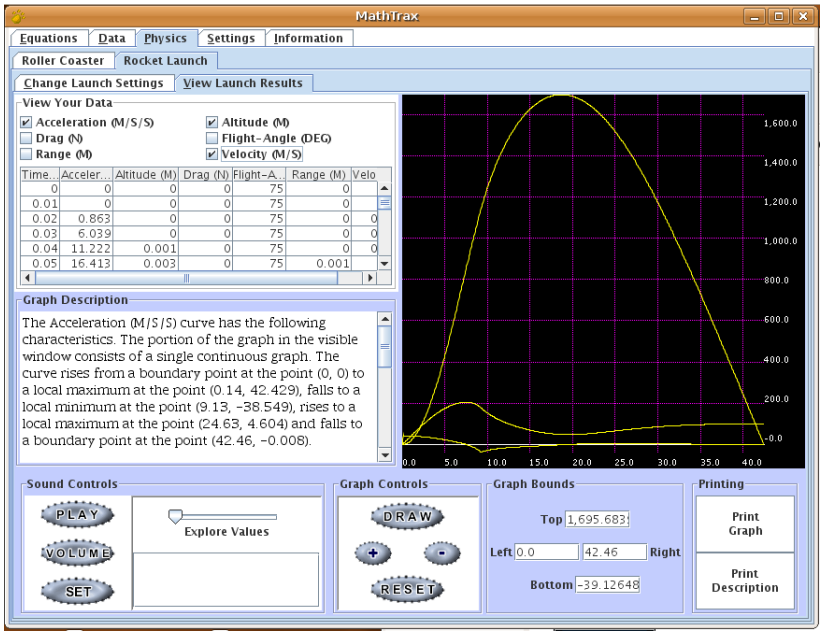
As amazing as this feature is, the NASA designer of this program, Dr. Robert Shelton, made it even more powerful. To see how, click your mouse on the *play* button at the bottom left of the screen. If your sound is turned on for your computer, you will hear a tone that changes pitch based on the height of the graph. This way you can not only see your graph and read a description of your equation, but hear your graph as the cursor moves along the horizontal axis! These features were added for anyone who has impaired vision, but I think they are of value to anyone, even if your vision is perfect. Algebra can be tricky, and any help is welcome!

In addition to being a great tool for exploring algebraic equations, ***MathTrax*** also has a rocket launch simulator built in. To use it, click on the *Physics* tab at the top of the screen, and

choose the *Rocket Launch* tab that appears. You will see a table where you can enter the details of the rocket design you want to test. Some of this data is easy to get, and some of it may require some additional measurements on the rocket's engine. Once you have the form filled out (it comes pre-filled with some data), you just click your mouse on the *Launch Your Rocket* button at the bottom of the screen, and then click on the *View Launch Results* tab near the top.



This switches you to a graphical view of the launch results. You can choose to plot one or more things at the same time. For example, I've chosen to plot the acceleration, velocity, and altitude of the rocket.



You can go back to the table view, change some of the numbers, relaunch your rocket, and see immediately what effect your changes had.

After working with ***MathTrax*** for awhile, you may find yourself developing a better understanding of algebra than you ever thought possible!