Balance of the Planet

by

Chris Crawford

Limited Warranty

Chris Crawford Games provides to the original purchaser of the computer software product, for a period o f ninety (90) days from the date of the original purchase, the following limited warranties:
Media: Chris Crawford Games warrants that, under normal use, the magnetic media and the packaging p rovided with it are free from defects in materials and workmanship.

APPLE COMPUTER, INC. MAKES NO WARRANTIES, EITHER EXPRESS OR IMPLIED, REGARDING THE ENCLOSED OMPUTER SOFTWARE PACKAGE, ITS MERCHANTABILITY OR ITS FITNESS FOR ANY PARTICULAR PURPOSE. THE EXCLUSION OF IMPLIED WARRANTIES IS NOT PERMITTED B Y SOME STATES. THE ABOVE EXCLUSION MAY NOT APPLY TO YOU. THIS WARRANTY PROVID ES YOU WITH SPECIFIC LEGAL RIGHTS. THERE MAY BE OTHER RIGHTS THAT YOU HAVE WHIC H VARY FROM STATE TO STATE.

Copyright Notice

Credits

Game Design: Chris Crawford
Art Direction: Amanda Goodenough
Macintosh Program: Chris Crawford
IBM Program: Phil Garofalo of Incredible Technologies
Jim Weisz of Incredible Technologies
IBM Artwork: Dale Kerkman, Jr., of Incredible Technologies
Manual Text: Chris Crawford
Manual Edit & Design: Susan Lee-Merrow of Lee-Merrow Communications
Box Design: Sean Barger of Equilibrium
Box Art: Ed Cassell of Equilibrium
Box Copy: Susan Lee-Merrow of Lee-Merrow Communications
Creative Consultant: Brenda Laurel
Additional Artwork: Peter and Caitlin Mitchell-Dayton
Jaimie Stevens
Deanna Thomas
QA Testing: Corey Nelson of Testing 1-2-3
Playtesters: Carol Balkcom
Heather Bryden
Barry Goetz

Eric Goldberg
Eric Hulteen
Phillip Livengood
Dave Menconi
Marylyn Rosenblum
Gregg Williams
Dale Yocum

Table of Contents

Introduction

What would you do if you suddenly had the power to tackle the earth's environmental problems? Do you think that you could make this earth a better and happier place to live? This game gives you that chance. You have been appointed High Commissioner of the Environment by the United Nations, and you now wield vast power to levy taxes on activities that impact the environment, and to use the money so derived to grant subsidies to environmentally beneficial activities. You are responsible for many aspects of human life on earth, and your performance will be measured against a variety of standards. This may prove to be more difficult than you had imagined.

Goal

Your goal in this game is to get points. You gain points for environmentally good things, such as preserving biodiversity. You lose points for environmentally bad things, such as people dying from air pollution. You try to influence the world so that the good things are maximized and the bad things are minimized.

A Quick Walk Through the Game

When you first start the game, you will see Planet Earth. Click the mouse anywhere or hit any key. A new screen appears with two lists of points. This is your Results screen. Near the top is your total score. On the left side are positive points that you earn for environmental goodness. On the right side are negative points that you lose for environmental crimes. Select "Skin Cancer Points."

The computer takes you to a screen called Skin Cancer Points. You will see a picture and some text explaining that you lose points for all the people who die of skin cancer. Along the right edge of the screen are some other items. In the lower right corner is a bar chart with just one bar. This bar chart shows the number of skin cancer deaths that have occurred during the course of the game. Since you haven't played yet, it doesn't show much. Don't worry, it'll get more interesting in future turns.

Just above the bar chart is a number; it represents the value of the latest bar on the bar chart, which in this case is also the only bar on the bar chart. An additional bar is added to the bar chart at the end of each t

urn. Later on, when the bar chart changes, you will be able to use this number to get a quick impression o f how much things have changed. If you select a bar in the bar chart, this number will change to indicate t he value of the bar on which you clicked.

Above the bar chart are two lists: "CAUSES" and "EFFECTS." The former lists all the factors that are cau ses of Skin Cancer Points, while the latter lists all the consequences of Skin Cancer Points. In this case, t here are no effects, and only one cause: Skin Cancer Deaths. Select that. The program will take you to th at screen, which has its own bar chart and lists of causes and effects. Note that Skin Cancer Points is an effect of Skin Cancer Deaths, and Ultraviolet Light is the cause of Skin Cancer Deaths.

Now, you're losing lots of points because of skin cancer, so you want to know why that's happening and w hat you can do about it, so you had better explore this problem a little deeper. Select "Ultraviolet Light."

You get a new screen explaining that ultraviolet light comes from the sun, but is absorbed by ozone in the stratosphere. You will note that there are several effects of ultraviolet light. For now, leave them; you wan t to find out what's causing all this ultraviolet light that's making the skin cancer that's killing people and co sting you points. So select the only cause of ultraviolet light: "Ozone."

Here's a screen that explains ozone. And the only cause of that is stratospheric CFC, so you had better s elect that. This takes you to Stratospheric CFC, and more explanation. The cause of that is tropospheric CFC, so you select that and go to the Tropospheric CFC screen. This is a long trip, isn't it? You're still not done, though, because, the cause of tropospheric CFC is CFC production. Select that and you get a des cription of chloroflourocarbons - CFCs. At least now you know what CFC means! And one of the causes o f CFC production is CFC taxes. Select that and you encounter a new and different screen.

This screen has a scroll bar that allows you to set the tax rate on CFC production. If you raise the tax, it wi ll discourage production of CFCs and thereby result in less chloroflourocarbons released into the atmosph ere. With fewer CFCs, there will be more ozone and less ultraviolet light, therefore fewer deaths from skin cancer and fewer points assessed against you. Sounds good, doesn't it? Well, there will be some other e ffects that may not be so good, but you can learn about these complications later. For now, go ahead and raise the tax on CFCs.

Now examine the "Game" menu on the menubar. There are numerous options here, but for now, select " Results." This takes you right back to the Results screen. Check out "Skin Cancer Points." Oh, no! It's the same - nothing happened! You wonder what gives. Since you raised taxes on CFCs, shouldn't that help? Well, of course nothing happened yet; you haven't given the world any time to respond to your new tax. Y ou'll see how to do that in a minute, but let's look at something else first.

Go to the "Game" menu and select "Policy Summary." You'll see a screen rather like the points screen, o nly it lists monetary figures. On the left side are the taxes that you levy, with the tax rate and the net recei pts that you get. On the right side are the subsidies that you are allowed to grant. You will note that the ch ange in the tax on CFCs is reflected on this screen. The numbers require some explanation.

The taxes are levied against activities on a per-unit basis. For example, your tax on CFCs is levied agains t each ton of CFCs manufactured. If CFC production falls to half its earlier value, then your tax revenues will fall by half. Other taxes are similarly levied on a per-unit-produced basis.

The subsidies are handled in a different fashion. You are required by the United Nations to pay for all pro perty damage due to air pollution, and subsidize other efforts with the remainder of your proceeds. Thus, t he program takes your total income from taxes and subtracts out the property damage claims against you . What is left over is divvied out to the various subsidies on a pro-rata basis. That is to say, each subsidy gets a percentage of the remainder. At the beginning of the game, each subsidy gets 8% of your remaind er. You can change that.

Choose a deserving subsidy that you would like to increase. Select its name, and you will be taken to the i

ts subsidy screen. There is a scroll bar that allows you to change its percentage of your excess budget. E xperiment with the scroll bar; you will note that the bar chart in the lower right corner changes to reflect yo ur action. The value above the scroll bar is the tax or subsidy rate, while the value in the bar chart reflects the actual dollar revenue going in or out. When you are done, select "Policy Summary" from the menu to go back to the Policy Summary screen. You will see that your subsidy has indeed been changed.

There are restrictions on your taxes and subsidies that prevent you from making overly rapid changes in t he tax rates. Part of the compromise that was reached in debate in the United Nations was the agreement that you would not be able to raise taxes sky-high overnight. The fastest that you can raise them is by 40 0% every five years. Faster rates of increase would create too many economic dislocations. If you want to raise the tax on an industry by more than 400%, you will have to raise part of it in this turn and part of it in the next turn.

There are no such constraints on the speed with which you can change the subsidies. However, you are r equired to balance your budget. The program will not permit you to increase your total subsidies to a level higher than 100% of your treasury. So if you want to dramatically increase the subsidy to, say, Wood Sto ves, then you will first have to decrease the subsidy to something else. The percentage points that you fre e up by taking away from one subsidy can be given back to any other subsidy.

Your basic strategy, then, will be to levy taxes and grant subsidies in an effort to increase your point score . What makes this difficult - and interesting - is the complexity of the environmental problems you face, an d their interconnectedness. The only way to appreciate this complexity is to move through the system of c ause and effect presented in the game. This will take you some time; there are 150 different screens to ex plore. But this is also part of the fun. You can navigate through this network of cause and effect, seeing h ow environmental problems are all intertwined. If you get lost, or want to get your bearings, you can alway s select "Results" or "Policies" to get back to familiar territory.

When you have explored the game to your satisfaction, and set all your taxes and all your subsidies, go to the Results screen and select "Execute Policies" from the menu. The computer will go away for a few sec onds while it calculates all the environmental effects of your actions. When it comes back, you will see ho w your score has changed. Oh no! It went down! You must have done something wrong!

No, you haven’t. You inherited a seriously screwed-up planet that is going steadily downhill. Your job is to turn things around, but there is nothing you can do that will solve all our environmental problems overnig ht. So, for the first few turns, things will get worse and worse. If you do a good job, things will start to impr ove after a few turns, and your score will become positive.

There is one other screen that will help you figure out what you’re doing right and what you’re doing wron g. While you’re in the Results screen, select the option labelled,"Feedback." It will take you to a screen th at lists your biggest problems as well as your successes. The lists apply to the current turn only and shoul d help you decide what you need to do next. This is an information display only; when you’re finished look ing at it, return to the Results screen.

Your goal, of course, is to get lots of points. You have nine turns to play the game. After the ninth turn, in t he year 2035, the game is over and your score becomes your measure of success for that game. That’s a ll there is to it!

How to Win

At first, you will be frustrated by this game. Your score will go down and down, and you won’t be able to s ee exactly why at first. Be patient - environmental problems are tricky, and you are going to have to exert some effort to get on top of them. After all, if environmental problems were so simple that anybody could fi gure it out in a flash, we wouldn’t be in this mess, would we?

Winning this game is easy once you come to understand the cause-and-effect relationships at work. Ther e are a lot of interrelationships; and, if you fail to catch on to the connections, you can lose the game. For example, earlier in this manual I mentioned that you might want to increase the tax on CFCs to save the o zone layer. There is a problem with this: CFCs are also necessary for industrial production. If you cut dow n on CFC production, industrial output will be reduced, which will have damaging effects on other areas. T hus, you can't just clamp down blindly on CFCs. And this general principle applies throughout the game. Watch how the point scores change and identify the most serious problems. You can't solve every enviro nmental problem, but you can put a lid on the worst ones.

Taxation is the key to success. You must not be timid about quadrupling taxes on some of the activities. R emember, the initial tax rate is only 1% of the value of the good, so even if you quadruple it once, it will stil l amount to only 4% of the value, which is not by itself enough to discourage production. Remember, too, t hat taxes are the source of your income; they pay for all the good works you subsidize. So tax some activi ties heavily...

...but not all activities. Remember, if you shut down all industry, you will probably make matters worse in many areas. So be selective!

I will give you one hint: you probably do want to tax the bejabbers out of CFCs. If you fail to shut down CF C production quickly, the long-term damage to the ozone layer may be catastrophic. Even if you do shut d own CFC production completely, the CFCs already released into the environment will probably continue t o do a lot of damage.

Saving and Loading the Game

Oh, no! You're smack dab in the middle of a hot game and thirtysomething (or Wheel of Fortune, dependi ng on your tastes) comes on the telly and your VCR is on the fritz! What now? Well, there is a feature on t he menu called "Save Game." If you select this item, you will be able to save the game in its current state and then quit. Hours, days, or even years later you can start the game, select "Load Game" from the men u, and be right back where you were when interrupted.

Level 2:
Playing Other Biases

You've played the game a few times, you've had some fun, and you're ready to broaden the horizons of t he game. You've come to the right place, podner, because there's a feature that makes the game much more interesting. To use it, simply start up a fresh game, and select the "Load Bias" menu item. You must load the bias file immediately before you do anything else. You can only load a bias file at the very begin ning of the game, when you see the title screen with the words, "Balance of the Planet."

The computer will ask you what bias file you want to use. Try the "Pro-Nuclear" bias file for now. The com puter will load it and begin the game. This time, though, things are a little different.

The basic equations that make the simulation work have been modified in a way that favors nuclear powe r over all the other energy forms. This is because you are now looking at the world through the eyes of a p erson who is strongly in favor of nuclear power. You are seeing the world with his biases, his beliefs, and his prejudices. It's a very different world, and it demands a different set of policies.

The rules that operated in the original game have been changed, so the simulation will behave differently. To win, you'll now have to pursue policies that favor nuclear power. Whether or not you agree with these biases, you will find it an educational experience to see this version of the way things are.

You don't have to play just the Pro-Nuclear bias. You can also play with any of the four bias files included

with the program, and described below. Each offers its own way of looking at the world; each emphasizes different problems and different solutions; each will require that you walk a mile in another person's moca ssins. The environmental crisis is immensely complex, and to see it from many different angles is to gain a broader appreciation of its magnitude. If you can win the game with each bias, you will have learned a g reat deal.

Pro-Nuclear Bias

This bias file presents the view of an advocate of nuclear power. According to this bias, nuclear power is s afe, clean, cheap, and abundant. It paints a picture of nuclear power as the only alternative to fossil fuels. In this bias, coal is particularly dangerous and dirty, and solar energy is impractical. To win, you must do e verything possible to encourage the growth of nuclear power, while discouraging other forms of energy us e.

Environmentalist Bias

This bias file offers a view of the world that might be embraced by an environmentalist. There are as man y species of environmentalists in the world as there are of beetles in Amazonia, so this bias file represent s only a rough amalgam of a disparate group. It sees all industrial activity as dangerous and polluting; it pl aces great value on the preservation of life on earth. To win in this bias, you must move quickly to replace our reliance on fossil fuels with reliance on solar energy, dams, and energy conservation. Be warned, tho ugh, that the environmentalist bias is rather pessimistic, so winning may be difficult.

Industrialist Bias

This bias is as optimistic as the environmentalist bias is pessimistic. The industrialist thinks that the world is in great shape, that environmental problems are overblown, and that what we need is more of the same . Thus, all the predicted problems of global warming, ozone depletion, soil erosion, and so forth are given short shrift, while the material values are emphasized. If you do nothing in this bias, you'll still win. Techno logical optimism is high, so money spent on research will yield big results.

Third World Bias

This bias tackles the disparities between the North and the South. It asserts that all human life is equally v aluable, and adjusts the point system accordingly. This dramatically shifts the game towards the problem of starvation and away from such "minor" matters as lung disease, which, after all, affects a comparatively few Northerners. It is less concerned with preserving nature, for the appreciation of nature's beauties, in t his bias, is a luxury that only well-fed people can appreciate. This one is difficult to win. Starvation is your top priority.

Level 3: The Formulas

You've played the game with several different biases and you've enjoyed yourself, but you're still hankerin g for more. My, my, you do have a voracious curiosity! Well, there's still more to this game, an entirely ne w section of play that will take you much deeper into the structure of the environmental problems that bed evil humanity.

Changing the Formulas

If you wish, you can make your own bias files, just like the Pro-Nuclear bias file and the Industrialist bias file. In the process, you will confront some serious technical and ethical issues. It is all to be found behind a little menu item "Formula" in the "Game" menu. Let's look at an example:

Fire up the game and go to the Results screen. From there, select "Skin Cancer Points"; from that screen select "Skin Cancer Deaths." You are now looking at the famous "Here Lies Fred" tombstone. Good. Select the "Formula" menu item, and you will see a completely new screen:

This screen presents the equation used by the simulation; it explains the equation and allows you to modify it.

First comes the formula itself. In this case, the equation says that the number of skin cancer deaths is equal to the incidence of skin cancer multiplied by the amount of ultraviolet light reaching the ground.

Next comes the RETURN box. Select this if you want to go back to the main screen - or just press RETURN on the keyboard.

Next comes the proportionality constant; in this case, it's Skin Cancer Incidence. Its current value is shown (241 thousand) next to a scroll bar. Under that is the variable; in this case it's ultraviolet light. Its current value is also shown, along with the unit of measurement (0.414 watts per square meter).

Lastly comes some text that explains the equation and any special factors that pertain to it.

So what you have here is a simple little formula that shows you how the simulation calculates the number of people who die of skin cancer each year. It's nice to know that, isn't it? But after considering this equation carefully, you may decide that it is not correct. Suppose, for example, that you think this equation is too bloodthirsty. Suppose you say, "C'mon, Crawford - not that many people will die of skin cancer!" That's fine with me; why don't you fix the equation? Just change the value of the proportionality constant (Skin Cancer Incidence) with the scroll bar until it is just right.

If you find it confusing that you can change the constant and not the variable, it's because the terms refer to what is going on during the "Execute Policies" portion of the gameplay, when all the formulas are executed. During execution, the constants don't change; they stay at the value set on the Formula screen. On the other hand, the variables do change as a result of the execution of other related formulas. For example, as the amount of ozone increases, the variable for ultraviolet light increases, because more wattage per square meter is reaching earth.

Changes in the formula will not produce any effects immediately; that will happen during "Execute Policies."

Most of the equations are fairly straightforward, such as this one of Skin Cancer Deaths. A few, though, are more complex and will require some mathematical sophistication. An appendix on page 31, "Quickie Math Refresher," might be useful if you get stuck.

Limitations on Your Freedom

There is a ceiling and a floor on every number you can set in the equation. For example, the value of Skin Cancer Incidence must lie between 10 thousand and 1 million. There are two reasons for limiting the range. First, we are trying to simulate reality - people don't drop like flies at the merest whiff of ultraviolet light, nor are they utterly invulnerable to ultraviolet light. Second, if you take the numbers too far afield, the equations will blow up, and you will crash the game.

However, even with the limits, you can still crash the simulation. Basically, you have the keys to a sports car and guard rails have been erected in front of all the dangerous curves and cliffs; you can still crash the car if you push it too hard. If you do crash, no harm will be done. The computer tells you that an error has occurred, and the program will terminate. Try again with more conservative numbers.

Subjective Issues: Values

The real fun with the formulas comes when you tackle highly subjective issues. For example, just how dangerous is radioactive waste from nuclear power plants? How expensive is solar energy, how dirty is coal burning, how destructive can strip mining be? You have lots of opportunity to tailor this game to your own opinions.

In fact, you even have the option of setting the value of human life. To see what I mean, go to the Results screen, and from there go to the screen titled Skin Cancer Points. Select "Formula," and get a load of this equation:

Whoa! This has suddenly gotten very heavy! Here is a number that quantifies the value of one human life. Given all our values about the sanctity of human life, this is an almost heretical concept. Perhaps it offends you. But the issues raised by this equation cut straight to the very heart of the environmental problems we face. The environmental crisis is not, ultimately, a technical issue nor an economic one. The root causes of the environmental crisis are the values that we live by.

We value many things. We value material well-being, such as having nice cars, good food, comfortable homes, and the like. We value human life and seek to preserve it. We value nature, deriving joy from its pristine beauty and its myriad of creatures. The problem is that the things we value are now coming into direct conflict with each other. If we want to drive our cars, we will create air pollution that threatens human life and damages nature. The CFCs that we use to manufacture our electronic devices will damage the ozone layer, therby killing plants, animals, and people.

Now, we can take a black-and-white approach to these problems. If cars make air pollution, then ban all cars. Get rid of all the CFCs. Shut down all the nuclear power plants and factories and anything else that makes pollution. But these polluters also do social good. They make things that billions of people all over the world value, things like food, clothing, and shelter. A black-and-white approach will throw out the baby with the bath water.

We need to weigh the benefits offered by these activities against the costs they impose. This process of weighing benefits against costs is fundamentally a quantitative process. Exactly how important are nice cars? Just how bad is it when one person dies because of air pollution? Are a thousand cars worth one human life? A million?

Society handles these problems through the price mechanism - assigning a dollar value to each of the activities and then allowing the marketplace to determine the results. However, in this game, a point value is set on all value-laden activities. Each good or bad thing is worth some number of points. I set up the game with some numbers that I think are correct, but they represent my own opinions. You are welcome to change them to reflect your own values.

Saving and Loading Biases

The collection of all those constants used in all the formulas is called the "Bias File." Together, they constitute an entire set of values, opinions, and judgments about the world. Once you have gotten them all adjusted to the state you want, you can save them to your hard disk so that they will be available another time. To do this, just select "Save Bias" from the "Game" menu. The computer will ask you to name the bias fi

le. Later on, when you restart the game, you can use the "Load Bias" menu item to reload all your own bia s numbers.

If you are a teacher, you can set up your bias files to suit the educational needs of your students, and the n have them play using those biases. You have a great many options here.

When you save a game with the "Save Game" option, it automatically saves the biases as well. This coul d cause you some confusion if you save a game with one set of biases, then change the biases, and then load the old saved game. In this case, you'd be back to the biases that you had when you saved the gam e. Reload the biases to avoid this little problem.

How Accurate is the Simulation?

You've played the game a few times and you've learned much. But you wonder just how much confidence you can place in the lessons you have learned. How do you know that the lessons it is teaching you are c orrect? Just how much can you trust the game?

Because the game is a simulation, it necessarily falls short of reality. The degree of detail that I built into t he simulation doesn't always reflect the complexities of the different phenomena. I deliberately excluded a great many factors in my effort to make it easier to play and more understandable.

For example, the chemistry of ozone in the stratosphere is a very complex subject. There are a number of chemical reactions affecting ozone that depend on such things as temperature, the amount of sunlight hit ting the atmosphere, and even the amount of dust and ice crystals in the air. I boiled all that complexity do wn to a single cause and effect: the amount of ozone depends on the amount of CFC in the stratosphere, because CFCs are the most important factor in the destruction of the ozone layer. This kind of simplificati on has been used throughout the simulation.

I have also built many of my own beliefs into the game. These beliefs are based on a good deal of resear ch (see "Bibliography"), as well as my own values and prejudices. You have some protection from my prej udices, since you can modify the proportionality constants in the equations. However, there remains a hid den form of prejudice that you can't change: the equations themselves.

Take, for example, Radiation Cancer. The equation in this simulation says that Radiation Cancer is propor tional to the amount of radiation exposure that we generate for the population as a whole. As it happens, t his has been bitterly debated within the scientific community. Scientists arguing for the Threshold Hypothe sis say that, below a certain level, radiation has no effect on people. Scientists espousing the Linear Hypo thesis say that, even at very low levels of radiation exposure, there is still a chance that radiation can hurt people. This issue has not been resolved, because it is very difficult to prove miniscule effects spread ov er a large population.

If the Threshold Hypothesis is true, the low-level radiation that nuclear power plants emit is probably not h urting anybody at all. If, on the other hand, the Linear Hypothesis is true, nuclear power plants are certain to kill some people. This simulation uses the Linear Hypothesis, not out of any political bias, but because t he linear equation used by the Linear Hypothesis is easier to understand and manipulate than the more c omplex equation used by the Threshold Hypothesis.

There is also the lack of time lags. All of the equations in the game are basically carried out instantaneous ly. But in reality, lots of environmental problems express themselves years after the triggering event. For e xample, most environmentally induced cancers remain latent for about twenty years before they turn on, b ut this simulation shows them happening immediately after the exposure.

Another inaccuracy is the lack of technical substitution in the economic system. For example, CFCs are tr eated as an industrial necessity. There is no provision for the possibility that research chemists will disco ver some new compound to take their place. Some people think that science can solve all of our problem

s. Why should we make sacrifices today when the scientists will surely come up with some whizbang doo dad that will make our problems go away? I didn't want to encourage this attitude by including technologi es that don't exist. This is a WYGIWYG simulation: what you've got is what you get. No fantasies allowe d.

There is also no direct economic substitution in the game. In the real world, if the net price of a commodity rises, people will change their behavior to substitute something else for it. Sometimes these substitutions are very indirect. If the price of petroleum rises, the price of jet fuel and hence air fares will rise. Some peo ple will respond by relying more on the telephone to handle business transactions. Unfortunately, showing this effect properly would be too complex.

So what's the bottom line? Is this simulation accurate or isn't it? Well, it's as accurate as I could make it while keeping the game understandable, playable, and fun. Hopefully, it will enhance your understanding of the environmental problems we face. If you find it interesting, if you find yourself asking deeper questio ns, then I urge you to delve into other sources of information, to get different points of view. Explore some of the books in the bibliography. It's a big world out there.

Technical Notes

This section is for those people who love to get into the gory details of the simulation. There are some dis crepancies between what the game says it's doing and what is actually happening. They are all minor, but if you're the type who whips out his calculator, takes notes, and compares figures, you may have noticed two small differences. For you, read on, MacDuff.

One discrepancy arises from the difference between one-year rates and five-year turns. For example, if th e birth rate is 2%, and the population is 10 billion, then on the next turn, the population will not be 10.2 billi on. Remember, the birth rate is 2% per year, but one turn covers five years, so the population will be a bit higher than 11 billion (because of compounded growth rates). Because of the difference between the one-year rates presented for everything and the five-year turn, it is not possible to accurately predict exactly h ow a number will change for the next turn.

Then there's the price-supply loop. You probably noticed that most of the commodities have the price acti ng as both cause and effect for supply. That's because the two are intertwined in the real world, with high er prices making possible increased supplies, which will in turn lower prices. It is possible to find an analyt ical solution to the problem, but that gets us into some hairy mathematics. I therefore decided on a simple r approach. The simulation uses the displayed equations, but they are executed inside a loop that runs ei ght times per year. The price is averaged with the previous value of the price. This creates a relaxation al gorithm in which the price slowly approaches its equilibrium value with the supply.

Designer's Notes

My feelings about this game range from great pride in its many creative achievements to near-shame for t he many sloppy corners I had to cut. I faced three big problems that had to be overcome in the design of t his game: the huge intellectual breadth of the problems, the intrinsic "numberiness" of the situations, and t he problem of bias.

The first problem gave me fits. A good game designer looks for some simplifying factor, some way of pres enting the issues in a common format. That factor, which I call the "key element" of the game, must be ins tantly recognizable to the player and easily manipulable. But environmental problems don't fit into any nea t slots. They're scattered all over the intellectual map, involving industrial, technical, financial, legal, cultur al, and emotional issues. My solution was to accept the lack of a key element and use a hypertexty syste m that showed the awe-inspiring complexity of the interrelations. Rather than try to boil environmental iss ues down to seven key factors, I decided to present the entire mess in all its glory, and trust that the user would be able to handle it.

The second problem I call "numberiness." This is the fact that so many environmental problems turn on e soteric numbers. Television and newspapers like to show dead seagulls and smelly garbage dumps, but t he real action often lies in issues so rarefied that numbers are the only way to present them. How much o zone is left in the stratosphere? How many hectares of forest land have been destroyed this year? What's the atmospheric concentration of carbon dioxide? Any game that tackles these problems is going to over whelm the user with a mountain of statistics. I faced the prospect of creating a game about as exciting as your local spreadsheet.

I used a number of tactics against this problem. First was the emphasis on the delightful images that Ama nda Goodenough created. They have an innocent and nurturing flavor that reassures the player. Second, I used bar charts to present the numbers, relying on a graphic image to present the most important inform ation. Third, I presented the number itself in fine print just above the bar chart, to suggest to the user that he really need not concern himself with the precise value of the number itself. And fourth, I relegated the r eally hairy number stuff (the Formula display) to a background screen that the player can completely skip.

The solution to the third problem is the source of my greatest pride and remains my greatest fear. How to handle the problem of bias in a field that is so intrinsically biased? My solution - allowing the player to adju st the values that quantify the biases - adds an entirely new dimension to the game. It lets the player com e backstage in the simulation and control many of the critical factors. Not only does this empower the play er, but it also challenges him to closely examine his own beliefs. I am particularly pleased with the manner in which this highlights the moral dilemmas arising out of the quantification of the value of human life. Thi s is a tough and difficult issue that some people don't have the courage to face. I like the fact that the gam e raises the matter so powerfully.

On the other hand, the game retains a great many personal biases that lie beyond user control. I am painf ully aware that I will be shot at from both sides of the environmental spectrum. There is bias built into the f orms of the equations, into the limits imposed on the constants, and into the choice of factors to include. If I were a genius, I could have created a design that all sides would applaud as insightful, thorough, and fa ir. Alas, such greatness eludes me. A little more RAM would have helped, too.

Acknowledgements

A great many people contributed to the creation of this product. First among these was my wife Kathy. No w, it is common for authors to credit their spouses for the emotional support they provided during the man y months that it took to create the work of art, etc. etc. Kathy played a much more significant role. She wa s a business partner, financial officer, operations manager, and all-around decision-sharer. She had a voi ce in just about every major decision I made, sometimes the only voice. We've been through hell together getting this thing out the door. And our marriage seems to have survived the test.

Amanda Goodenough was the second major player in this project. Amanda's official credit line says "Art Director," but she did more than that. During the crucial early design phase of the project, she and I spent a great deal of time together hammering out the concepts behind the game. She critiqued my ideas, sugg ested some of her own, and helped me give form to the developing design. On top of that, she created m ost of the artwork for the game, added the colors, and managed the other artists.

Brenda Laurel acted as a Creative Consultant, primarily on matters of user interface design. She made a great many suggestions for improving the cleanliness of the design and saved me from at least one major blunder. Her husband, Eric Hulteen, thumped his User Interface Guidelines bible at me in a vain effort to bring me to the path of user interface righteousness, but I remain a sinner. Mea culpa, mea culpa, mea m axima culpa!

Susan Lee-Merrow wore so many hats, she deserves some sort of award for quick-change artistry. She cr itiqued the design, playtested the game, wrote the marketing plan, edited this manual, designed and prod uced it, wrote the box copy, advised us on business matters, and managed the public relations for the proj

ect. She flies jet fighters in her spare time, and her long-term goal is to eliminate hunger and promote worl d peace. (I made up that last sentence.)

Dale Yocum provided a readily bent ear and a penetrating analysis of the user interface problems of the g ame. He playtested it and helped with the overall tuning and polishing problems.

Dave Menconi provided professional-level playtesting. Dave found many flaws in the most subtle aspects of the gameplay. You will never encounter the scores of tiny nits that Dave picked out of the tangled fur of this game.

Phil Garofalo of Incredible Technologies handled the difficult process of converting the program from its or iginal Macintosh form to something that would work on an IBM PC . In the best of circumstances, this is a difficult task, but I made it doubly difficult by changing the program even as Phil worked on it. Dale Kerk man, Jr., and Jim Weisz also contributed to the 90-Day Wonder Port.

Thanks also to Peter and Caitlin Mitchell-Dayton, Jaimie Stevens, and Deanna Thomas for artwork; NAS A for the image of the earth; Cliff Johnson for his bargain-basement color ideas; Ed Cassell for the magnif icent artwork for the box; and Sean Barger of Equilibrium for the package design.

Finally, thanks go to the many people who playtested the game and enriched it with their comments: Eric Goldberg, Heather Bryden, Gregg Williams, Steve Axelrod, Carol Balkcom, Marylyn Rosenblum, and Phil lip Livengood.

Quickie Math Refresher

So you’re a little intimidated by all the math stuff in the game? Don’t be - it’s really just stuff you learned in high school. So, to refresh your memory:

Strange numbers (e.g., "3.65e-5")

This is a variation on scientific notation. It’s a very compact way of expressing almost any number. The ex ample number is read as "3.65 times ten to the minus 5 power." It is the same as .0000365. That’s 3.65 w ith four zeros in front of it. 3.65e8 would be 365000000. It’s not the number of zeros that we count, but ho w many places the decimal point has been shifted.

Why do I saddle you with such a confusing system, you ask? In the first place, writing out all those zeros gets clumsy. In the second place, it causes all sorts of problems with the computer program. If I had a nu mber like 4.19e-27, then I’d have to print all 26 zeros before I came to the "419" part; I would run off the e dge of the screen and out onto your desk. In short, those numbers just don’t fit in the screen space availa ble. So I have to use this notation. Look on the bright side; next time you want a raise, just tell your boss y ou want only 1e5 dollars. Maybe it’ll work.

Log

This stands for "logarithm." Now, logs may seem really bad, but you don’t need to understand all the theor y to use them in this simulation. All you need to know is this: a log takes a big number and squishes it do wn to a much smaller number. For example, the log of 10 is 1; the log of 100 is 2; the log of 1,000 is 3, an d the log of 1,000,000 is 6. I use logs to keep dangerous numbers under control.

For example, suppose that I have a number that could go shooting through the ceiling. It starts off as 2.4 but could explode up to as much as a billion. Slapping a log on it is like tying a heavy-duty rubber band to its nose and its feet. If it tries to stretch taller, the rubber band will hold it back. It can still grow, but slowly.

Sqrt

This stands for "square root." This is another number-squishing function, only it's not as strong as a log. For example, the sqrt of 10 is 3.16; the sqrt of 100 is 10; the sqrt of 1,000 is 31.6; and the sqrt of 1,000,000 is 1,000. I like to use sqrt on less rambunctious numbers. It's like a kinder, gentler rubber band.

Sqik

This is what ducks do when you hold them in your lap.

Variables

A variable is a number in an equation that could be almost anything. For example, consider this simple situation: you're on a Wonder Diet that promises to lose 2 pounds a day. Then the equation for your weight loss is as follows:

Total Weight Loss = (2 pounds per day) * Days on Diet

In this equation, "Days on Diet" is a variable. It could be anything, and the equation would still be true. If you are on the diet for one day, then you will lose two pounds. If you are on the diet for two days, then you will lose four pounds. If you are on the diet for 10 days, then you will lose 20 pounds. No matter what number you plug into "Days on Diet," the equation will work. Thus, we call "Days on Diet" a variable. It doesn't matter what number you plug into the formula, it will still work.

Constants

A constant is a number that doesn't change. This is in contrast to a variable, which is expected to vary. A constant is expected to stay the same. So how come the constants in this game can be changed? Doesn't that make them variables? Not really. My intent is that you change them only once, at the beginning of the game, and then let them remain constant during the game. If you really want to vary them during the course of the game, I won't stop you. But you'll get weird results, that's for sure.

Glossary

Exajoule: An exajoule is equal to 1018 (one quintillion) joules. That's a lotta joules. What's a joule? A joule is a unit of energy used in the metric system. It is named after that famous scientist, Joe Joule. Technically speaking, a joule is equal to the amount of work done when a force of one newton is applied over a distance of one meter. That doesn't help, does it? OK, how about this: when you hoist your body up a single step in a flight of stairs, you expend perhaps 100 joules worth of energy. When you lift a floppy disk up to put on a shelf over your head, that's about one joule worth of work. Thus, one exajoule would be enough to propel you up ten quadrillion steps, which should be enough to get you up to the CEO's office. One exajoule would lift a quintillion floppy disks from your desk to the bookcase over your desk, but be quick about closing the bookcase door or they'll all spill out!

Goodies: This is my very own unit for measuring Consumer Goods. This is an arbitrary unit; I just made it up. Does that mean it's wrong? No, it just means that it can't be compared with anything in the real world. Its only use if for comparing Consumer Goods for different years with each other.

Happies: This is my very own unit for measuring how happy people are. I use it in the Northern Lifestyle, Southern Lifestyle, and Quality of Life screens. Like Goodies, this is an arbitrary unit that I made up. All by itself, it doesn't mean much.

Hectare: This is the metric version of an acre. An acre is, of course, the amount of land enclosed by a square 160 rods on a side. You don't know what a rod is? OK, how about this: an acre is equal to 4,840 square yards. Or 43,560 square feet. Still confused? OK, try this: there are 640 acres in a square mile. There are, by the way, about 2.5 acres in one hectare. A hectare is the amount of land enclosed by a square 100 meters on a side. There are 10,000 square meters in a hectare. That's a silly way to measure area, isn't it?

Person-Rem: This unit measures the total radiation dose that a population receives from some activity. It's equivalent to one person getting one rem, or ten people getting a tenth of a rem each, or any other such combination. OK, so what's a rem? Well, that's an acronym for rad equivalent in man. Rad is an acronym for radiation absorbed dose. It is equal to one hundredth of a joule of ionizing radiation per kilogram of tissue.

Riparian: Things associated with bodies of water and their borders.

Annotated Bibliography

- - . The Global 2000 Report to the President. New York: Penguin Books, 1982.
President Carter commissioned this huge and detailed projection of resource and environmental issues. When it was completed, President Reagan ignored it. If you want facts and figures, this book has them.

- - . "Special Issue: Managing Planet Earth." Scientific American, September, 1989.
I include this magazine because it covers many of the issues addressed by the game. This offers a more technical approach to the problems.

Beckman, Petr. Health Hazards of Not Going Nuclear. Boulder, CO: Golem Press, 1976.
This is a cantakerous, sarcastic, and utterly hilarious defense of nuclear power. Beckman's caustic jabs at anti-nuclear claims hit the mark all too often. He occasionally gets carried away with his rhetoric, but it's fun reading for the open-minded - and may even change your mind about some aspects of the nuclear power controversy.

Brown, Lester. State of the World 1989. New York: W. W. Norton; 1989.
A series of chapters on major issues facing humanity. Each chapter presents a lot of meat on the problem. Environmental issues dominate, but there is also material on AIDS and global demilitarization. The same group also offers a series of pamphlets on environmental issues, loaded with thorough research; I highly recommend these.

Goldsmith, Edward, and Nicholas Hildyard. The Earth Report. Los Angeles: Price, Stern, Sloan, Inc., 1988.
This is a left-wing view of environmental problems. A little shrill and alarmist in places, it nevertheless offers some useful observations.

Gribbin, John. The Hole in the Sky. New York: Bantam Books, 1988.
A discussion of the problem of ozone depletion. Slightly muckraking in style, not overly technical.

Lovins, Amory. Soft Energy Paths. Cambridge, MA: Ballinger Press, 1977.
This is a brilliant theoretical book that raises fundamental questions about the way in which we utilize the energy resources available to us. A must read for anybody seriously interested in energy policy issues. Be careful, though: Lovins plays fast and loose with his numbers, and all of his mistakes seem to further his political program.

Myers, Dr. Norman. Gaia: An Atlas of Planet Management. New York: Doubleday, 1984.
This is a great book! At first it looks like just a big pretty-pictures book, but it is loaded with solid information, and the numerous full-color charts, diagrams, and illustrations greatly improve the presentation of subj

ects that can be tedious. Some of the opinions are a little too left-wing for me (such as the fawning praise for the labor-intensive Chinese agricultural system) but these are exceptions. If you have time for only on e book on environmental problems, this is the one to get.

Thompson, William Irwin. Gaia, A Way of Knowing. San Francisco: Lindisfarne Press, 1987.
A strange book that takes a philosophical approach to environmental problems. Very countercultural in st yle.

World Commission on Environment and Development. Our Common Future. New York: Oxford Univers ity Press, 1987.
Also known as the Bruntland report, this book examines the overall environmental issues facing the plan et. It takes a very even-handed tone while calling attention to the gravity of the situation.

Individual Topics

This section of the manual presents additional information on the topics presented in the simulation. Most of the topics have an entry that follows; however, some are handled in groups - and a few have no entries at all.

This list tells you where to look in the following pages for particular topics that are grouped:

To find this topic:	See this entry:
Ave Energy Price	Price
Basic Research	$ Subsidy
Beef Tax	Tax
Biodiversity	Points Life Points
BioResearch	$ Subsidy
CFC Tax	Tax
Coal Price	Price
Coal Research	$ Subsidy
Coal Tax	Tax
Computer Games	Pts April Fool’s
Dam	$ Subsidy
Dam Price	Price
Fall	Points Death Points
Family Planning	$ Subsidy
Fertilizer Tax	Tax
Forest Life	Points Life Points
Heavy Metal	Points Death Points
Heavy Metal Price	Price
Heavy Metal Tax	Tax
Inundation	Points Death Points
Lake Life	Points Life Points
Land Abuse	Points Death Points
Logging Tax	Tax
Lung Disease	Points Death Points
Marine Life	Points Life Points
Natural Gas Price	Price
Natural Gas Tax	Tax
Nuclear Price	Price
Nuclear Research	$ Subsidy

To find this topic: See this entry:

Nuclear Tax Tax
Oil Price Price
Oil Research $ Subsidy
Oil Tax Tax
Pesticide Death Pts Death Points
Pesticide Tax Tax
Quality Points Life Points
Rad Waste Points Death Points
Radiation Points Death Points
Recycling Center $ Subsidy
Skin Cancer Points Death Points
Solar Energy $ Subsidy
Solar Energy Price Price
Solar Research $ Subsidy
Starvation Points Death Points
Sustainability Points Life Points
Tot Heavy Met Use Total
Total Coal Use Total
Total Nat Gas Use Total
Total Nuclear Use Total
Total Oil Use Total
Wood Stove $ Subsidy