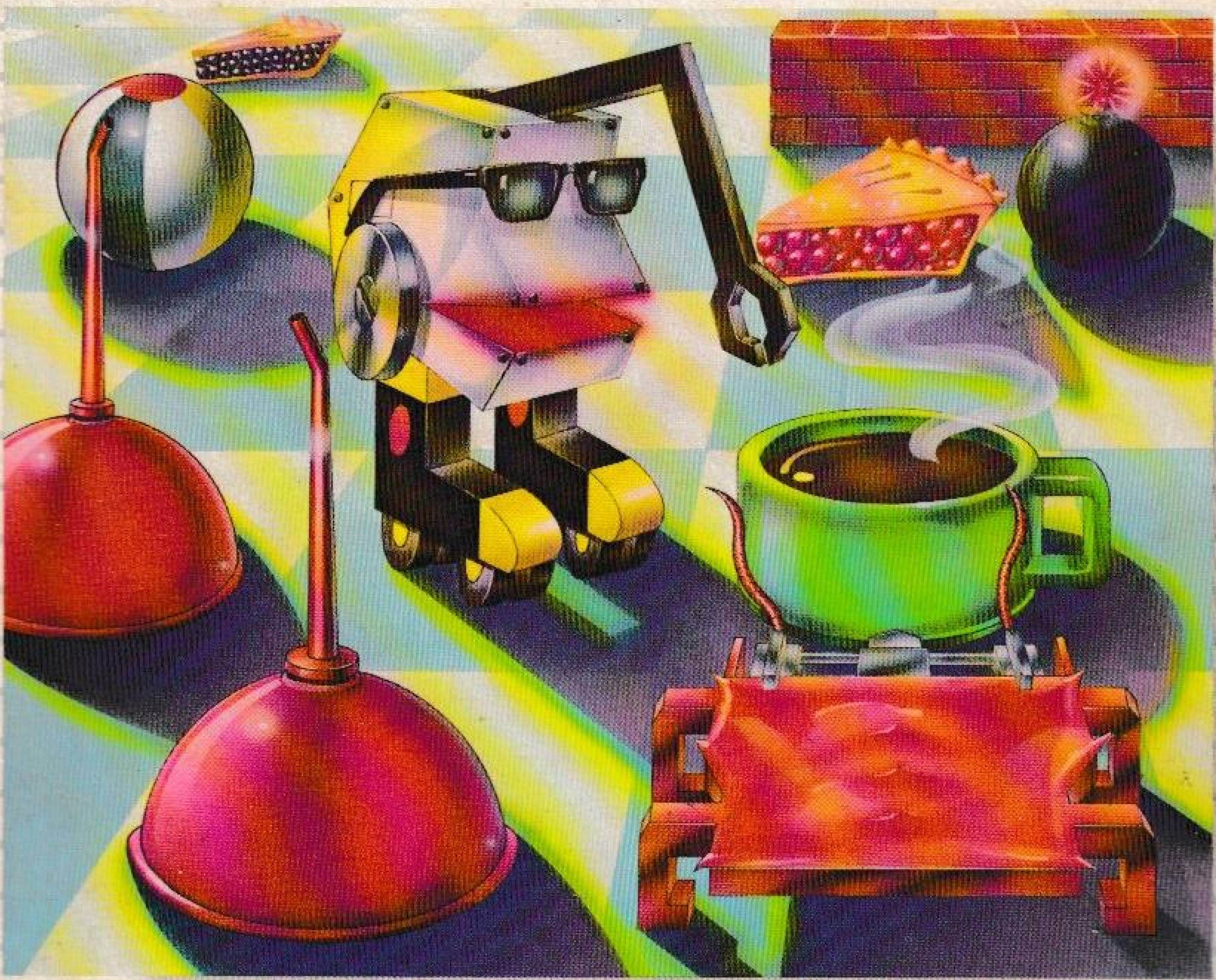
A product of BRAINPOWER

CHIPWITS™

Robots You Teach to Think for Themselves

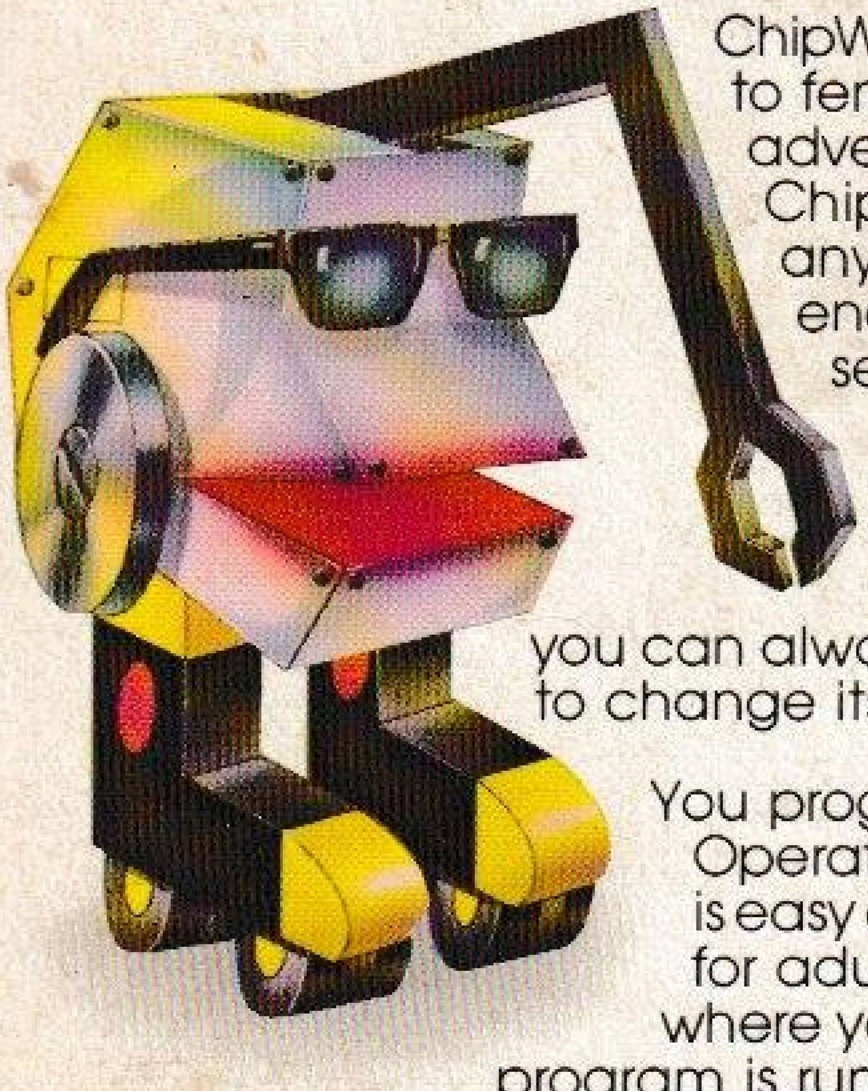


- A Challenge for Ages 12 thru Adult
- Introduces computer programming
- No programming knowledge required
- Develops problem solving and reasoning skills

For 128K and 512K Macintoshes and the Macintosh XL with Macworks XL • Imagewriter optional

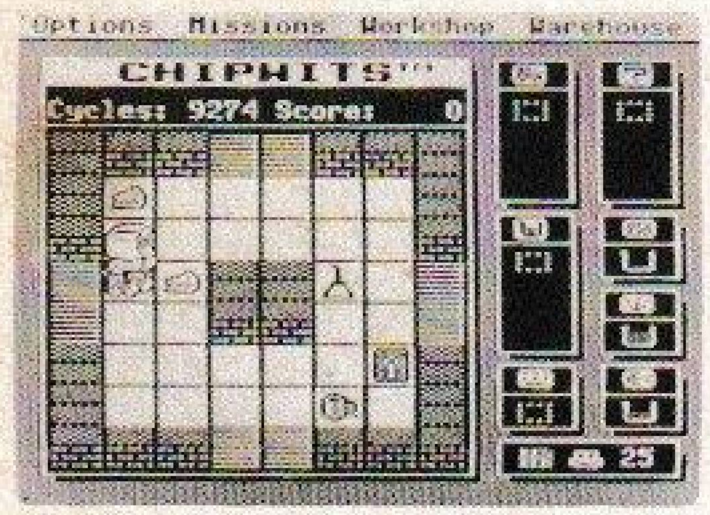
CHIPWITS™

. . . easy to get started on . . . virtually limitless in complexity . . .
In a world where most educational software is on an intellectual pair with Saturday morning cartoons, ChipWits is like public television's Nova USA TODAY

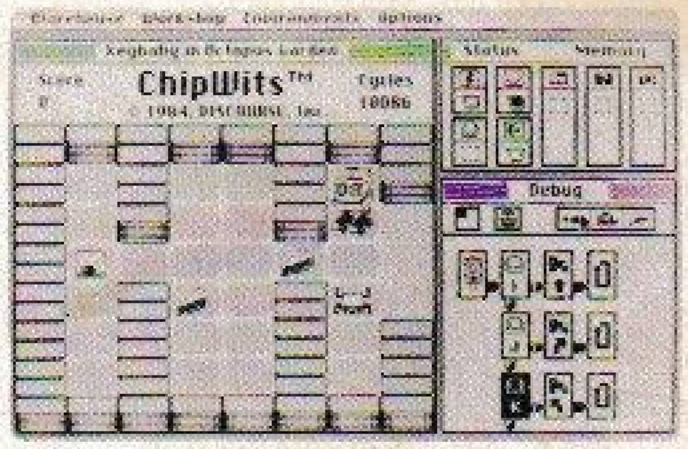


ChipWits are computerized robots you program to fend for themselves in eight different adventure environments. You can teach a ChipWit to do just about anything: move in any direction, avoid enemies, attack enemies, search for food using different senses, even sing songs! Once you are ready, send your ChipWits on a series of exciting, dangerous missions of increasing difficulty. Will they succeed? Will they even survive? It's up to you. And you can always send a ChipWit back to the workshop to change its behavior.

You program ChipWits using IBOL (Icon Based Operating Language), a picture language that is easy enough for kids, yet sophisticated enough for adults. A debug panel lets you see exactly where your robot program needs work while the program is running the robot. Programming your ChipWit sharpens your own problem-solving and reasoning skills.



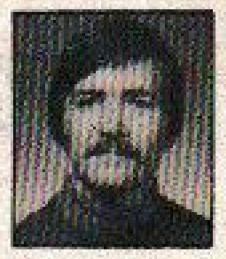
Apple ChipWits Environment



Macintosh ChipWits Environment

"Revolutionary . . . Leaps over other educational and game packages . . . We predict without hesitation that ChipWits will become a cult favorite . . . THE MACAZINE

Authors



Doug Sharp.
Author of electronics & physics courses for Control Data Corporation.

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Co-author. Instructional programmer. Instructor at the University of Minnesota.

BRAINPOWER, INC. 24009 Ventura Blvd., Calabasas, CA 91302 818-884-6911

What every teacher and parent should know about instructional software

by Sherwin A. Steffin, President, BrainPower, Inc.

Computer software can be a powerful educational tool. But to get the most out of it, teachers, parents, and learners should know that different software is designed to teach in different ways.

As a professional educator, I recommend avoiding sugar-coated methods known as "edu-tainment" or "educational games." These approaches have been shown to be ineffective.

Serious instructional software can take one of three basic forms. When properly prepared and presented, each has a useful place in the educational process:

Tutorial software is designed to teach specific new subject matter.

Drill and Practice is designed to reinforce skills or knowledge one already has.

Discovery Learning aids to develop fundamental intellectual skills such as logic, memory, and problem-solving. This is the approach used in all BRAINPOWER educational software. Instead of teaching a particular subject, our software concentrates on the development of critical thinking and reasoning processes – all within the framework of stimulating and challenging program concepts.

The goal of BRAINPOWER is to help people learn how to learn. We believe that this is the most valuable aspect of the educational process, because these skills carry over as general intellectual tools that can be applied to a variety of other, unrelated situations.

Sherwin Steffin is a pioneer in the field of educational software, and is nationally known as a designer of instructional materials at the high school and college levels. He holds a master's degree in instructional Technology, and has 13 years of teaching and administrative experience.

Electronic Education magazine has named him as one of its "People Shaping Educational Computing."

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ChipWits Macintosh Quick – Start Set Up.

1. Insert disk in Macintosh and turn computer on.
2. When "Ready when you are." screen appears, pull down ENVIRONMENTS menu and select START MISSION.
3. Now the ChipWit Greedy is exploring the Environment Greedville.
4. In the lower right hand window is the Debug panel. This shows the program running Greedy. Click on the shoe icon in the top row of the Debug panel. Now the program running Greedy executes at the rate of one chip for each mouse click.
5. Click your mouse. Look at the chip that the program executed after each click and see what Greedy does. Can you figure out what the chips are telling the robot to do? After reading the beginning of the manual, it will be easy!
6. Now click on the hummingbird icon in the top row of the debug panel. The program and Greedy are back operating at top speed. Want to learn how to program your own ChipWits? The User's Manual has all you need to know!

ChipWits Apple Quick–Start Set Up

1. Insert the disk in your 64K Apple II, II+, IIe, or IIc and turn the computer on.
2. When the title page appears, click Button 0 on your joystick, click your mouse, or click a Button your Koala Pad™ to continue.
3. Use what ever peripheral you have attached to your Apple (joystick, mouse, or Koala Pad™) to move the screen cursor to the word MISSION in the menu bar. Click on MISSION and the Menu is displayed.
4. Keep you Button depressed and move the cursor to highlight the first menu choice START MISSION. Release Button.
5. Now the ChipWit Greedy is exploring the Environment Greedville.
6. Want to learn how to program your own ChipWits? The User's Manual has all you need to know!

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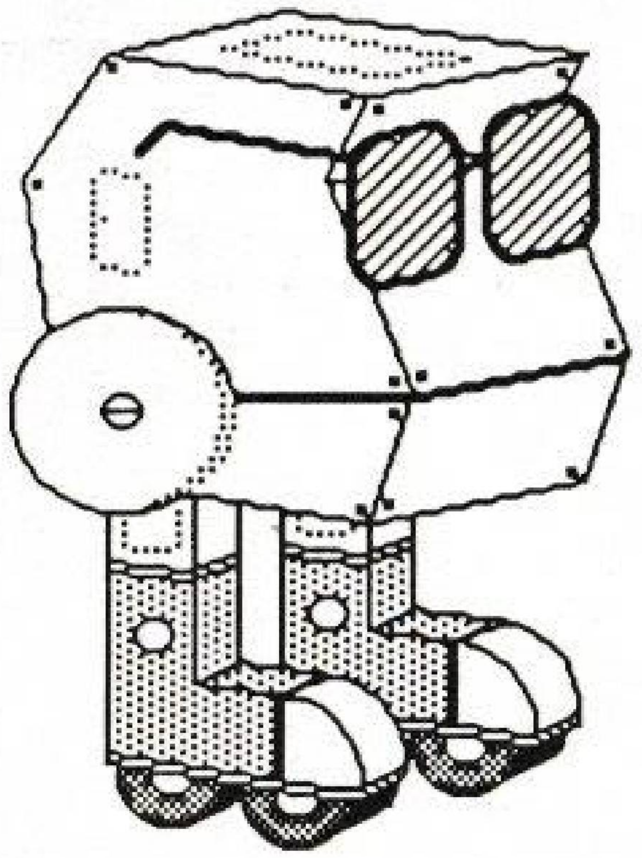
CHIPWITS™

by Doug Sharp and Mike Johnston Version 1.1

Ready when you are.



For Macintosh

Acknowledgments

The development of software is a task that requires the participation of many people from many disciplines. The design and programming of ChipWits was done by Michael Johnston and Doug Sharp. Sherwin A. Steffin served as project manager. Joseph Koenka managed the quality assurance and testing phases of development with the help of David White, Eileen Spinner, and Adam Zalesny. ChipWits' documentation was written by Michael Cuneo. Additionally, BrainPower would like to thank all the ChipWit users who took the time to share with us the expertise they gained with the product.

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Introduction

Robots are becoming a part of our everyday lives. Their presence has moved from science fiction to reality in only a few short years. Robots first made their appearance in steel mills and automobile factories. As they became more precise and intelligent in their operation, they made their way into new areas such as law enforcement and the exploration of dangerous environments. Now they are becoming available for the home in small but increasing numbers. The ChipWits system gives you an opportunity to experiment with programming a robot in a variety of missions. ChipWits also helps sharpen your logical reasoning and problem solving skills. As you develop these skills in your robots, you will develop them in yourself as well.

In summary, ChipWits is a robot-programming simulation and a tool for learning new problem solving skills.

THE MANUAL

This manual is designed to make it easy to use the ChipWits system. We begin by showing you around the system and letting you see a ChipWit in action. Next, you get a thorough lesson in ChipWit programming. This ends with a detailed analysis of a ChipWit. The final section of the first chapter provides details about the different ChipWit Environments (where missions take place) and about statistics kept on ChipWit missions.

Chapter II shows how to use some of the advanced features of the ChipWit system to program more efficient and effective robots.

Appendix A (The Rogues' Gallery) offers four ChipWits for study and refinement. The manual ends with a Glossary of ChipWit terms.

Introduction

Throughout the manual, bold type is used in two ways. Usually, names are put in bold type to alert you that you should locate that thing on the Macintosh screen. Occasionally, bold type is used to refer to section titles in the manual.

Finding Your Way

The Table of Contents at the beginning of the manual will help you find where specific topics are discussed in the text. If you encounter terms unfamiliar to you, use the Glossary at the back of the manual to understand how each of these terms is used in the ChipWits system.

To help you program your ChipWits, a Quick Reference Card is included. This will help you select the elements you use as you program each ChipWit.

HARDWARE REQUIREMENTS

To operate ChipWits, you will need a 128K or 512K Macintosh with the mouse and keyboard connected. ChipWits will also work on a Macintosh XL operating under Macworks XL. An Imagewriter printer must be connected if you wish to print the Workshop and Environments screens. **However, a printer is not required for using this system.**

Chapter 1: Operating ChipWits

INTRODUCTION

After you read this Chapter you will be able to:

1. Program ChipWits to prepare them for specific missions.

2. Enter any ChipWit into a mission and critically observe its performance.

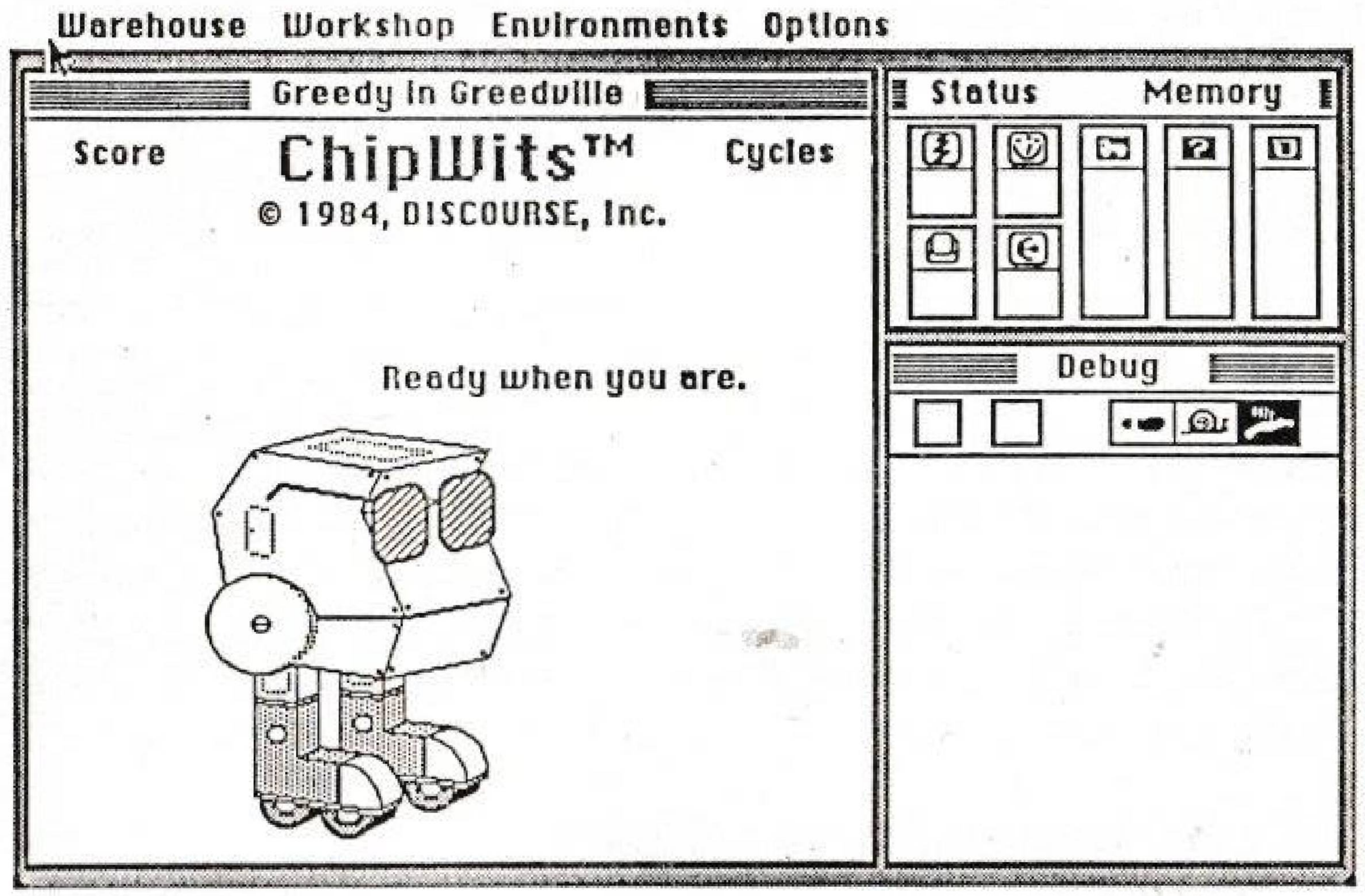
3. Modify a ChipWit, based on observing it on a mission, to improve its performance.

Start Up

Let's begin.

1. Insert the disk in the Macintosh. Turn the computer on.

2. The BrainPower identification screen will come up. After a few moments, the ChipWits opening screen appears. It looks like this:



ChipWits Menu Bar

The Menu Bar across the top of the screen has the choices **Warehouse, Workshop, Environments,** and **Options.**

Warehouse Menu

The Warehouse is where ChipWits are stored. Click on its menu and pull it down.

There is room for sixteen ChipWits in the Warehouse. The first two have been programmed already. They are named Greedy and Mr. C.W. Unprogrammed ChipWits are represented by numbers.

The ChipWit name or number with the check mark next to it is the default ChipWit. This ChipWit will be used in the Workshop (where ChipWits are programmed) and the Environments (where ChipWits go on missions) until you select another ChipWit.

ChipWits are either in outline or boldface type. (Greedy is in outline type and Mr. CW is in bold.) Outlined names represent ChipWits which have been designed specifically for the current Environment. (To see which Environment is the current one, pull down the **Environments** menu and see which is checked.)

Workshop Menu

The Workshop is where ChipWits are named, programmed, and re-programmed. Click on and pull down the **Workshop** Menu. You have the standard Macintosh Cut, Copy, and Paste capabilitites in the Workshop. This means that work you do on one ChipWit can be transferred to another or shifted around inside the same ChipWit.

We will return to the Workshop soon.

Environments Menu

Environments are places where the ChipWits undertake missions. (A mission is when a ChipWit explores an Environment. You evaluate and reprogram your ChipWit based on how it does on missions.) There are eight ChipWits Environments: Greedville, ChipWit Caves, Doom Rooms, Peace Paths, Memory Lanes, Octopus Gardens, Mystery Matrix, and Boomtown. Each one offers the ChipWits (and their programmers!) different challenges, dangers, and goals.

Environments are either in outline or boldface type. (Greedville is in outline type, the other seven are in boldface.) Outlined names represent Environments for which the current ChipWit has been specifically designed.

The first two menu choices on the Environments menu are **Start Mission** and **Series.** Start Mission puts the current ChipWit (the one in the Warehouse with the check mark next to it) in the current Environment (the one in the Environments Menu with the check mark next to it) and begins a mission.

Series runs an unending string of missions with the current ChipWit in the current Environment. Series gives you an accurate average score for a ChipWit if you let it run the robot through enough missions. You can terminate a series by selecting **Last Mission** (when Series is running, the menu choice Series become Last Mission) from the Environments menu. Once this has been selected, when the mission the ChipWit is currently on ends, the series will be over. If you select **End Mission** (when Series is running, Start Mission becomes End Mission) from the Environments menu, the series will immediately terminate. This is not the best way to end a series, however, since the score of the abbreviated final mission will be averaged into the ChipWits performance statistics. (Statistics are kept automatically on each ChipWit and displayed at the end of every mission.)

Options Menu

The Options menu has five selections: **Print Screen, Print Panel, Sound Off/On, Debug On/Show Stats**, and **Quit**.

Print Screen will print out the current ChipWits screen provided an Imagewriter is attached and turned on. This selection will print out both Environment and Workshop screens.

Print Panel prints out just the Environment panel during a mission or the panel being programmed when you are in the Workshop. The windows on the right of the screen (Status, Memory, Debug, Stats, Operators and Arguments) are not printed. Printing panels from the Workshop is a good way to back-up your work.

Sound Off/On is a toggle switch selection that merely turns the ChipWit noises off (if they are on) or on (if they are off).

Debug On/Show Stats is another toggle selection. It allows you to change the display in the lower right of the Environments screen from the Debug Window to a Statistics Window. When you are working on programming your robot, you will probably want the Debug Window since it shows you where you need to reprogram. When you are running a Series to get an average score, you are probably not even sitting at the computer, but merely checking in from time to time. Therefore, you will probably want the Statistics Window.

The ChipWit executes faster when the Statistics Window is on screen than when Debug is on.

Quit returns you to the Macintosh desktop. If you are editing in the Workshop, changes you have made to a ChipWit are lost if you do not save them before you select Quit.

To restart ChipWits from the desktop, simply double click on the ChipWits icon.

A Trial Mission

Before you begin programming your own ChipWits, let's see what a ChipWit does in an Environment on a mission. If you have not already done so:

1. Insert the ChipWits disk in the Macintosh drive and turn the computer on.

2. Wait for the BrainPower screen to come up. A few seconds later, a screen with a large ChipWit saying "Ready when you are" appears.

Now you can begin a mission.

1. Pull down the **Warehouse** Menu. Is **Greedy** selected? If it isn't, select Greedy.

2. Pull down the **Environments** Menu. Is **Greedville** selected? If it isn't, select Greedville.

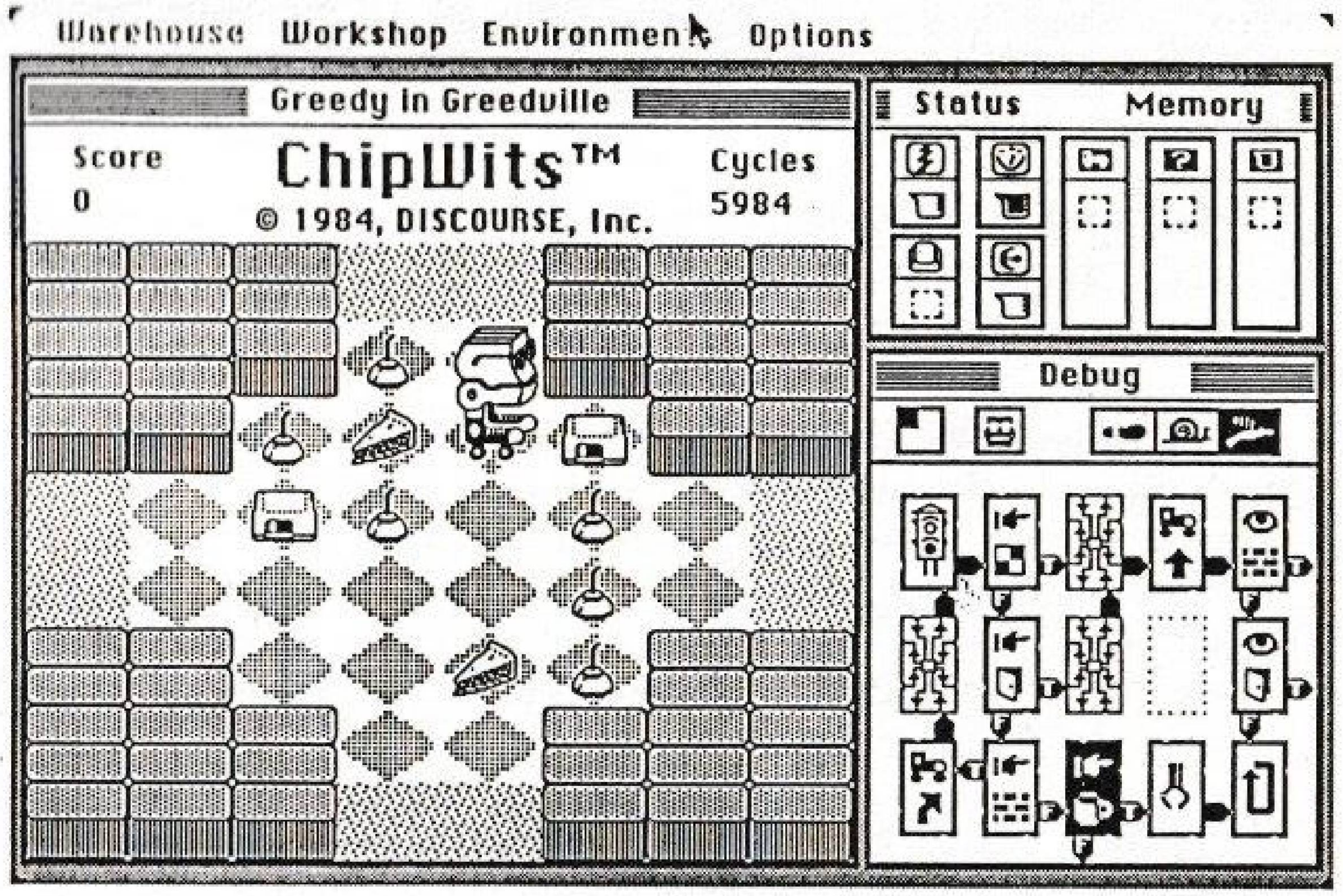
3. Pull down the **Environments** Menu again. This time, select **Start Mission.**

4. Before we begin our tour of the Environment, observe Greedy and his efforts in Greedville for as long as you like.

The next section explains the various components of the screen you are watching now. Leave the ChipWit running as you read on. If all the beeping and roller-skating distracts you, pull down the **Options** menu and select the third choice, **Sound Off.** If the mission ends, select Start Mission (from the Environments Menu) again.

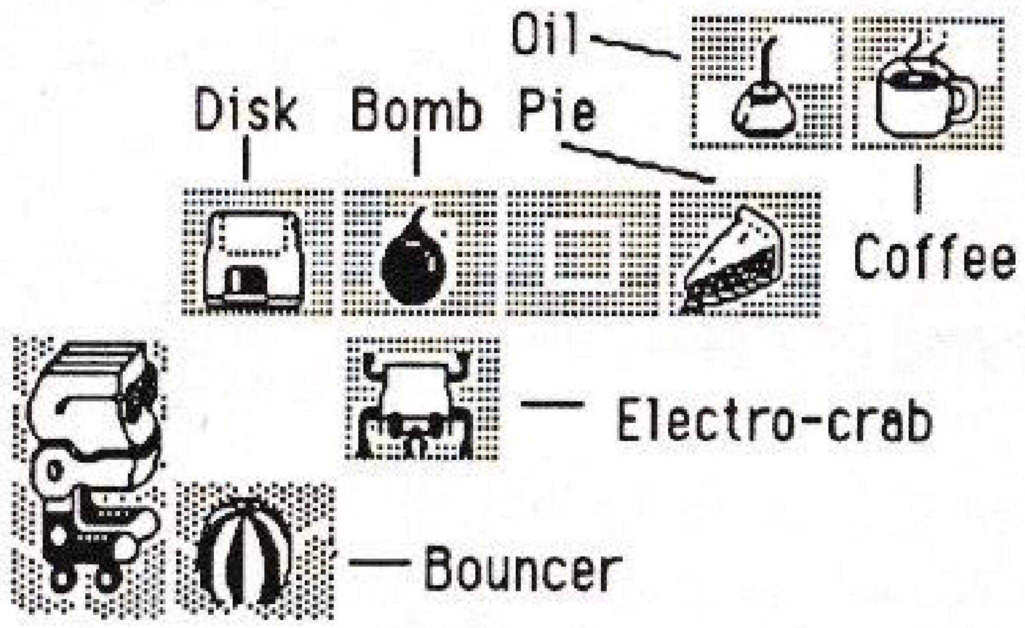
INSIDE AN ENVIRONMENT

The large window on the left side of the screen displays the ChipWit on a mission in an Environment. The window identifies both the ChipWit and the Environment. (You should be watching Greedy in Greedville.)



Each Environment consists of a series of rooms. The rooms are bounded by walls and a floor. Walls are also constructed in the middle of rooms in some Environments. Openings in the outer walls are doors. When a ChipWit reaches a door and moves through it, a new room is automatically displayed.

Contained within the rooms are a variety of Things. ChipWit Things are oil cans, pie, coffee, electro-crabs, bouncers, bombs, and disks. Parts of the Environment (doors, walls, and the floor) are also considered Things by the robots.



While the ChipWit is on a mission, there are two running counts visible in the Environment window. In the upper left corner of the window is the Score, and in the upper right corner of the window is the Cycles count. The ChipWit receives points added to its score whenever it acquires an oil can or disk, or zaps a bouncer or an electro-crab. The number of points it receives depends on which Environment it is in. (Details follow in the section titled **Environments.**)

Cycles represent the ChipWit's life span. At the start of a mission, the ChipWit is assigned a fixed number of cycles. The cycles are expended based on the ChipWits activities. When the cycles count reaches 0, the mission is over. (Details on how many cycles are assigned at the start of missions in each of the different Environments and how many cycles each ChipWit action requires follow in sections titled **Environments** and **Some Vital Statistics.**)

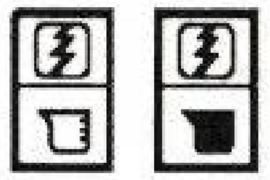
Status Meters

As you watch your ChipWits perform, you will want to have some information concerning their health. This is provided by the **Status Meters** found in the upper right hand corner of the Environment screen. The Status Meters tell you how much damage your ChipWit has sustained, how much fuel your ChipWit has, what the last Keypress Argument was, and what the current value in the ChipWit's Range Finder is. Each is explained below.

Damage Meter

ChipWit damage is caused by the robot running into anything in the Environment or trying to pick up walls, bouncers, electro-crabs, or bombs. The Damage Meter (illustrated below) shows the amount of damage your ChipWit has sustained on its current mission in the Environment. When the beaker in the Meter is empty, it means the ChipWit has sustained no damage. When the beaker is full, it means the ChipWit has been completely damaged. When this happens, the mission is over!

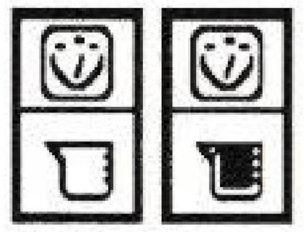
ChipWit damage is not repairable. (The amount of damage inflicted under various circumstances is detailed in the section **Some Vital Statistics**.) One of the goals of ChipWit programming is avoiding damage.



The Damage Meter
No Damage and Completely Damaged

Fuel Meter

The ChipWit begins each mission with a full fuel tank. This is indicated by a full beaker in the Fuel Meter (illustrated below). Fuel is expended in two ways. Each action that the ChipWit makes requires fuel. (The amount of fuel each action requires is detailed in the section titled **Some Vital Statistics**.) The ChipWit also looses fuel when it is attacked by an electro-crab.

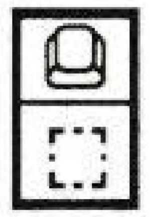


Fuel Meter: Empty and Full

The ChipWit refuels itself by eating pie or drinking coffee. Pie and coffee are available in all the Environments. One of the goals of ChipWit programming is to make sure the ChipWits has enough fuel. If it does not find and acquire pie and coffee, it runs out of fuel and ends the mission.

Keypress Meter

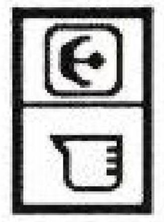
Keypresses are discussed at the beginning of Chapter II. The Keypress Meter looks like this:



The Range Finder

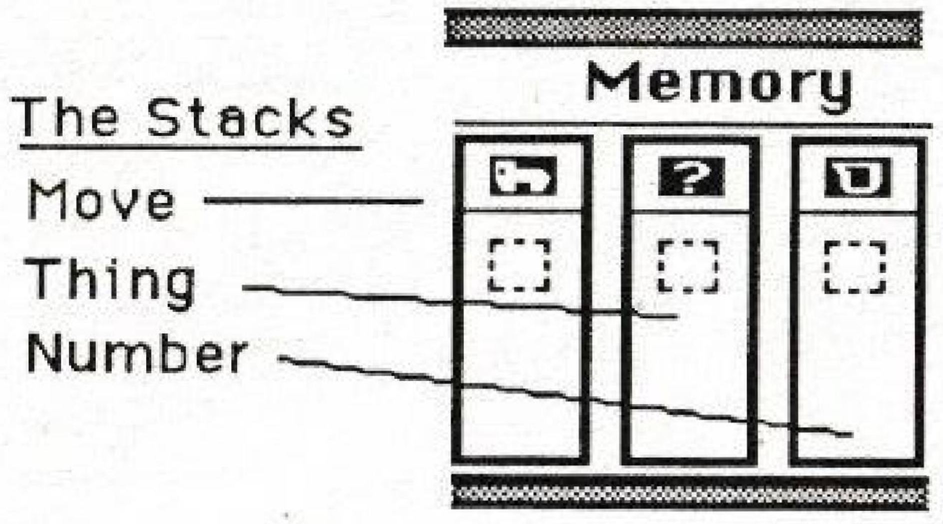
After any Look command, if the ChipWit has located a Thing (wall, door, floor, electro-crab, bouncer, bomb, pie, coffee, disk, or oil can), the object's distance from the ChipWit is indicated in the beaker in the Range Finder. A full beaker means 7 floor tiles, an empty beaker means 0. Graduations in the beaker each represent two spaces.

Use of the Range Finder is discussed in Chapter II. The Range Finder Meter looks like this:



Memory Stacks

To the right of the Status Meters are the Registers for the **Memory Stacks**. The three columns show the top items in the Move, Number, and Thing Stack. The roller skate on top of the first stack labels that stack as the Move Stack, the question mark on top of the second stack labels it as the Thing Stack, and the beaker on top of the third stack labels it as the Number Stack.



Stacks are lists that you can request the ChipWit make of three types of items: moves (the ChipWit makes), Things (the ChipWit sees, touches, smells, zaps, or eats), and numbers (that the ChipWit can get from a multitude of sources). These lists (or stacks) are made and used by the ChipWit on a first item in, last item out basis. The Memory Registers that are the displayed on the screen indicate the top three items in each of the three Memory Stacks. (These are the last items that have been put into the stacks and the first, therefore, that will come out.) Each Memory Stack has room for 256 items.

The use of stacks is discussed in Chapter II.

The Debug Window

The **Debug Window** is in the bottom right corner of the Environments screen. This window is designed to help you determine which parts of your ChipWit program need editing.

ChipWit programs, as we will see in a minute, are made up of panels (groupings) of chips. The programmed chips for the currently loaded ChipWit are shown executing while the ChipWit moves through its mission. As each chip executes, it becomes inversed and stays that way until the next chip executes. This lets you follow your program and see if your plan is working as intended.

Since the action is fast, you may wish to slow it down to follow what is happening. To slow down both the execution of the program and the corresponding action of the ChipWit, point to the snail icon (located at the top of the Debug Window) and click

the mouse once. This will cut the speed of the action significantly. To slow the action down even more, point to the shoe icon (to the left of the snail icon) and click once. Now the program will execute one chip for each mouse click. To resume full speed, point to the humming bird icon (to the right of the snail icon) and click once.

The panels (grouping of chips) are as large as the Environments Window! Because there is not enough room in the Debug Window to display the entire active panel, only one quarter of it is displayed. The square in the upper left corner of the Debug Window represents the panel which is currently active (and being displayed). The moving black box within the square represents the quarter that is displayed executing. The adjacent box identifies the active panel. If there is a ChipWit face in the box, then the Main Panel is being executed. If a letter is shown, it refers to one of the Sub-Panels. (There will be more on panels soon.)

At the end of the mission, the Debug Window is replaced with a Stats Window. Displayed in the Stats Window is the highest score made by the current ChipWit in the current Environment, the average score of all missions run by the current ChipWit in the current Environment, and the number of missions that the ChipWit has run there. The program will automatically update the Stats record each time that ChipWit runs a mission in that Enviroment until you make a change in the ChipWit (edit it to make it better). At that you point you have a new ChipWit and a new Stats file. Changes made to the active ChipWit will zero out the old scores in the mission Stats file.

Summary

Each Environment has distinct goals for the ChipWit (the mission). In the easier Environments, the ChipWit is faced with minor dangers like running out of energy or being damaged by running into Things. In more difficult Environments, ChipWits face hostile Things: electro-crabs, bouncers, bombs , and lack of fuel sources.

The Status Meters and the Memory Registers give you information about what your ChipWit's internal condition is during the mission. The Debug Window lets you see where the problems in your ChipWit's program are. You can slow the execution down to your own pace (footstep), and see exactly how your programming has made the robot behave.

The next section teaches you how to program a ChipWit. This is the fun part-- what ChipWits is all about!

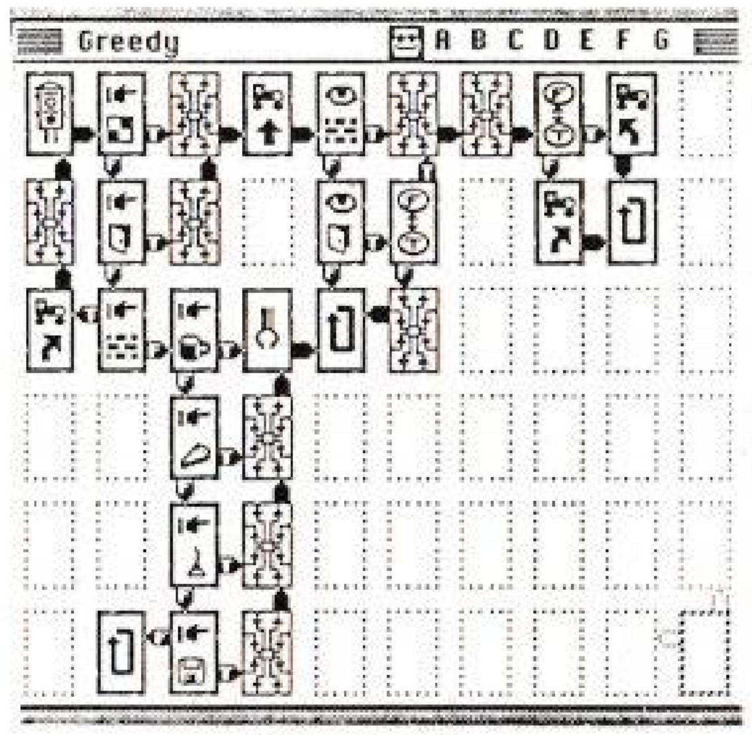
THE WORKSHOP

Introduction

If you are reading this documentation through while at the computer, you should still be watching Greedy scoot around in Greedville. We will now be leaving the Greedville Environment and entering the Workshop where Greedy and all other ChipWits are programmed and reprogrammed.

Into the Workshop!

You may enter the Workshop by simply pulling down the Workshop menu and selecting the first menu choice: **Enter**. Do this now. If you were running Greedy, you should now be looking at Greedy's Main Panel. It looks like this:



If you are looking at the panel of another ChipWit (the name of the ChipWit you are viewing is at the top of the large window on the left), switch to Greedy by going to the Warehouse Menu and selecting Greedy. If you are looking at Greedy, but are seeing a blank panel, click on the ChipWit face to the left of the letter A in the bar at the top of the large window.

A Workshop Tour

Before we learn how ChipWits are programmed, let's take a quick look at the tools you will use programming your robots. These tools include: panels, chips, Operators, Arguments, true/false wires, and the garbage can. (You might want to select Sound On from the Options menu now. The Workshop is a pretty quiet place compared to an Environment during a mission.)

Panels

ChipWits are controlled by programs written in IBOL (Icon Based Operating Language). The programs are made up of chips set into panels. Each rectangle in the large window is a chip. (Chips can have either one or two icons in them.) The window itself is a panel.

There are two types of panels: the Main Panel and Sub-Panels. The Main Panel controls the overall flow of the program while the seven Sub-Panels execute only when called by the Main Panel. You can determine which panel you are working on by the Main Panel/Sub-Panel Identification at the top of the panel to the right of the ChipWit name. There you see a ChipWit face followed by the letters A through G. The face represents the Main Panel while the letters are the seven Sub-Panels. You can tell which panel is displayed in the window by which of the letters (or the face) is inversed. You choose a panel for display merely by clicking its letter (or the face for the Main Panel).

If you click on any letter when Greedy is in the Workshop, you will see an empty panel. This is because Greedy is programmed only on the Main Panel. Notice that all the panels are identical in size and shape. Each has space for sixty chips. In row 1, column 1 of each panel is a traffic light chip. (This is where each panel begins executing.)

Chips

The chips contain instructions to the robot. The instructions are comprised of Operators (verbs) and Arguments (objects) which we will discuss in a moment. The chips execute in a sequence determined by the robot builder. This sequence is set by the position of the chips in relation to one another and by true and false wires on the chips.

Operator/Arguments

There are three other parts on the Workshop screen that you should look at before beginning programming. These are the **Operators** Menu, the **Arguments** Menu, and the **Wastebasket**.

The Operators Menu allows you to choose Operators for each chip. Operators are the equivalent of verbs: Look, Touch, Move, etc. This menu is found directly below its title on the right side of the Workshop screen. To see how this menu works:

1. Click on the empty chip in the lower right hand corner of the screen. Its borders should now be moving showing it is the active chip (the one being programmed).

2. Now click on the icon for Look. It is a picture of an eye and looks like this:

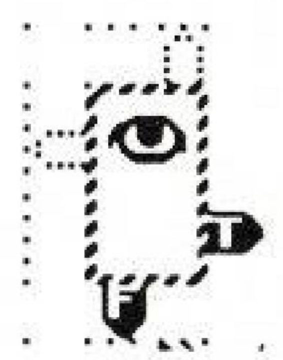
3. The eye is now in the top of the chip. Selecting from the Operators Menu is done merely by clicking on an icon there. The Operator icon is placed in the chip that is active (has moving edges).

Did you notice that when you select an Operator, often the Arguments Menu fills in with icons? Arguments are the objects of the Operators (more about this later). Items in the Arguments Menu appear only after an Operator is selected. The Arguments which appear in the menu after an Operator is selected are those Arguments available for that Operator. In some cases, Operators do not take an Argument. In those instances, the Arguments menu remains blank.

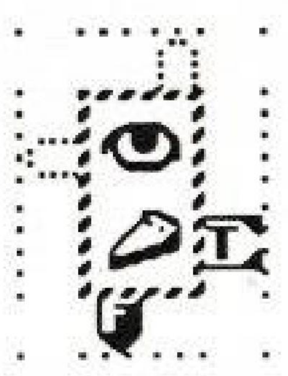
The Arguments Menu works in the same manner as the Operators Menu. Select items merely by clicking on them. Arguments fill in the bottom of the chips when selected.

True/False Wires

Select a chip away from the corner and put both the Look Operator and an Argument in it. Notice that after you selecte your Operator, two wires appear on the sides of the chip. One wire has the letter T in it and the other has the letter F in it. The letters stand for True and False. They look like this:



These wires will control the flow of the program from one chip to another. Click on one of the wires. It will reverse (become black on white) so it looks like this:



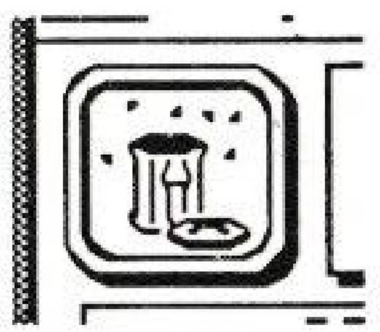
Now click on one of the wire outlines on another side of the chip. The wire moves to the side you just clicked on. The wires are as important as the commands (Operators and Arguments), and you will be moving them around a lot.

Moving Chips

Chips can be moved from one location on a panel to another by clicking and dragging (with the mouse button down). When you release the mouse button, the chip will be placed at the cursor. If you drag a chip over an existing chip, it will replace the existing chip.

The Wastebasket

The **Wastebasket** is available to delete chips you wish to remove (clear of Operators, Arguments, and wires). Merely click on the chip you want removed and then click on the Wastebasket icon.



An existing chip which you want to alter does not have to be sent to the Wastebasket. Simply click on the chip (making it active) and select the new Operator and Argument for it.

PROGRAMMING A CHIPWIT

Now our tour of the Workshop is over. You know about all the tools of ChipWit programming and are ready to begin learning how to use them. After reading this section you will be able to program ChipWits, evaluate them, and reprogram them to make them better point scorers.

Programming Goals

The fun and the challenge of the ChipWit system is programming your ChipWits to master effectively the Environments in which they are placed. What does "master" mean? Essentially, mastering an Environment means gaining the maximum number of points there. Points are gained or lost depending on what the ChipWit eats and zaps. Points are counted on the screen during every mission (remember seeing them running in the upper left when Greedy was in Greedville?). They are the gauge by which you measure the success of your robot building efforts.

COMMUNICATING WITH CHIPWITS

Giving instructions to a ChipWit (programming it) is just like talking to a small child. If you were to teach either a ChipWit or a child to set the table for dinner, you would give them a clear sequence of instructions.Then you would watch what the child or the robot does and give another sequence of instructions based on this. You might begin:

Command Sequence	Resulting Actions
Look in the cupboard for the plates.	The child finds them.
Bring them to the table.	Child brings them.
Now look for the glasses.	Child cannot find glasses.
Look in the cupboard on the left.	Child now finds glasses.

Looking closely at the above example of programming, notice that it can be broken into three distinct components: Telling the child/ChipWit what to do (The Instruction Set), telling it when to do it or giving it the commands in the right order (The Sequence of Instructions), and checking the resulting action to see if it was able to execute the command (Conditional Testing).

These are three basic elements of programming. Let's take a closer look at each to see how they work with the ChipWit tools: Operators, Arguments, and wires.

The Instruction Set

Each Operator represents an action you are commanding the ChipWit to perform. Operators are the same as verbs in imperative sentences. For an example, take the command: **[You are to] LOOK [for] PIE.**

When a sentence is spoken or written in English, the bracketed words are used to make the meaning of the sentence clear. In an imperative (command) sentence, the subject, You, is often left unsaid. Thus, we are used to hearing the sentence as: **LOOK [for] PIE.** The preposition **[for]** makes listening to the sentence easier and more comfortable for people. ChipWits, being computer robots, do not require prepositions for communication. Thus, we can edit down the original sentence to two words: **LOOK PIE.**

In ChipWit (and programming) terminology, the verb **LOOK** is an Operator and the noun **PIE** is an Argument. The two combine to form an Instruction Set. They combine to make up a command.

Operators/Arguments

As you have already seen, IBOL, the ChipWit programming language, uses icons, or symbols, to represent Operators and Arguments. The symbol :

stands for the Operator **LOOK**. The symbol:

stands for the Argument **PIE**.

The following catalogue:

1. lists each of the ChipWit Operators.

2. tells what each Operator commands the ChipWit to do.

3. shows the icons that stand for each Operator, and

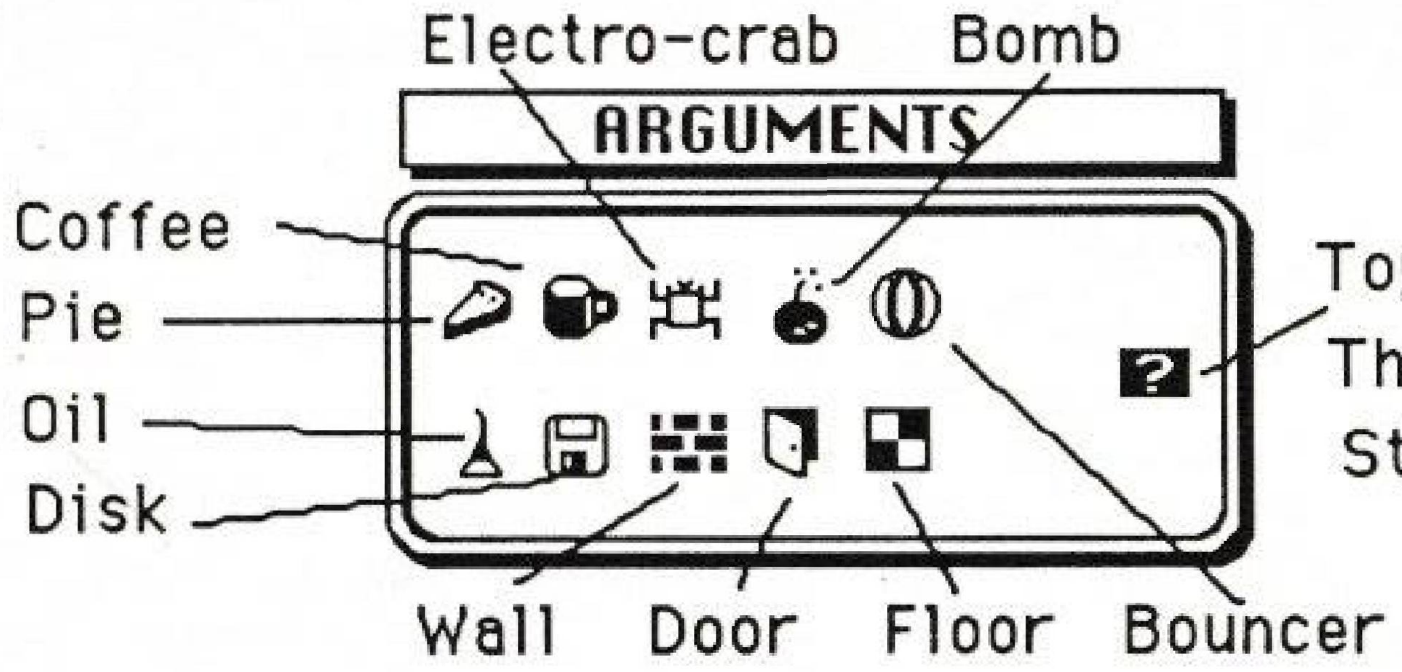
4. tells what Arguments each Operator uses (what can be the object of the command).

<u>The Operator LOOK</u>

LOOK commands the ChipWit to look in a straight line directly ahead for a specific Thing. Whatever Argument you use with this Operator is the Thing the ChipWit will look for. If the Thing is seen, the program continues through the LOOK chip's true wire to the chip connected to that wire. If the Thing is not seen, the program continues through the chip's false wire to the chip connected to that wire.

Whenever LOOK is used and the ChipWit sees the Thing, the number of tiles from the ChipWit to the Thing is placed in the Range Finder. Chapter II gives some ideas about how to use this feature with the Number Stack.

The Operators for LOOK are all the Things that might be found in an Environment. They are:



The Operator SMELL

SMELL commands the ChipWit to smell an entire room for a specific Thing. Whatever Argument you use with this Operator is the Thing the ChipWit will smell for. If the Thing is smelled, the program continues through the SMELL chip's true wire to the chip connected to that wire. If the Thing is not smelled, the program continues through the chip's false wire to the chip connected to that wire.

The Operators for SMELL are all the Things that might be found in an Environment. For a listing of these Arguments, see LOOK above.

The Operator FEEL

FEEL commands the ChipWit to feel directly ahead one space

(floor tile) for a specific Thing. Whatever Argument you use with this Operator is the Thing the ChipWit will feel for. If the Thing is felt, the program continues through the FEEL chip's true wire to the chip connected to that wire. If the Thing is not felt, the program continues through the chip's false wire to the chip connected to that wire.

The Operators for FEEL are all the Things that might be found in an Environment. For a listing of these Arguments, see LOOK above.

The Operator PICK UP

PICK UP commands the ChipWit to reach directly ahead one space (floor tile) for a Thing. PICK UP is used to acquire disks and oil for points and pie and coffee for fuel. If the ChipWit attempts to PICK UP a bomb, it will be blown up. If it attempts to PICK UP a bouncer, electro-crab, or a wall, it will sustain damage.

There are no Arguments for the PICK UP Operator. The ChipWit will try to PICK UP whatever is on the tile directly in front of it. If nothing is there, it will reach just the same.

The Operator ZAP

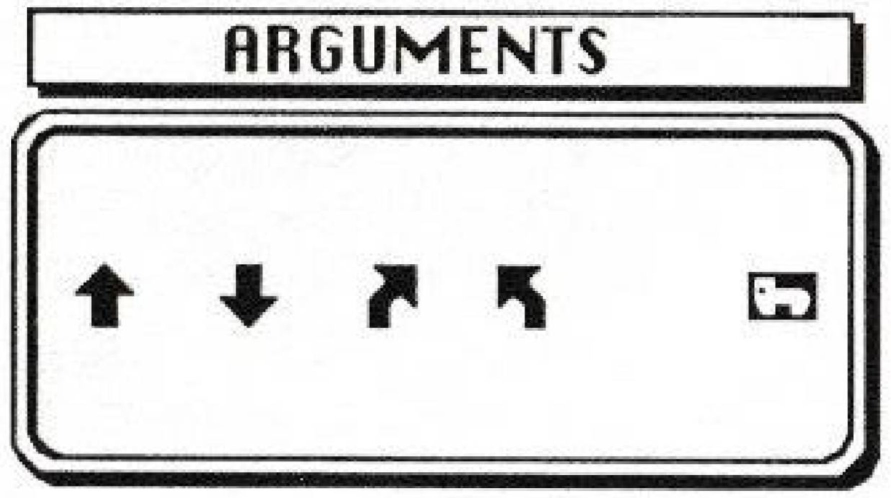
ZAP commands the ChipWit to attack with its plasma beam anything directly ahead in the room. ZAP will remove anything except walls and floors from the Environment. A ChipWit only receives points for ZAPping electro-crabs and bouncers. If it ZAPs a bomb, it will get itself blown up. If it ZAPs pie or coffee, it will not gain the fuel it would have had it picked it up. If it ZAPs disks or oil, it will not gain the points those Things are worth if they are picked up.

Like the PICK UP Operator, the ZAP Operator has no Arguments.

The Operator MOVE

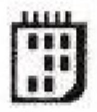
MOVE commands the ChipWit to move either forward or backward one tile, or to rotate 45 degrees in either direction on the tile it occupies.

The Arguments for MOVE are four arrows indicating direction and rotation. They look like this.



MOVE has another Argument that tells the ChipWit to execute the top move stored in the Move Stack. (Remember, stacks are lists that you can have the ChipWit make as it goes on a mission.) The Move Stack is discussed in Chapter II.

The Operator SUB-PANEL



SUB-PANEL commands the program to leave the Main-Panel and continue execution at the beginning of a specified Sub-Panel. Since Sub-Panels can be reached only from the Main Panel, the SUB-PANEL Operator can only be used on the Main Panel.

The Arguments for SUB-PANEL are the letters A through G. They stand for the Sub-Panel that you are requesting the program to go to.

SUB-PANEL is a command to the program rather than a behaviorial command to the ChipWit

The Operator LOOP

LOOP commands the ChipWit program to go back to the beginning (the stoplight) of whatever panel is executing and continue execution from there.

LOOP has no Arguments. It, too, is a command to the program rather than a behaviorial command to the ChipWit.

The Operator BOOMERANG

BOOMERANG commands the ChipWit progam to go back to the Main Panel and continue execution with the chip after the Sub-Panel chip that sent the program to the Sub-Panel. Since BOOMERANG returns the program to the Main Panel, it is only available for use on Sub-Panels.

BOOMERANG has no Arguments. Like the LOOP and the SUB-PANEL Operators, BOOMERANG is a command to the program, not the ChipWit.

The Operator JUNCTION

JUNCTION merely connects two chips with each other. It is used when the lay-out of your program necessitates a link between two chips that are one space or more apart. More than one JUNCTION chip can be strung together to cross large areas of a panel.

The Operator COIN FLIP

COIN FLIP generates a random choice for a branch from the chip's true or false wires.

The Operator SING

SING commands the ChipWit to sing a note. The note it sings is determined by a number with 0 being the first pitch in a scale and 7 being the last, an octave higher.

The Arguments for SING are the numbers which determine the pitch it sings. They are the numbers 0 through 7 (as represented by the graded beakers), the Number Stack (which causes it to sing the top number there), the Fuel Meter (which causes it to sing the value there), the Range Finder (which causes it to sing the value there), and the Damage Meter (which causes it to sing the value there).

The Operator KEYPRESS

KEYPRESS checks to see if a specified key on the Macintosh keyboard is being pressed at the time the chip is executing. If the key is being pressed, the program will branch through the true wire. If the key is not being pressed, the program will branch through the false wire. KEYPRESS allows the programmer to step in and direct the flow of the program. KEYPRESS is discussed in Chapter II.

The Arguments for KEYPRESS are the letters of the alphabet and a blank square. The letters stand for specific keys you want the KEYPRESS to check for. The blank square will cause a true branch if any key is pressed.

The Operator SAVE MOVE

SAVE MOVE commands the ChipWit to put a specified move (the Argument) into the Move Stack. This is the way the ChipWit makes the list of moves that constitutes the Move Stack. Uses of the Move Stack are discussed in Chapter II.

The Arguments for SAVE MOVE are the four directional move arrows.

The Operator COMPARE MOVE

COMPARE MOVE commands the ChipWit to examine the move on the top of the Move Stack and compare it to a specified move (the Argument). If the moves are the same, the program branches through the true wire of the COMPARE MOVE chip. If the moves are different, the program branches through the false wire of the COMPARE MOVE chip.

The Arguments represent the move that you want the ChipWit to compare to the move at the top of the Move Stack. They are the four directional arrows and the empty square. The empty square represents the bottom of the Move Stack. If the Move Stack is empty, and you use this Argument, the chip will branch through its true wire.

The Operator SAVE THING

SAVE THING commands the ChipWit to put a specified Thing into the Thing Stack. This is the way the ChipWit makes the list of Things that constitutes the Thing Stack. Uses of the Thing Stack are discussed in Chapter II.

The Arguments for SAVE THING are the same Things that are the Arguments for LOOK.

The Operator COMPARE THING

COMPARE THING commands the ChipWit to examine the Thing on the top of the Thing Stack and compare it to a specified Thing. If the Things are the same, the program branches through the true wire of the COMPARE THING chip. If the Things are different, the program branches through the false wire of the COMPARE THING chip.

The Arguments represent the THING that you want the ChipWit to compare to the Thing at the top of the Thing stack. They are the same Things that are the Arguments for LOOK (minus the call to the Thing Stack itself). The bottom of the Thing Stack is represented the same way as the bottom of the Move Stack.

The Operator SAVE NUMBER

SAVE NUMBER commands the ChipWit to put a value into the Number Stack. This is the way the ChipWit makes the list of values that constitutes the Number Stack. Uses of the Number Stack are discussed in Chapter II.

The Arguments for SAVE NUMBER are the numbers to be put into the stack. They are the numbers 0 through 7 (as represented by the beakers), and the values from the Fuel and Damage Meters, and the current reading from the Range Finder.

The Operator COMPARE NUMBER: EQUAL?

COMPARE NUMBER: EQUAL? commands the ChipWit to

examine the value on the top of the Number Stack and compare it to a specified value. If the values are the same (equal), the program branches through the true wire of the COMPARE NUMBER: EQUAL? chip. If the values are different, the program branches through the false wire of the COMPARE NUMBER: EQUAL? chip.

The Arguments represent the value that you want the ChipWit to compare to the value at the top of the Number Stack. They are the values 0 through 7 (as represented by the beakers), the value from the Fuel and Damage Meters, the current reading from the Range Finder, and the bottom of the Number Stack (represented by the empty square).

The Operator COMPARE NUMBER: LESS THAN?

COMPARE NUMBER: LESS THAN? commands the ChipWit to examine the value at the top of the Number Stack and compare it to a specified value. If the value in the Number Stack is less than the specified value, the program branches through the true wire of the COMPARE NUMBER: LESS THAN? chip. If the value in the Number Stack is greater than or equal to the specified value, the program branches through the false wire of the COMPARE NUMBER: LESS THAN? chip.

The Arguments represent the value you want the ChipWit to compare to the value at the top of the Number stack. They are the values 0 through 7 (as represented by the beakers), the value from the Fuel and Damage Meters, and the current reading from the Range Finder, and the bottom of the Number Stack (represented by the empty square).

The Operator INCREMENT

INCREMENT increases the value at the top of the Number Stack by one. Numbers increase from zero to seven and then wrap around (return) to zero. There must be a value in the Number Stack to be INCREMENTed.

The Operator DECREMENT

DECREMENT decreases the value at the top of the Number Stack by one. Numbers decrease from seven to zero and then wrap around (return) to seven. There must be a value in the Number Stack to be DECREMENTed

The Operator POP

POP removes the item from the top of the specified stack.

The Arguments for POP are the Number, Thing, and Move Stacks. They represent the stack you want the item removed from.

Instruction Sequence

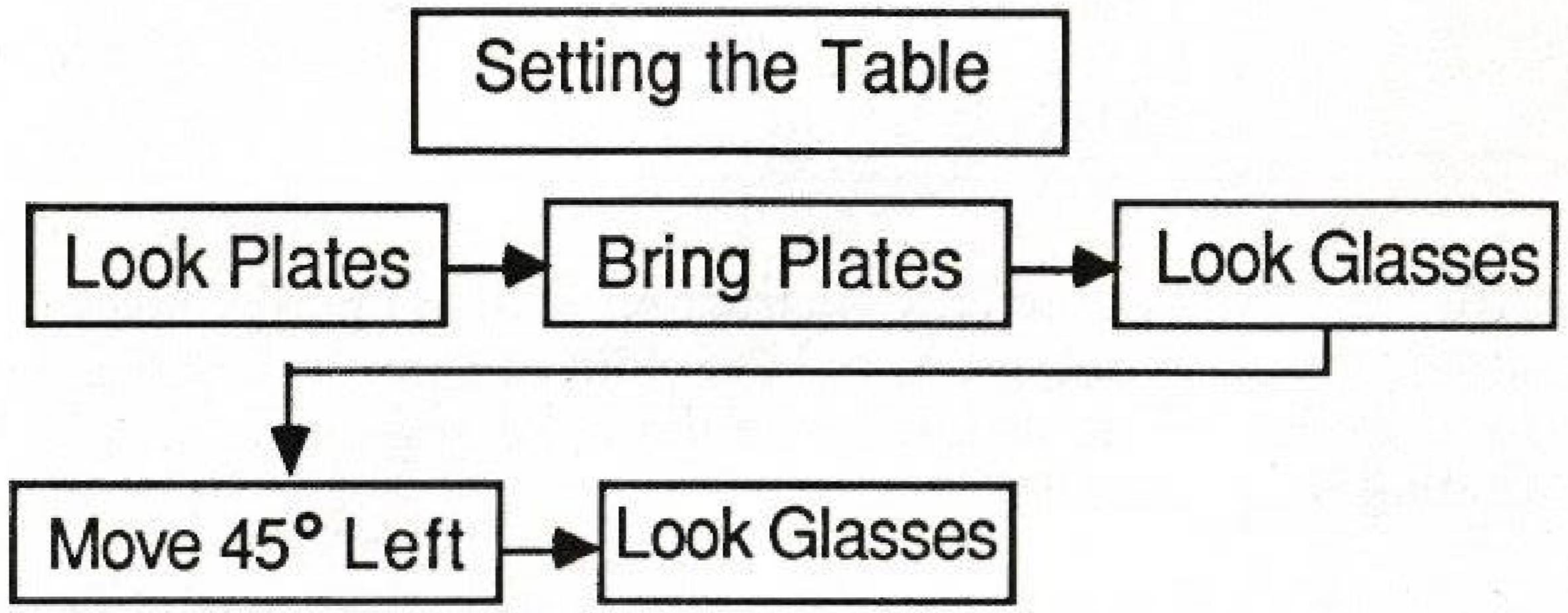
You now know almost everything you will need to tell a ChipWit what to do (to make up Instruction Sets for the robot). Now let's see how we determine the order of our commands: The Sequence of Instruction.

Looking at the sample set of instructions for the child, you see that if our commands were programmed on chips, they would read like this:

1. LOOK PLATES
2. BRING PLATES
3. LOOK GLASSES
4. MOVE 45 degees LEFT
5. LOOK GLASSES

Notice that the chips are programmed to perform in a very specific order. ChipWit programming, like all other computer programming, requires that the instructions be placed in a

sequence that allows the program to achieve its objectives. Programmers often use Flow Charts to help them figure out the best sequence (or flow) of commands. The example we have been looking at is represented in a simple flow chart below:



Each rectangle represents an Operator and an Argument (one instruction set). The arrows and positions of the rectangles point out the sequence in which the instructions are carried out. As you develop your ChipWit programs, you may want to sketch out simple flow charts for yourself.

The Sequence of Instruction for ChipWits is determined by the true and false wires that are attached to almost every chip. The wires are attached to every chip that performs a Conditional Test (see next section). It is this Conditional Testing that determines, to a large degree, the actual flow of instruction in the ChipWit's program.

Conditional Testing

Conditional Testing is the third major component of programming ChipWits (remember, the first two are Instruction Sets and Flow of Instruction). Conditional Testing is the process of checking to see what the results of an Instruction Set are and branching to a new Instruction Set based on those results.

There is an example of Condition Testing in the Instruction Set that we have been using. The child ran into a problem after step number 3:

1. LOOK PLATES
2. BRING PLATES
3. LOOK GLASSES
4. MOVE 45 DEGREES LEFT
5. LOOK GLASSES

After the child carried out Instruction 3, based on the results of that Instruction Set, we asked the child to change direction and look again. (This was because the child was unsuccessful in finding the glasses.)

What we were saying in instruction 3 was, "**[If you] LOOK [and find the] GLASSES, [then] BRING [the] GLASSES [to the table].** We provided an alternative in case the glasses were not found. This alternative, instruction 4, was to **MOVE 45 DEGREES LEFT**, and (instruction 5) **LOOK GLASSES** again.

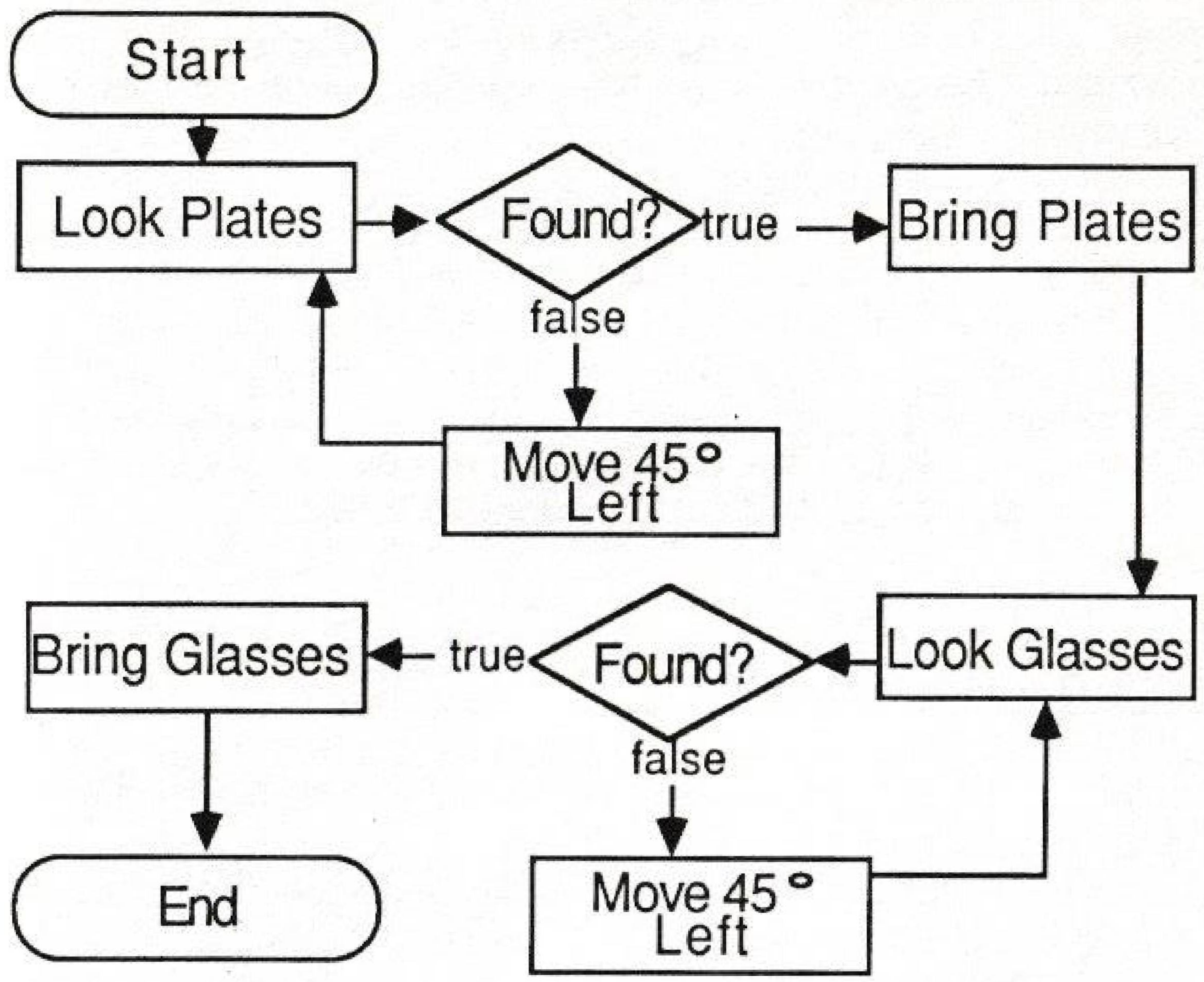
We can set up a general rule for this kind of Conditional Testing. That rule is:

IF [something is true or meets some condition you have set,] THEN DO [something]. IF [it is] FALSE, THEN DO [something different].

Programmers, who hate to use more words then they absolutely have to, have a much shorter way of expressing the same rule:

IF (x)...THEN DO (y)...IF NOT(x)... DO(z)

A more detailed flow chart for the example we have been using showing Conditional Testing, looks like this:



The diamond shaped figure which you see is the Decision Box. It represents the test determining whether the condition asked for is true or false (whether the command in the Instruction Set was executed). It determines what the next instruction set should be. In this case, since the test of LOOK GLASSES is false, the next instruction is to MOVE 45 DEGREES LEFT, followed by another instruction to look for the glasses. If the answer had been true, the next instruction would be to bring the glasses.

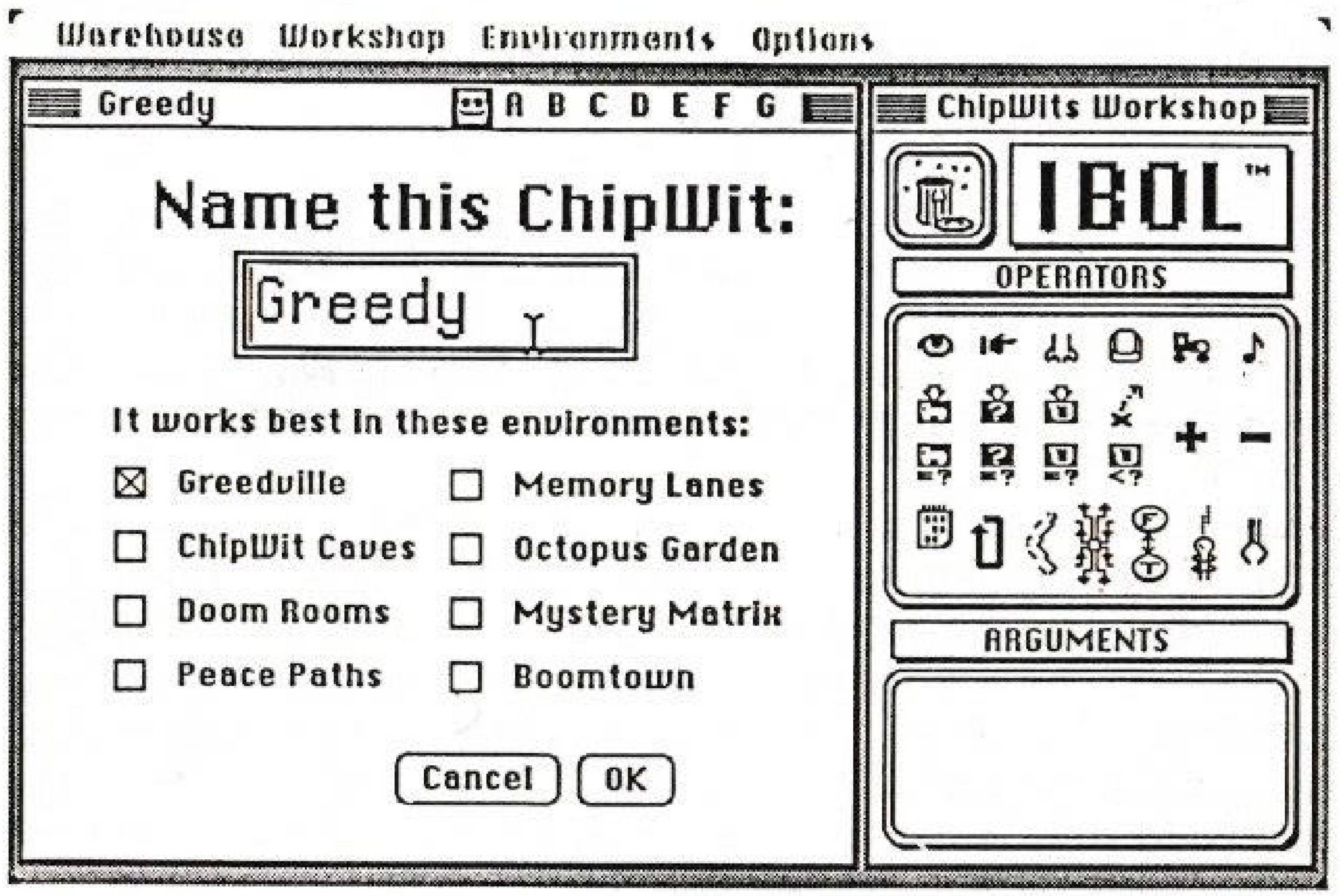
The main difference between programming a ChipWit and instructing a child to set the table is that when you program, you must <u>anticipate</u> the problems and situations your robot will face. When working with a child, you can jump in at any time and give new instructions. With the ChipWit, the Debug Panel lets you see where your instructions need to be modified. To make the necessary changes, however, you must take the ChipWit out of the Environment and into the Workshop for reprogramming.

Flow charts, like the one above, will help you plan your program's Sequence of Instructions based on Conditional Testing.

Most of the chips which have an active Operator/Argument combination provide for some sort of testing to determine whether specified conditions are being met. Only chips that contain Instruction Sets with Conditional Testing have true and false wires. Notice how a MOVE FORWARD does not have true and false wires since the ChipWit will do exactly as you tell it (even if it moves into a bomb and blows up).

SAVING A CHIPWIT

When you have been working on a ChipWit in the Workshop, YOU MUST SAVE IT EITHER BEFORE PUTTING ANOTHER CHIPWIT INTO THE WORKSHOP OR AN ENVIRONMENT OR TURNING THE COMPUTER OFF. Do this by selecting **Save ChipWit** from the Workshop menu. A dialogue box that looks like this will appear.



Type the name you want to give your ChipWit in the rectangle. Click in the box for each Environment for which you designed the ChipWit specifically. (A second click in a box removes an assignment made by mistake.) When you are finished, click on OK and your ChipWit will be saved to disk.

If you load in another ChipWit (either to an Environment or the Workshop), quit ChipWits, or turn the computer off without saving changes made to the one currently in action, the changes will be lost.

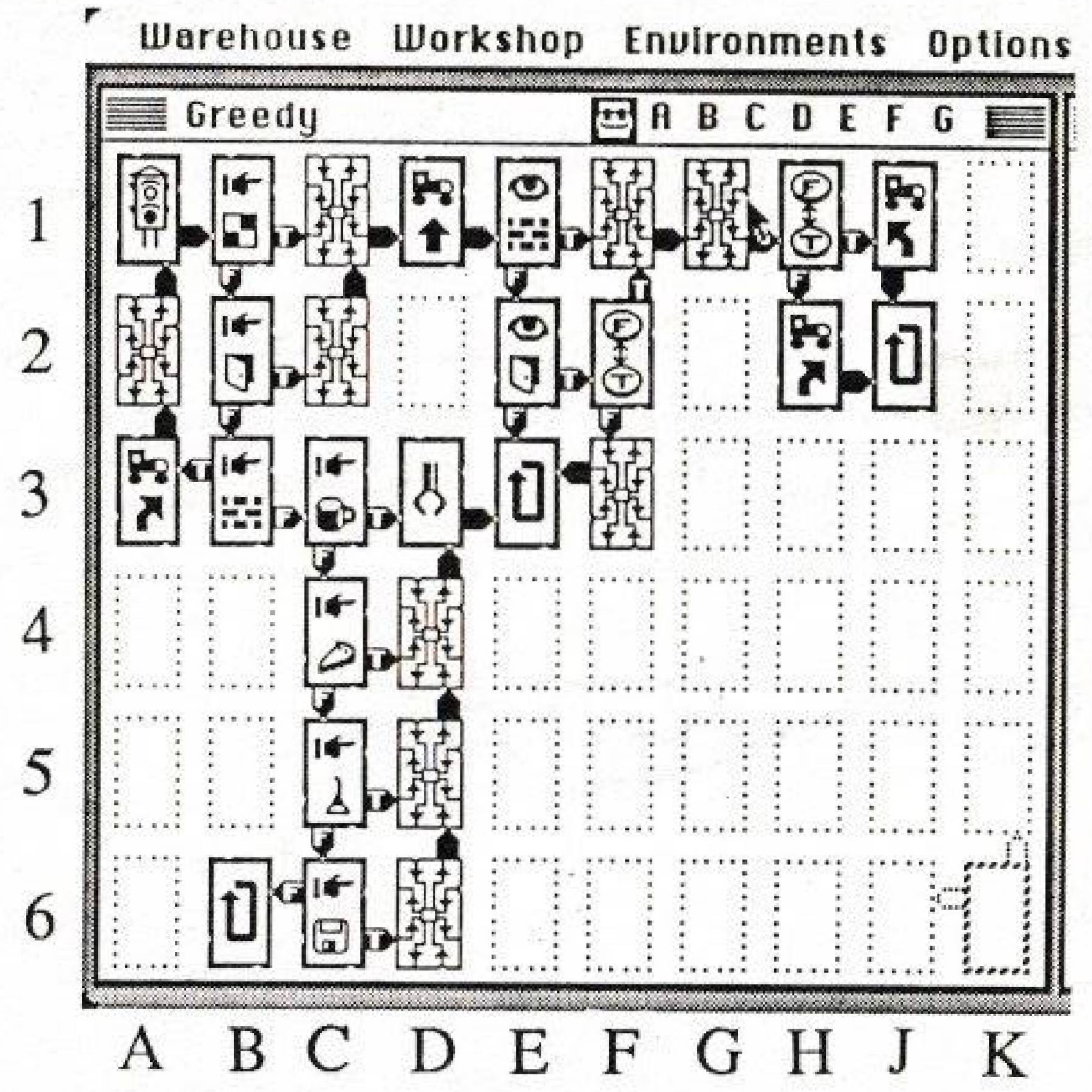
A CLOSE LOOK AT GREEDY

At this point, you are probably fired up and ready to build the ChipWit that ate New York! If you want to try just that, skip the next section and go straight to the section titled **SOME FINAL DETAILS.** Here you will find an explanation of several tools that will make your time in the Workshop easier and a precise catalogue of what your ChipWits can expect in each Environment. What follows next is a chip by chip look at a simple ChipWit: Greedy. Unless you are an experienced programmer, if you skip this part now, you will want to return to it later after you have had a try at programming.

Greedy: Life and Times

Greedy, a simple one panel ChipWit who was born and raised in Minneapolis, was destined by fate (actually, by a ChipWit builder) to spend his days in Greedville. Although you can place Greedy in any of the Environments, as we will see, he functions efficiently only in his adopted hometown, Greedville.

A printout of Greedy's Main Panel is shown below so that, in the event you are reading this in the bathtub or an airplane, you will be able to see what we are referring to. Greedy's panel has been assigned number and letter coordinates so we can discuss specific chips (like A1... the stoplight) easily.



Greedy begins its exploration of Greedville by feeling for the floor (chipB1). If it doesn't feel the floor, it branches out its false wire on chip B1 and feels for a door (chip B2). If it does not feel a door, it branches through the false wire on B2 and feels for a wall (chipB3). This sequence has determined that there is something in front of the robot (or else it would have felt the floor) and that something is not a fixed part of the Environment (a door or a wall). By the process of elimination, the robot builder has established that there is either oil, pie, coffee, or a disk in front of the ChipWit. (Greedville does not have electro-crabs, bombs, or bouncers.) Any of these four possible Things are desirable and attainable through the PICK UP Operator.

But Greedy is not the most efficient ChipWit in the Warehouse. Rather than just grabbing, it goes through a sensing routine for coffee, pie, oil, and disk just as it did for floor, door and wall earlier. It wants to know what it is picking up! If a conditional

test for one of these Things is positive (chips C3, C4, C5, and C6), the program branches through a true wire either to the PICK UP chip (D3) or to a JUNCTION chip (D4, D5, or D6) which connects to the PICK UP chip. From the PICK UP chip the program branches to a LOOP chip (E3) and returns to the stoplight.

Notice that there is a LOOP chip attached to the false wire of the FEEL FOR DISK chip (C6). There would be no instance in Greedville where this chip could be reached. But if Greedy were in Doom Rooms, it could be feeling an electro-crab. Thus, it would branch through the false wires of the complete identify Thing routine (chips B1, B2, B3, C3, C4, C5, and C6) without successfully finding a true wire.

We have now seen how Greedy reacts when it finds itself in front of a good Thing. Let's now see what it does when it finds itself in front of a wall, door, or an empty floor tile. We will see that the programmer of Greedy has taken a casual attitude toward controlling the robots movement.

If Greedy senses a wall (chip B3), it rotates 45 degrees and LOOPS back to the stoplight. Regardless of whether it senses the floor or a door (via chips B1 or B2), Greedy goes to the same movement sequence. (This is mandated by the JUNCTION chips C1 and C2 which funnel true wire responses from either B1 or B2 to chip D1.)

This response consists of moving forward one tile (chip D1). Now Greedy has moved to a new space. To make sure it isn't about to slam into a wall, Greedy then looks for wall. If it has moved in front of a wall, the robot runs the routine in chips F1, G1 H1, I1 H2, and I2. This routine uses a COIN FLIP Operator to generate a random rotation movement. Greedy then loops and begins the panel again.

If Greedy does not see a wall, chip E1 branches to E2 and the robot looks for a door. If a door is seen, Greedy uses a COIN FLIP Operator to determine if it will loop to the beginning of the panel or run the routine used when a wall is sensed. Not only is the decision made randomly, but one of the choices of the random decision is a routine that is based on a random decision (chip H1).

An Analysis of Greedy

Greedy was programmed on the assumption that there were plenty of good Things to acquire in the Environment it would be operating in. This means its programmer did not concern himself with carefully controlling the movement of the ChipWit. Greedy feels for Things to acquire, and, if they are there, it never misses acquiring them. If it doesn't feel them, it moves randomly (usually under the control of COIN FLIP Operators: chips F2 and H1).

Improving Greedy

Assuming we are custom building Greedy for Greedville, we can edit out the routine it runs when it has determined there is a Thing in front of it. Chips C3, C4, C5, C6, D3, D4, D5, and D6 can be replaced by a PICK UP Operator in chip location C3.

Greedy's movement is a problem. Can you see how chips E1 and E2 cause the robot problems? Could the use of the Range Finder in conjunction with these chips to improve Greedy? (See Chapter II for suggestions on Ranger Finder uses.)

Greedy moves in and out of rooms based on COIN FLIPS rather than whether the rooms have anything it may want. See if you can develop a routine for Greedy to (A.) realize when it is moving out of a room and (B.) smell the room it is leaving for disks. (Disks are worth the most points of all Things in Greedville as you will see when you read SOME FINAL DETAILS.) If there are disks remaining, have the robot turn around and find them.

As it stands now, Greedy is a good point producing ChipWit. Can you make it better and more elegant besides? The next section tells you a few more ChipWit details you'll need to understand the different Environments and it also shows some Workshop time savers.

There are four ChipWits in the Appendix in the back of the manual. Mr. C.W., another ChipWit, is on disk. Study these examples as we have done with Greedy. They all need improvement!

SOME FINAL DETAILS

This section has two parts. The first part shows you some standard Macintosh editing features that ChipWits takes advantage of in the Workshop. These let you Cut, Copy, and Paste your work. The second section tells you about each of the eight ChipWit Environments: what your ChipWits should be prepared to find there, and how much each Thing is worth. It also gives you specifics on ChipWit fuel, damage, and energy statistics.

Cut, Copy, Paste

There are three standard Macintosh functions and one special function that will help you manipulate entire panels in the Workshop. The Cut, Copy, and Paste functions (menu choices 3,4, and 5) work exactly like all Macintosh Cut, Copy, and Paste functions.

Selecting Cut will clear the panel on the screen and put that panel in memory. Simply select another panel by clicking on another letter (or the Main Panel identifier). When that panel comes on screen, select Paste and the panel you Cut will be transferred to the new panel. You can load in another ChipWit from the

Warehouse and paste the panel into that ChipWit as well. A Cut panel will remain in memory until another panel is either Cut or Copied. It may be Pasted in different locations as many times as desired.

Copy functions the same way as Cut does, except that the panel you Copy remains in place while also being copied into memory. This allows you to take an especially good panel you have developed for one ChipWit and place it in another as well. You use the Paste selection to put the new panel where you desire just as you used it for Cut. A Copied panel will remain in memory until another panel is either Cut or Copied. It may be Pasted in different locations as many times as desired.

NOTE: Panels that are Cut replace previously Cut or Copied panels in memory and panels that are Copied replace previously Cut or Copied panels in memory. There is only one panel in memory at a time, be it Cut or Copied.

Clear Panel

The sixth selection on the Workshop menu is **Clear Panel.** This does exactly that to the panel that is on screen at the moment. The panel is not saved into memory. It is gone forever. Clear Panel is a useful tool. So is a band-saw. Be careful.

Environments

There are eight ChipWits environments. All of them have pie and coffee for the ChipWit to refuel with (no points are gained when these two foods are acquired). Each Environment has a different layout, number of rooms, population of Things, and a different set of point assignments for those Things. Here are the details.

Greedville

Geography and Characteristics: Four confusingly connected rooms filled randomly with only good Things. There are no dangers here for a ChipWit except running into and trying to pick up walls.

Inhabitants and their point values: Disks are worth 100 points and oil is worth 50 points.

Cycles allotted ChipWit upon entry: 6,000

ChipWit Caves

Geography and Characteristics: Eight connected rooms that spell out a word dear to every ChipWit's heart (Main Panel?). The Caves are filled with dangerous electro-crabs which drain ChipWits' fuel. The crabs offer additional point opportunities for the robots, however.

Inhabitants and their point values: Disks are worth 100 points, oil is worth 50 points, and electro-crabs are worth 50 points.

Cycles allotted ChipWit upon entry: 10,000

Doom Rooms

Geography and Characteristics: How could there be any other number of rooms but thirteen in Doom Rooms? The Rooms are filled with electro-crabs and bouncers-- more opportunitites for points. But beware! Crabs drain fuel, and bouncers, when you run into them, inflict damage. There are no good Things (disk and oil) in the Rooms!

Inhabitants and their point values: Electro-crabs are worth 100 points and bouncers are worth 250 points.

Cycles allotted ChipWit upon entry: 10,000

Peace Paths

Geography and Characteristics: Peace Paths offers the ChipWit strategist a novel challenge. Your robot will be confronted by electro-crabs, but you must teach it to avoid them rather than Zapping them. You lose points by attacking your enemies! Point opportunities are disks and oil. The fifty-four rooms are not densely populated so you might consider some sensing routines to make sure your robot doesn't tarry too long in barren fields.

Inhabitants and their point values: Disks are worth 150 points, oil is worth 20 points, and electro-crabs cost your ChipWit 30 points.

Cycles allotted ChipWit upon entry: 16,000

Memory Lanes

Geography and Characteristics: The ten room maze contains a regenerating disk at either end. Traveling back and forth allows you to garner this prize multiple times (the disk regenerates while you are at the other end of the maze). Along the way are both electro-crabs and bouncers as well as oil.

Inhabitants and their point values: Disks are worth 250, oil is worth 30, electro-crabs are worth 30, and bouncers are worth 60.

Cycles allotted ChipWit upon entry: 20,000

Octopus Garden

Geography and Characteristics: Eight hallways and fourty-four rooms branch off of a central location. At the end of each hallway is a high point value Thing. Why would the Move Stack be helpful here?

Inhabitants and their point values: Disks are worth 250 points, electro-crabs are worth 10 points, and bouncers are worth 20 points.

Cycles allotted ChipWit upon entry: 20,000

Mystery Matrix

Geography and Characteristics: The Matrix consists of one hundred rooms, all with identically located doors. Discover the secret of the high-point pathway by having your ChipWit read the signposts. (Signposts? What signposts? I didn't know a ChipWit could read!)

Inhabitants and their point values: Disks are worth 250 points, oil is worth 150 points, electro-crabs are worth 20 points, and bouncers are worth 40 points.

Cycles allotted ChipWit upon entry: 30,000

Boomtown

Geography and Characteristics: The nine rooms in Boomtown are the most dangerous rooms a ChipWit will ever face. They are filled with bombs that blow ChipWits up if the robots so much as sneeze on them. You'll see a pattern to the way the bombs are layed out-- and you better teach your ChipWits to see it as well or else they'll never go far in Boomtown (except straight up in the air).

Inhabitants and their point values: Disks are worth 250 points and electro-crabs are worth 40 points.

Cycles allotted ChipWit upon entry: 12,000

Some Vital Statistics

We have talked rather vaguely about fuel consumption, cycle consumption, and damage. In general, of course, you want your ChipWit to stay away from the fuel draining electro-crabs and the damaging walls and bouncers. Here are specific numbers to indicate the exact nature of these dangers.

Fuel

A ChipWit begins each mission with 7,000 units of fuel. When it eats pie or coffee it gains 1,200 units of fuel. When it is attacked by an electro-crab, it looses 200 units of fuel. The amount of fuel consumed by each Operator is the third column in the chart below.

Cycles

ChipWits begin each mission with a set number of cycles. This number is determined by the Environment. Cycles are expended for each Operator executed. The amount expended for each Operator is the second column in the chart below.

Operator	Cycles	Fuel
Loop	1	1
Sub-Panel	1	1
Boomerang	1	1
Junction	0	0
Move	3	5
Pick up	1	5
Zap	1	7
Sing	2	2
Feel	4	4
Look	4	2

Smell	4	2
Coin Flip	3	1
Keypress	3	1
Compare Numer: Equal?	2	1
Compare Number: Less Than?	2	1
Compare Thing: Equal?	2	1
Compare Move: Equal?	2	1
Save Number	1	1
Save Thing	1	1
Save Move	1	1
Pop	1	1
Increment	1	1
Decrement	1	1

Damage

A ChipWit begins each mission in perfect health. Damage to a ChipWit is not repairable. 1,400 Units of damage kills a ChipWit. Attempting to Pick up a wall inflicts 50 units of damage. Attempting to Pick Up an electro-crab or bouncer inflicts 150 units of damage. Bumping into an electro-crab or a bouncer inflicts 100 units of damage. Bumping into all other objects inflicts 50 units of damage. Detonating a bomb inflicts 1,400 units of damage.

OBJECTIVES

In Chapter I you learned how to operate your ChipWits system. You also learned the elements of beginning programming with the Workshop. After completing this section you will be able to:

1. Use the Keypress for testing program routines within an environment.
2. Use stacks to improve the efficiency of your ChipWit programs.
3. Increase the speed and efficiency of your ChipWit and your programming.

THE KEYPRESS

The Keypress Operator is represented by an icon of a computer key with no letter on it.

The Arguments for Keypress are the letters of the alphabet and a blank key.

When a chip with a Keypress executes, it instructs the program to check if a specified key (the letter you have choosen for the Argument) on the Macintosh keyboard is being pressed. If the key is being pressed at the time the chip executes, the program branches out the Keypress chip's true wire. If the chip is not being pressed, the program branches out the chip's false wire. The blank key represents a wild card choice. If any key is pressed, the blank key Argument will cause the chip to branch through its true wire.

By selecting Keypress and a letter from the Arguments Menu, you install a manually controlled command in your ChipWit. The Keypress Operator gives your ChipWit the benefit of your human intelligence.

Uses

In Chapter I, we broke ChipWit programming into three parts: Instruction Sets, Sequence of Instruction, and Conditional Testing. To help you master robot building, the Keypress can be used to separate the challenges of constructing Instruction Sets from those of determining the larger Sequences of Instruction.

For example, one of the challenges a ChipWit faces in any Environment is knowing when it is time to leave a room and then finding a door and exiting. You can substitute the routine in which the ChipWit determines whether it should leave the room with a Keypress linked to a routine to find a door and exit. As you are watching this ChipWit on a mission, make the decision yourself about when the robot should leave the room . Activate the Keypress and send your ChipWit to the exit routine.

This allows you to perfect the exit routine. Once this is accomplished, go back and create a routine for determining when it is time to leave a room. Put this in the program replacing the Keypress you used before to control the exit decision.

In general, the Keypress allows you to focus on perfecting Instruction Sets while you control the overall flow of the program manually. After all routines to perform specific functions have been worked out (clearing a room of dangerous Things, clearing a room of good Things, finding doors, etc.), the Keypresses used to call them can be substituted by new routines that determine when it is appropriate to activate each specific function. By removing the Keypress commands and substituting sensing routines, you will remove your guiding hand and let the ChipWit think for itself!

Each routine that you control with the Keypress can easily be constructed in a Sub-Panel. Place your Keypress chips on the Main Panel and connect the true wires to Sub-Panel chips.

When you are ready to replace the Keypress with an internally driven routine, put that routine on a Sub-Panel and replace the Keypress chip with a call to that Sub-Panel.

You now can practice making the ChipWit perform tasks, and you can add manual controls in case your ChipWit is not sure when to perform them.

A Special Application

Appendix A in the back of this manual has a few ChipWits for study (and improvement). ChipWit #1 is called Keybaby. It is a completely Keypress controlled ChipWit. By using the I-J-K triangle of keys on the keyboard, you can control Keybaby's movement. Pressing Z causes a Zap and P causes a Pick Up.

Keybaby works effectively because the program is so small that you never have to be concerned about being far away (in the program) from the Keypress you need. In larger programs with Sub-Panels, repeating Keypresses and the routines they call may be necessary.

Keybaby was designed for two reasons. He is a great tool for the savvy ChipWit builder to use to explore ChipWit Environments. Such explorations yield information about the Environments that is helpful in building true, internally driven ChipWits. Keybaby is also great for acquainting younger people with the ChipWits system.

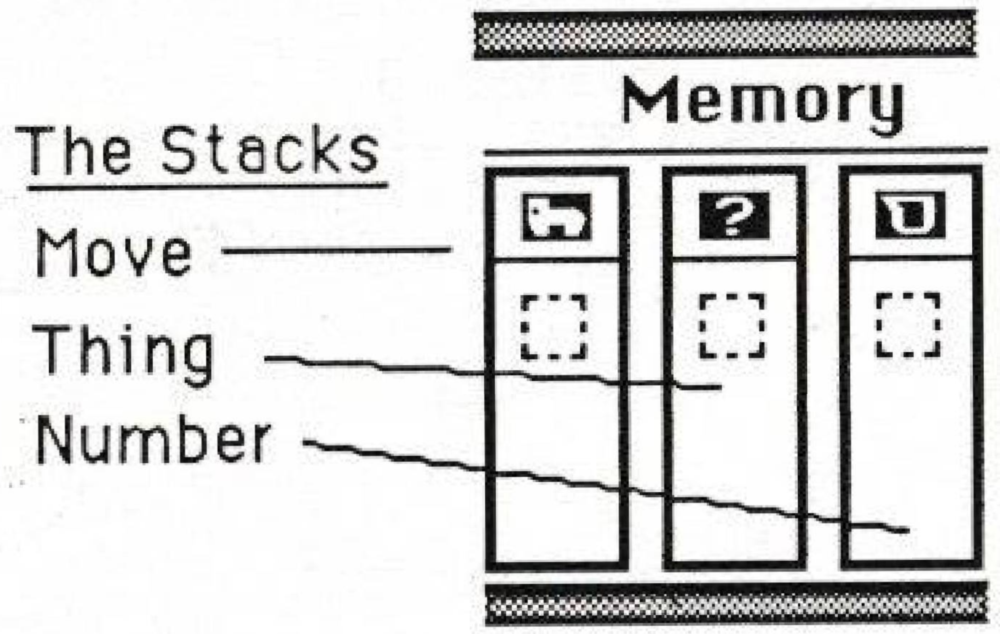
MEMORY STACKS

Memory Stacks were discussed briefly in Chapter I in the section on Operators and their Arguments. Stacks are storage areas in which you can have the ChipWits keep lists of:

1. Moves the ChipWit makes.
2. Things your ChipWit encounters.
3. Numbers (from a variety of sources).

Items are stored in the memory stacks on a first in/last out basis. This means that the last item (move, number, or Thing) that you asked the ChipWit to remember will be at the top of the stack. When you ask the ChipWit to save another item, that item becomes the top item on the stack and the former top item moves to the second slot.

The Memory Panel shows the top three items in each of the stacks. The item at the top is first in the stack, the item at the bottom is third. The stacks, from left to right, are the Move stack, the Thing Stack, and the Number Stack.



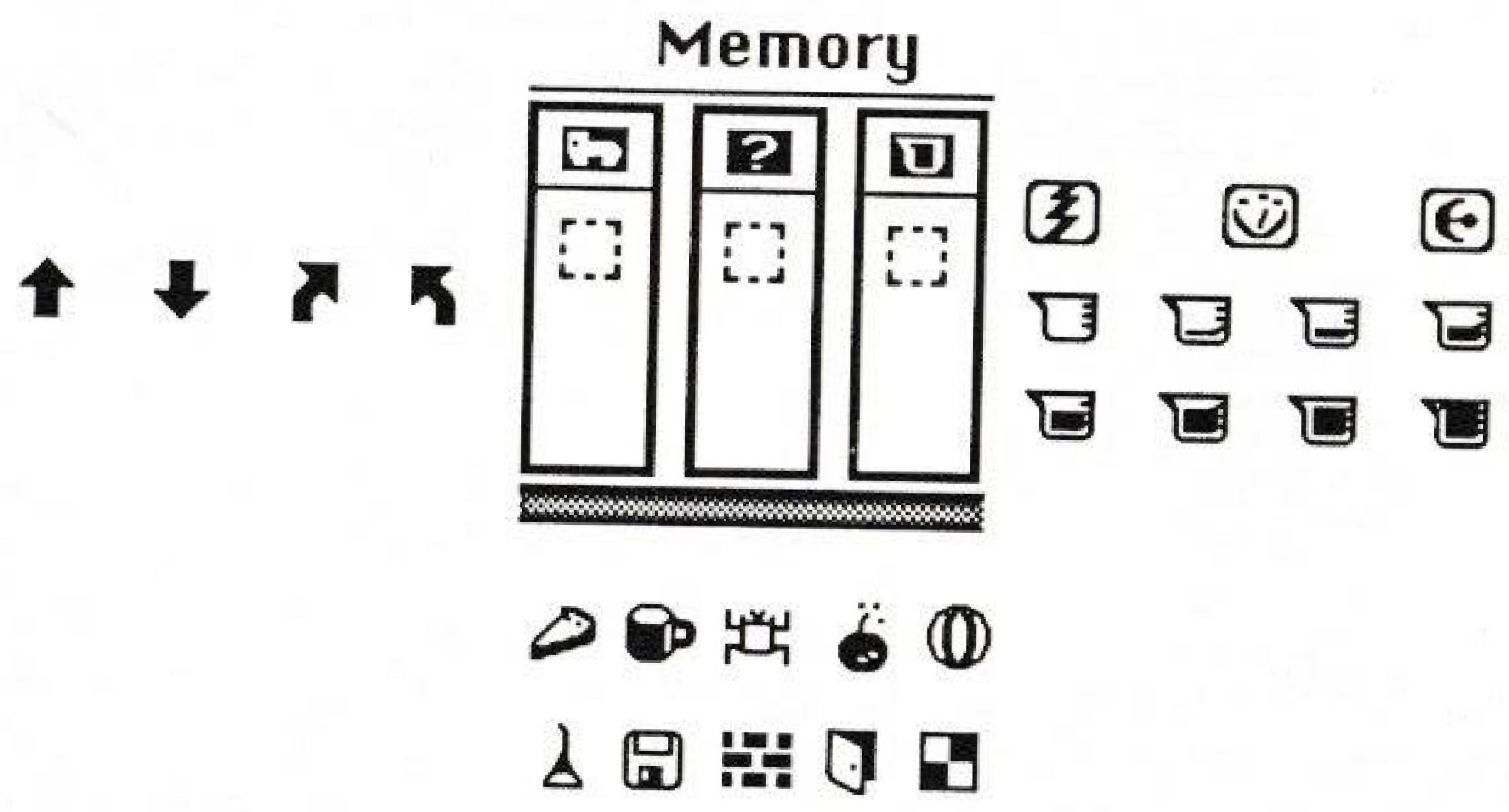
The ChipWit has access to only the top item of the stack at any one time. When you use the Operator COMPARE MOVE, for example, you are commanding the ChipWit to compare the Argument of the COMPARE MOVE chip (it will be a directional arrow key) with the move at the top of the Move stack. Likewise, if you use the COMPARE NUMBER: EQUAL? Operator, you are commanding the ChipWit to compare the Argument of that chip (it will be a number or a value derived from one of the meters) with the number at the top of the Number stack.

For the ChipWit to use items other than the top one in a stack, it must use the POP Operator to remove the top item from the stack. (The Argument that goes with the POP Operator tells the robot which stack to remove the top item from.) After POPping the stack, the item that was in the second slot becomes the first item. All other items move up one space as well.

Stacks can keep lists up to 256 items long. The 257th item pushes out the item that was put in the stack first.

Saving to Stacks

By using the three SAVE to STACK Operators, you command the ChipWit to add items to the three stacks. Below is a chart which shows the NUMBER, MOVE, and THING Stack Registers and the Arguments that go with each Stack. The Arguments represent the items that can be saved to that stack.



Stack Functions

What can the ChipWit (and you, the ChipWit programmer) do with the information that has been stored in a list in the stacks? Where does the ChipWit get the information that is saved into the stacks? How do you use the information to build a better ChipWit once it is there? Read on!

The Thing Stack

The ChipWit can compare the top item in the Thing Stack to any one of the ten ChipWit Things (pie, coffee, oil, disks, electro-crabs, bouncers, bombs, walls, doors, and floors) as well as to an empty square. (The empty square represents the bottom of the stack. If you choose COMPARE THING and select the empty square Argument, you are asking the ChipWit to test to see if the stack is empty.) If the Argument of the COMPARE THING chip and the Thing at the top of the Thing Stack are the same, the program branches from the true wire. If they are different, the program branches from the false.

The Move Stack

The Move stack functions in exactly the same way as the Thing stack. If the top move in the Move Stack is the same as the Argument of the COMPARE MOVE chip, then the program branches from the chip's true wire. If they are different, it branches from the false wire. Again, the empty square Argument for COMPARE MOVE represents the bottom of the Move Stack. If the stack is empty, the bottom of the stack will match the empty square.

The Number Stack

The Number Stack has two compare Operators: COMPARE NUMBER: EQUAL? and COMPARE NUMBER: LESS THAN? The former (COMPARE NUMBER: EQUAL?) works the same way as the compare Operators for the Move and the Thing Stack. If the match between the Argument and the value at the top of the Number Stack is identical, the branching is true. If the number in the top of the Number Stack is not the same, branching is false.

COMPARE NUMBER: LESS THAN? also compares the top number in the Number Stack to the chip's Argument. If the number in the stack is less than the Argument, the branch is true. If it is more than or equal to the Argument, the branch is false.

Both Operators utilize the empty square Argument to check if the stack is empty.

The Stacks in Use

We now know what the stacks are capable of doing. Below are hints for each stack that will show you two things:

1. Where you can instruct your ChipWit to get items for its stacks.
2. Some uses you can make of the stacks capabilities.

The Thing Stack

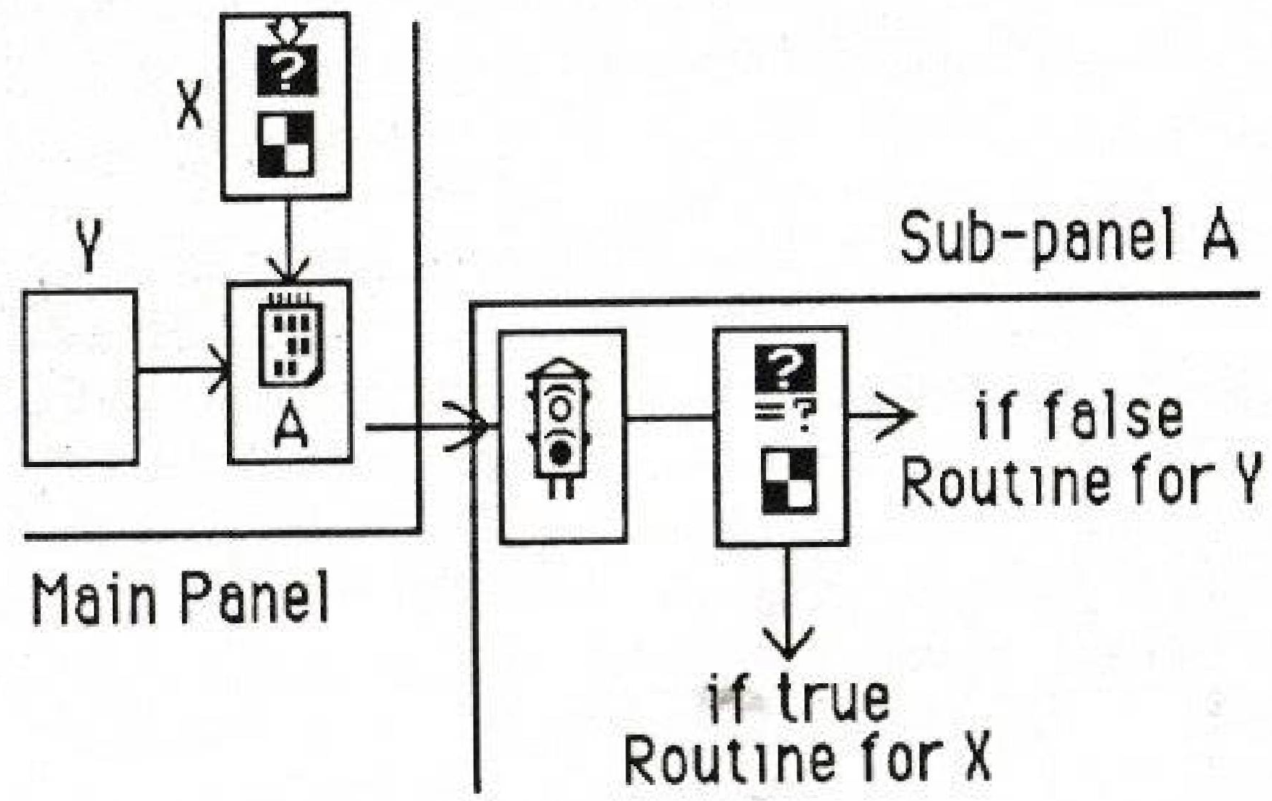
There are several methods you can use to construct lists in the Thing Stack. You can have the ChipWit push into the stack anything it smells, sees, or feels. Using the SMELL Operator, this will give you an inventory of all Things in any room. With such an inventory, you can insure that the ChipWit does not leave any room until it has acquired all the high point items (usually disks) available in the room.

Using the Environments description at the end of the first chapter as a guide, have the ChipWit push all possible Things for that Environment into the stack. Program this routine on the Main Panel. Follow it with a routine telling the ChipWit to SMELL for the item at the top of the Thing Stack. If the match is positive (the item at the top of the Thing Stack is SMELLed in the room), jump to a search and acquire Sub-Panel. If the Conditional Test is negative, Pop the item and SMELL for the new top item.

A variation on the method above can be used with the LOOK Operator. If the LOOK Operator on the Main Panel detects a Thing, push that Thing into the Thing Stack and jump to an acquire Sub-Panel. There, LOOK for the Thing at the top of the Thing Stack. Move in a straight line until acquisition is possible. If the Thing is one that you want to ZAP, no ChipWit motion is required at all.

All stacks can be used as codes. This is a fairly sophisticated but effective way of using them. Select an Argument that is not present in the Environment or a Thing-- such as FLOOR-- that you will not be storing in the Thing Stack. This Argument will have a special meaning when found at the top of the Thing Stack.

A Sub-Panel chip on the Main Panel that is accessed by two separate chips can use the coded Thing to determine which chip led to the Sub-Panel. Once you have jumped to the Sub-Panel, check to see if that Argument is at the top of the stack. Based on the presence or absence of the coded Thing, you can sub-divide the Sub-Panel. The true wire of the COMPARE THING chip can lead to a routine that addresses one potential situation. The false wire on the COMPARE THING chip triggers a routine completely separate in purpose. The illustration below clarifies.



The Move Stack

The Move Stack is especially helpful in bringing your ChipWit back from long trips away from the center of an Environment or in Environments where travel back and forth in a pattern is required. (This is particularily true in the case of several Environments. Can you tell which ones?) As a ChipWit makes moves, push the opposite move into the Move Stack. When the time comes to retrace steps, simply select the Move Stack Argument for the Move Operator. Remember to Pop off each move as you use it!

ChipWit 4 in Appendix A uses the Move Stack this way. Octobuster, although fairly complex, is worth study to see how this is done.

The Move Stack, like the Thing Stack, can be used as a code to pass information to Sub-Panels. This will allow you to use the Sub-Panels for more than one application.

The Number Stack

The Number Stack is perhaps the most useful of the three Memory Stacks. It can be a great aid in conserving fuel units and cycles, as well as monitoring the health and well being of a ChipWit.

If the ChipWit detects a Thing through a LOOK Operator, the number of floor tiles from the robot to the Argument are registered in the Range Finder. Use the SAVE NUMBER Operator and the RANGE FINDER Argument to store the distance in the Number Stack. Now have the ChipWit COMPARE NUMBER: EQUAL with the Argument one. True? Grab the Thing! False, move forward one tile and loop back (using JUNCTION chips) to the look command and repeat. Using the Number Stack in this situation-- as opposed to merely reaching and moving until the Thing was acquired-- allows you to program your ChipWit to operate efficiently.

The Number Stack can be used to keep watch on the ChipWits health. The Damage Meter and the Fuel Meter produce values that can be pushed into the Number Stack. If you wanted to build a ChipWit that ate only when it was hungry, you could monitor hunger by comparing the value from the Fuel Meter with a criterion you set (based, perhaps, on the availability of food in the specific Environment). When the meter reached a level you determine, send your ChipWit off to an acquire food Sub-Panel. In the mean time, let the robot concentrate on point producing acquisitions.

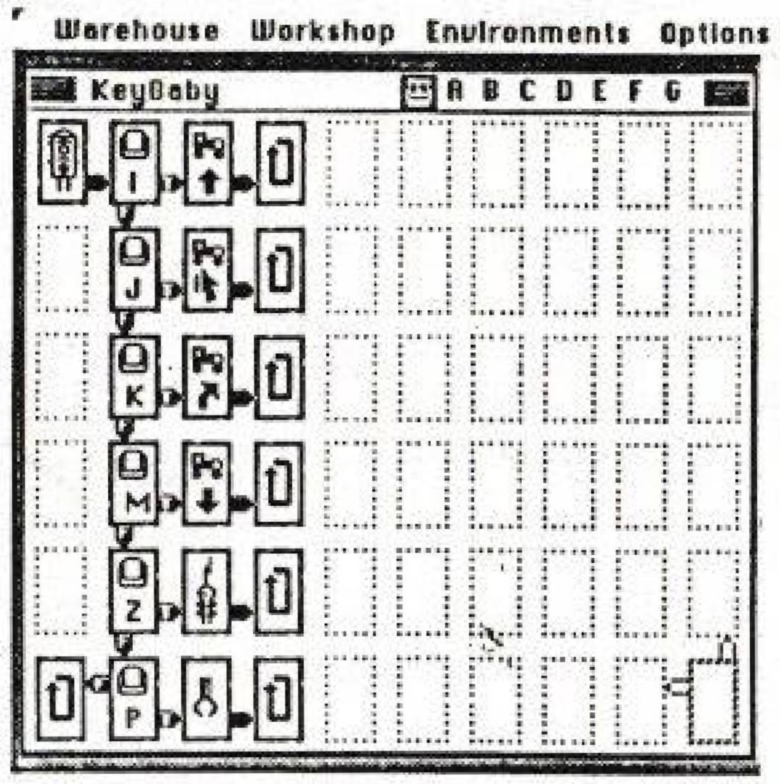
In the same way as you use the Number Stack to monitor ChipWit hunger, you can use it to monitor ChipWit damage. The Damage Meter, like the Fuel Meter, produces a value. This value can be pushed into the Number Stack and compared with criteria you set. If the ChipWit reaches the point where it must be careful not to sustain further damage, send it off to a Sub-Panel where a less aggressive movement and acquire routine will conserve its health.

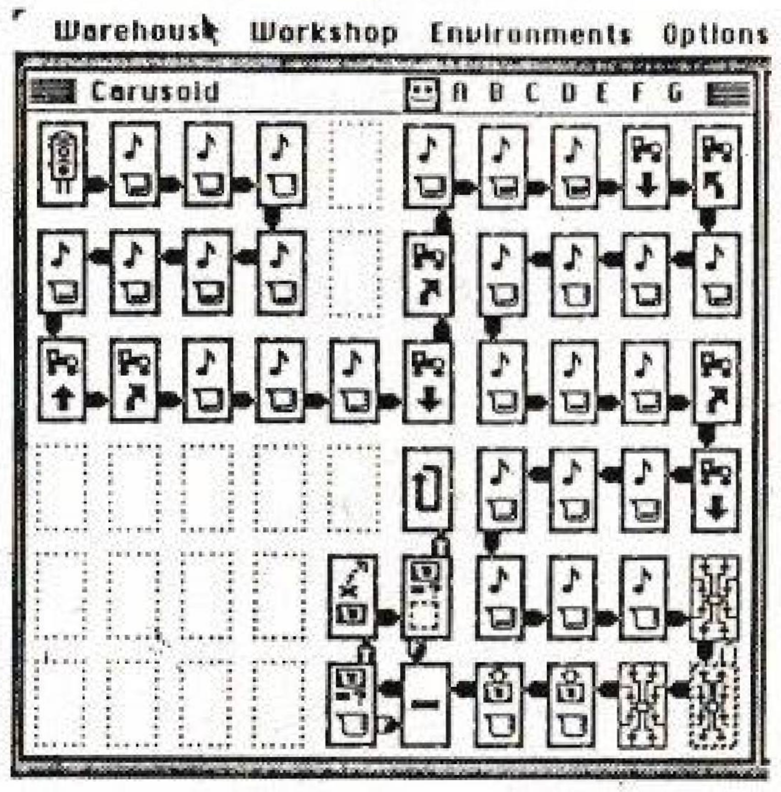
FINAL WORDS

In this documentation, we have tried to supply you with all the information you will need to enjoy ChipWits. The ultimate value of the program will be determined by the learning that occurs <u>after</u> you have read and understood the documentation. We hope we have teased your interest enough for you to go on and discover many clever ways to use stacks, Sub-panels, Keypresses and all the rest.

To help you along, we have included a Rogues' Gallery (Appendix A). This contains four ChipWits. Each needs improvement. General suggestions are offered, but the analysis of the changes needed and the implimentation is up to you. After you have cleaned up the scoundrels, you'll be more than ready to build your own robots from scratch. Maybe you already are!

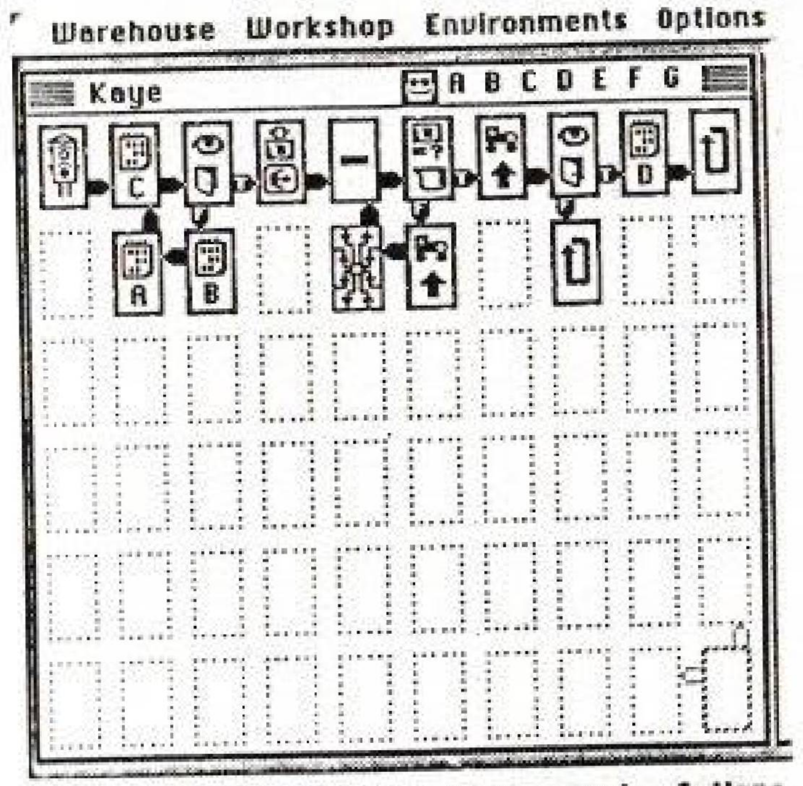
Keybaby: Keybaby, the darling of ChipWit builder Eric Madsen, is a great tool to use exploring Environments. It also allows very young children to play with ChipWits. Since the ultimate goal of all Keypresses is to be replaced by internally driven ChipWit Instruction Sets, see what you can train Keybaby to do for himself.

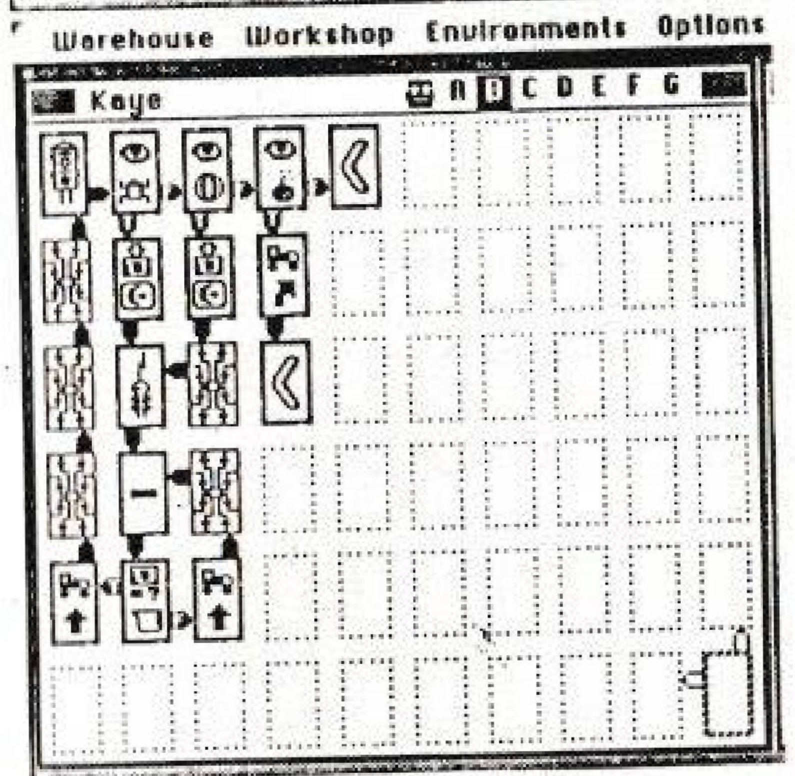


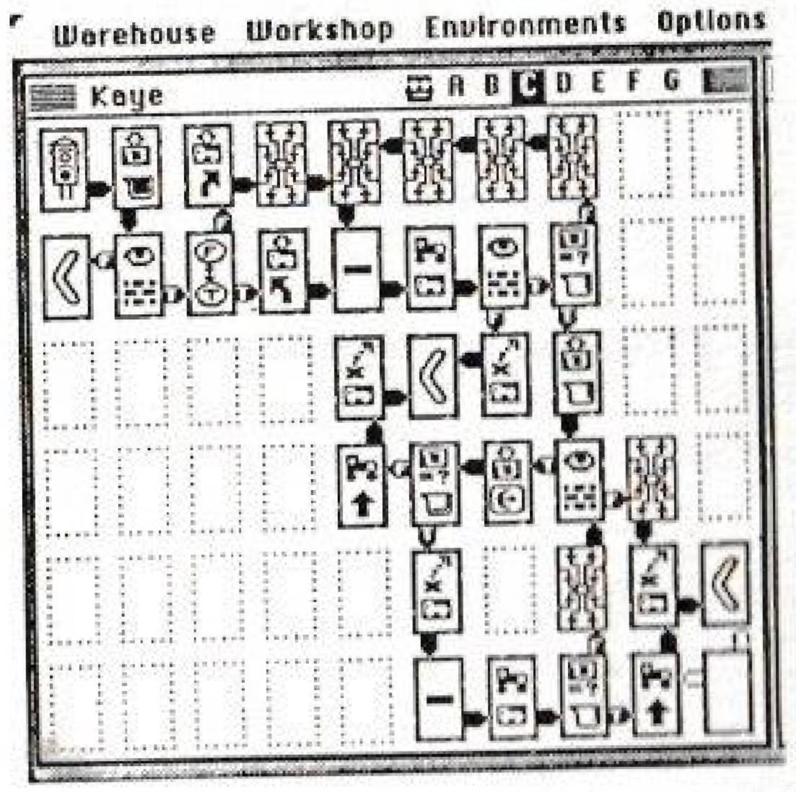


Carusoid. Carusoid, built by Leahcim Notsnhoj, is another ChipWit that will get young people interested in robot programming. Try having a beginner improving the singer bit by bit. Can you make him sing only in certain occasions (like before his dinner)? Remember, you can cut the song panel and place it on a Sub-Panel. There it can be used on special occasions. Perhaps you could teach him another song. Maybe just keeping him from destroying himself would be a good place to start. Basically, Carusoid is just for fun.

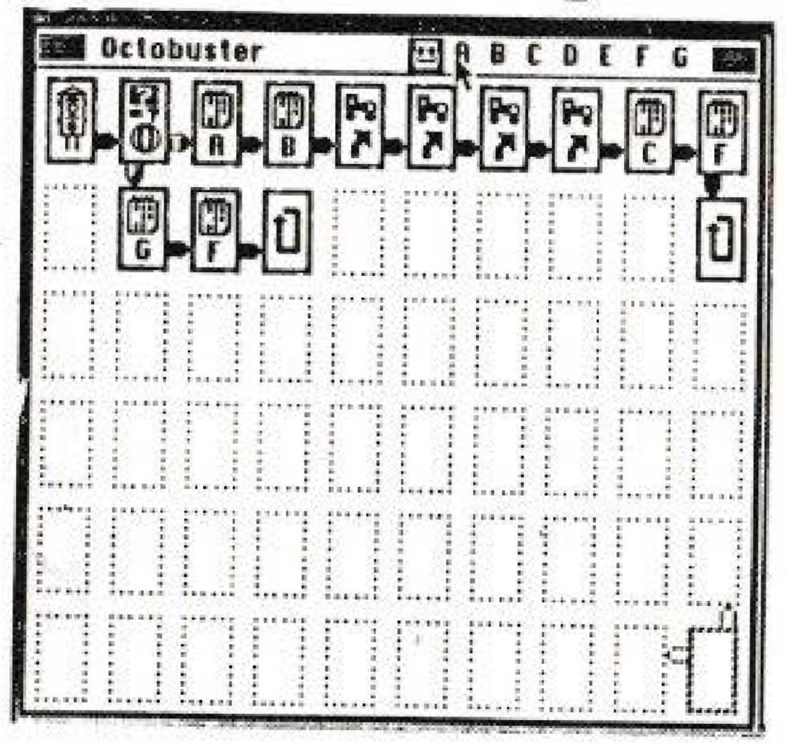
Kaye. Kaye, a darn good bread (point) winner, was built by Richard Phaneuf. Kaye is an aggressive ChipWit who runs in where she has conquered. Perhaps she is a bit reckless. Watch her perform. Can you see situations where she should be more cautious? Study the use of the Number Stack here. Pretty good, eh?

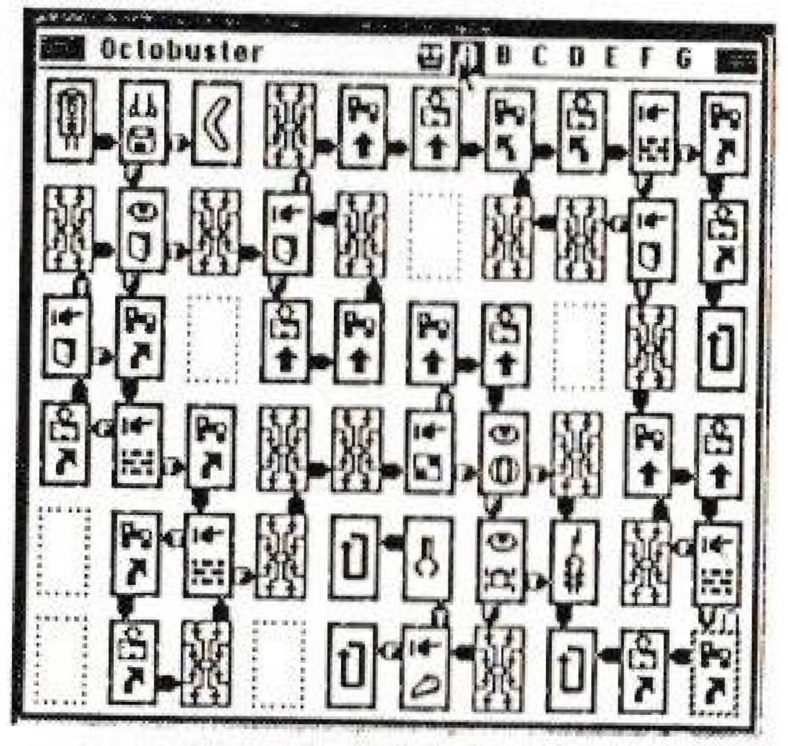


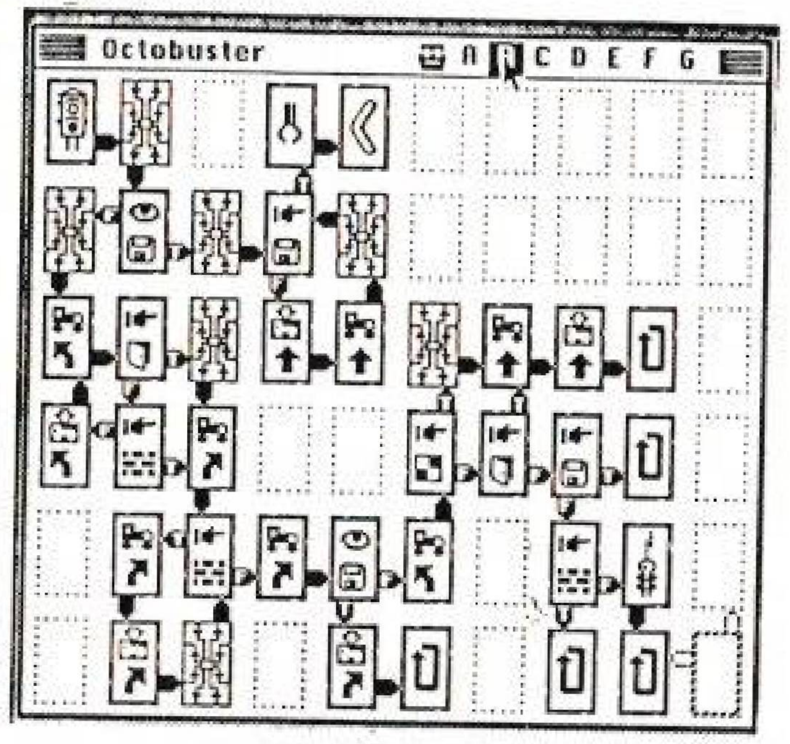


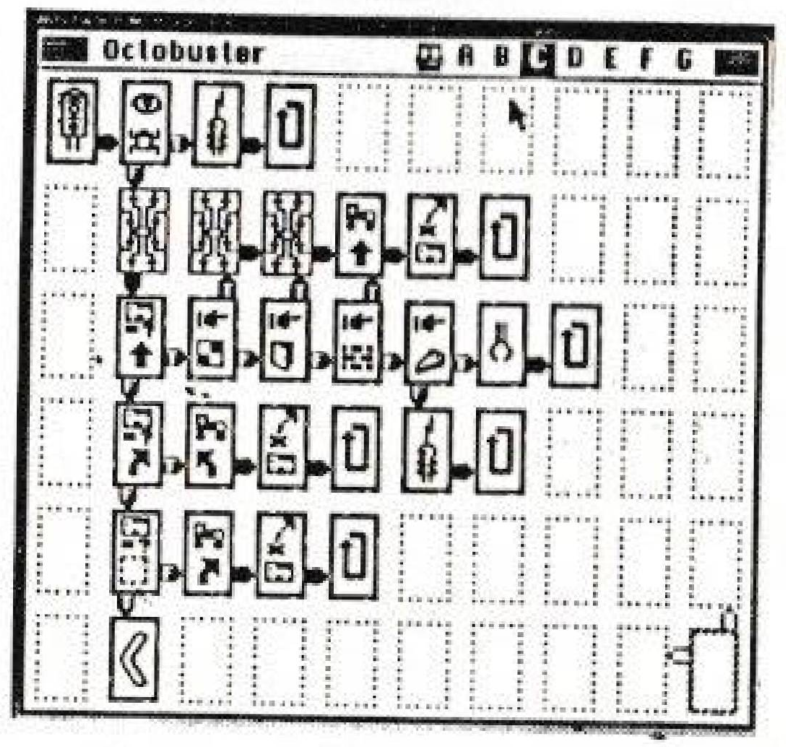


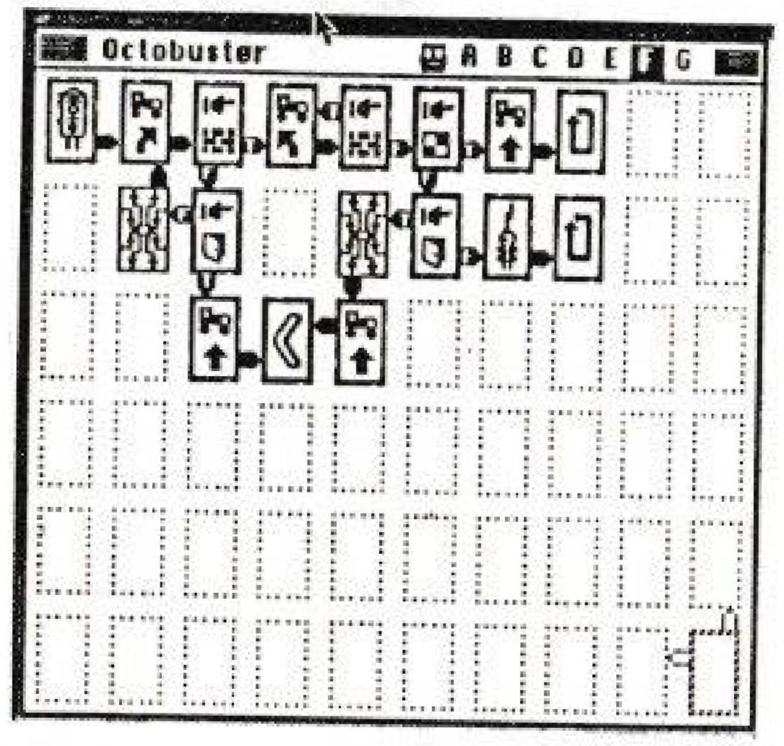
Octobuster. Octobuster was awarded the coveted grand prize in the Prix de Minneapolis in 1984. The humble author, none other then D. Sharp, Esquire, modestly points out that the use of the Move Stack in Octobuster is "...well, the finest example of ChipWit programming that you're every likely to see, frankly..., I mean really." Hmm. Do you thing Octobuster looks at his Fuel Meter often enough?

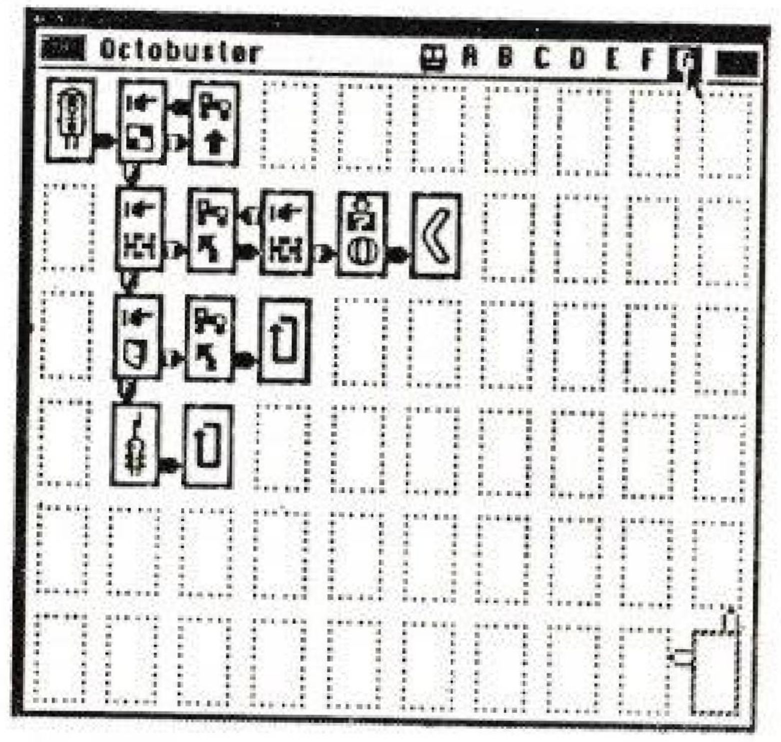












GLOSSARY

Argument - The object of an Operator.

Boomerang - The Operator that instructs the program to return from a Sub-panel to the Main panel.

Chip - The container of an individual Instruction Set (Operator and Argument). Chips are set in panels and connected to each other by true and false wires.

ChipWits - The robots you program.

Coin Flip - An Operator that performs a random choice between a True or a False branch.

Compare (Thing, Move, or Number) - An Operator which checks a Stack to determine if a condition (Things, Moves, Numbers) is present at the top of the stack.

Conditional Testing - Checking to see if a specified thing is present in an Environment or a stack. Depending on the presence of the thing, the ChipWit program branches through the testing chip's true or false wire.

Debug - An on-screen display providing information allowing the user to trace a ChipWit program's execution for the purpose of determining how well it is operating.

Decrement - An Operator that decreases the top value in the Number stack by one.

Default - A preset condition changeable by the user.

Environments - The rooms in which ChipWits carry out missions.

Flow Charts - A graphic format used by programmers to plan their programs.

Flow of Control - The Sequence of Instructions with in a program. The order in which the instructions are given to the robot.

IBOL (Icon Based Operating Language) - The picture defined set of commands which tells the ChipWit what to do.

Icon - A stylized picture which represents an instruction, action, Thing, or memory stack.

Increment - An instruction to increase a value in the number Stack by one.

Instruction Set - The combination of an Operator and an Argument which gives a command to a ChipWit. In some cases, an Operator alone (such as PICK UP) can make a complete Instruction Set.

Junction - A chip that has no other function than to connect two other chips.

Keypress - Operator which checks whether a specific key has been pressed and branches True or False based on this.

Loop - The return-to-beginning instruction in a Panel.

Main panel - The panel on which the primary Flow of Control is programmed. The Main panel calls the Sub-panels to execute.

Menu Bar - The strip across the top of the screen displaying the pull-down menus available to the user.

Mission Assignments - The objectives to be achieved within the different Environment by the ChipWit. Assignment vary based on the challenges of the Environment.

Operator - The action command telling the ChipWit what it is to do.

Options - A utility menu found on the Menu Bar.

Paste - An editing command allowing the user to transfer a previously Cut or Copied Panel to a new location within a ChipWit or to a new ChipWit.

Pop - Removes an the top item from a Stack.

Registers - On screen displays that show the top three items in each of the three stacks.

Save (Move, Number, or Thing) - An Operator which places (saves or pushes) a move, Thing, or number into a stack.

Stacks - Three different memory storage areas each holding up to 256 Things, numbers, or moves.

Stats Panel - A display showing the number of missions run by the current ChipWit in the current Environment, the average score for those missions, and the highest score from those missions.

Sub-panel - A panel which is called from the Main panel. Sub-panels are identified by the letters a through G and can be repeatedly used in the program.

Things - Objects that a ChipWit encounters in an Environment (oil, disks, pie, coffee, electro-crabs, bouncers, bombs, walls, doors, and floor tiles).

Warehouse - The place where ChipWits are stored. Also, the menu which allows you to load ChipWits into an Environment or the Workshop.

Wires - (True and False) Connected to each chip. Direct Flow of Control based upon the results of Conditional Testing.

Workshop - The place where you build your ChipWits. Also, a menu that allows you to begin building or editing ChipWits.

Zap - The command for destroying all Things (except doors, walls, and the floor).

WARRANTY

BrainPower, Inc. warrants all of its products to be free of operating defects, whether caused by media failure or program error. Should you find an error which you believe to be caused by a failure of the media or the program, you should return the disk for replacement along with a written description of the problem to **BrainPower, Inc., 24009 Ventura Blvd., Suite. 250, Calabasas, CA 91302**. Media failures occuring less than ninety (90) days after purchase will be replaced at no charge. Those occuring after this period, or submitted without proof of purchase will have a service charge of **$10.00** plus shipping and handling. Programming defects that are verified by **BrainPower** will be corrected and the program returned to you at no charge. This lifetime programming warranty shall remain in effect, so long as this product is being sold. Should **BrainPower** be unable to correct the error after a reasonable period of time, you will be entitled to a full refund of the original purchase price.

In no event will BrainPower, Inc., its employees, or its authorized representatives be liable for consequential or incidental damages arising from the purchase and/or use of this product, even if BrainPower, or its authorized representatives have been advised of the possibility of such damages. Some states do not allow the exclusion of liability for incidental or consequential damages, so the above limitations and exclusions may not apply to you.

In the event you wish to consult with **BrainPower** regarding any question you may have, please call us at 818-884-6911, and ask for **Customer Support.**