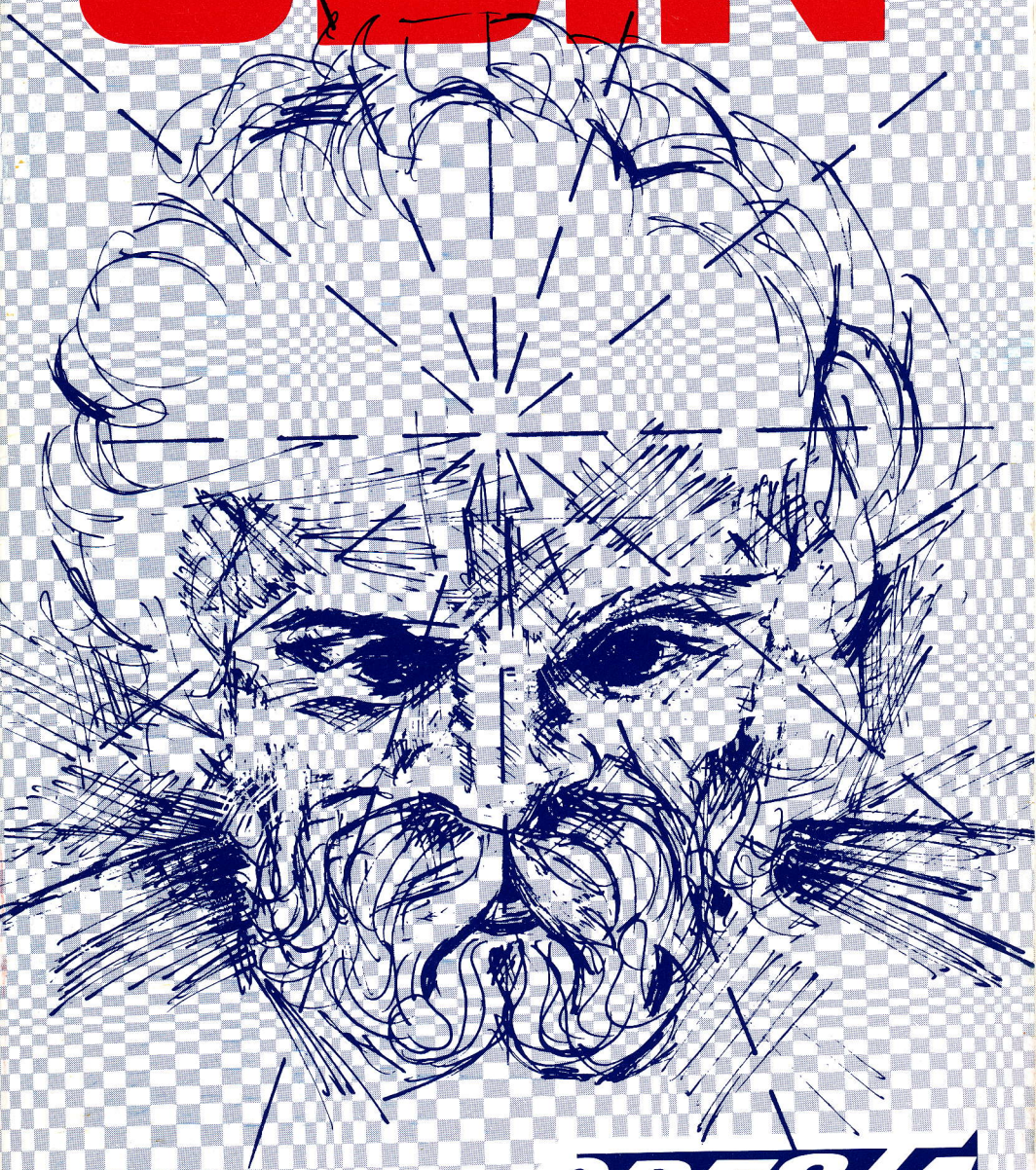# ODIN

ODESTA

Odesta

Odesta develops and publishes intelligent software for microcomputers, specializing in two areas — problem-solving business applications, and programs exploring complex strategy games. Programs are designed to optimize the use of the computer by a non-technical person. One of the distinguishing features of Odesta software is the combination of ease-of-use with extensive user oriented features in each program.

Odesta and the Alpha-Beta Software Group

Larry Atkin, Peter Frey, John Morgan, and David Slate (the Alpha-Beta Software Group) are well-known for their work in the field of machine intelligence.

Odin (Atkin, Frey), the first joint effort of Odesta and Alpha-Beta, has been over two years in the making.

Odin has developed out of extensive research and actual tournament play. It has been designed to provide a high degree of "user-friendly" accessibility to many types of strategic exploration.

David Slate's Checkers (released early 1982) is signally unique, and is as rewarding to the action-oriented tyro strategist as it is to the accomplished "intelligencer".

We are located at 930 Pitner, Evanston, Illinois 60202 (U.S.A.), and welcome requests for product information.
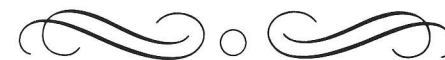
A Manual of Instruction

for

ODIN

A GAME OF SKILL AND PERCEPTION

*The manner of play conforms to
the rules set down by the*

UNITED STATES
OTHELLO ASSOCIATION

*TRS-80 version written by Peter Frey
Apple version written by Larry Atkin & Peter Frey*

Published by

∾◝ CONTENTS ◜∾

APPENDIX

Playing surface showing numbered rows & lettered columns.
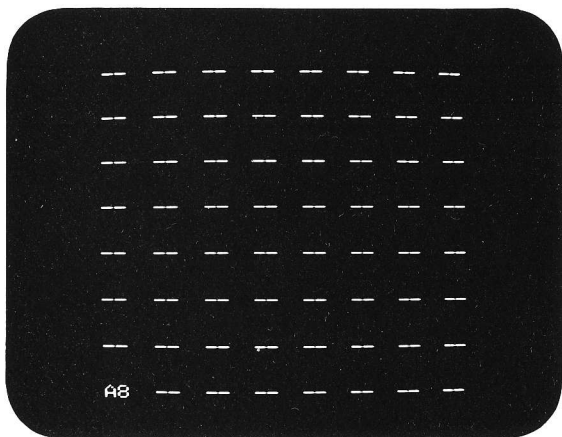
ODIN's playing field.
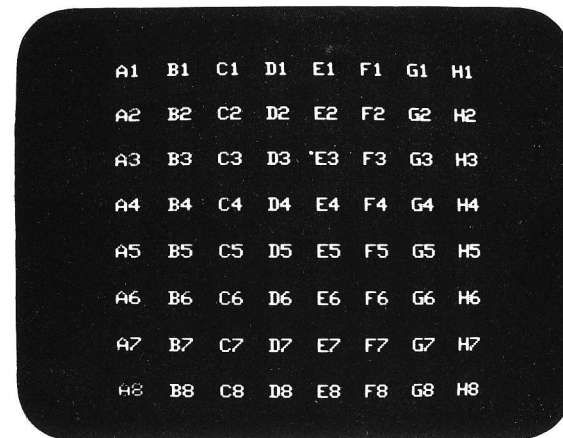
ODIN "Board" displaying full notation.

RULES OF PLAY
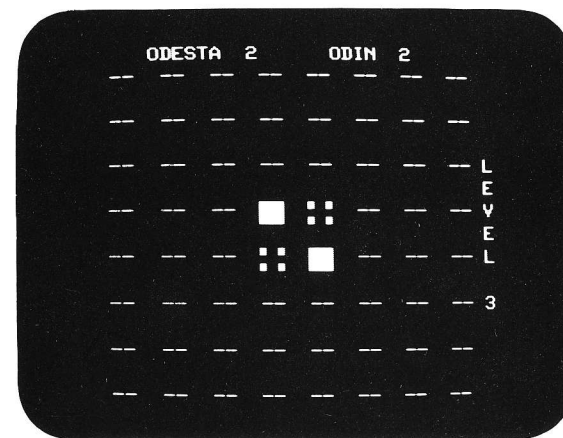
The start position (never varies)

The rules of play for Annexation (Reversi, etc.), have been modified slightly each time another variation of the game has appeared (see "BACKGROUND" - Appendix). ODIN plays according to the rules which are most frequently used in modern play. In rule considerations where

there may be several slightly different interpretations, ODIN follows the regulations established by the United States Othello Association.

The modern version of the game is played on an 8 x 8 grid (a chess or checker board). Each player has a large number of playing pieces which are a characteristic color or shape. Typically, small disks, painted black on one side and white on the other, are used. These are then flipped over as the pieces change sides. Play begins with four pieces occupying the centermost squares of the grid. Each player has two pieces lying on one of the main diagonals. Play consists of each contestant taking a turn by placing a piece in the playing area. The two contestants alternate turns until the playing area has no more empty spaces (or until neither has a legal move).

A move is legal IF it simultaneously fulfills three requirements.

First, each piece must be placed on an empty cell of the 8 x 8 grid. Attempts to place pieces on occupied locations are forbidden.

Second, the newly placed piece must be immediately adjacent to one or more of the opponent's pieces (vertically, horizontally, or diagonally).
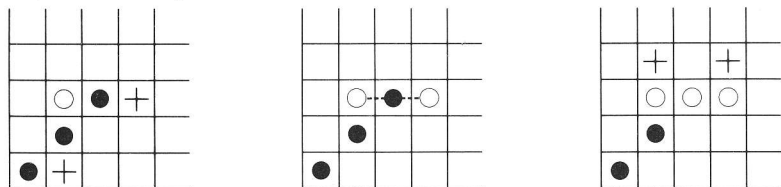
Example 1 (a)
(Black to move) "+" *signifies a legal move*
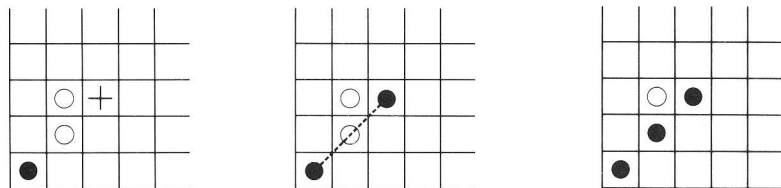
Example 1 (b)
(White to move)

Third, the placement must be made so that a straight line drawn from the newly placed piece, and going through one of the adjacent enemy pieces, must eventually intersect a friendly piece before it encounters an empty cell or the edge of the playing area (see examples). The enemy piece or pieces lying between the newly placed piece and the existing friendly piece are said to be "outflanked", and are captured by the player making the move. Each of these pieces reverses its status (changes sides). This outflanking can occur in more than one direction at the same time. When it does, all of these pieces are captured by the player. During the late stages of the game, a newly placed piece may outflank multiple rows of the opponent's pieces, causing whole sections of the playing area to change ownership. It is this characteristic of the game which presumably led to the names of Annexation and Reversi.

If a player has no moves, he or she must pass, and the opponent then plays again.. If the player has one or more moves, he or she must choose one of them. A player may not pass just because all of the available moves are undesirable. When neither player has a legal move, the game is over. The winner is the player with the larger number of pieces at the end of the contest.

If you are unfamiliar with this game, the easiest way to learn is to load the program and play a game. ODIN will not accept an illegal move, and will suggest a move for you if you so desire. After playing a few games, you will have easily mastered all of the rules of play.

∿ TO REITERATE ∿

1. Moves are permissable only onto unoccupied squares (and once placed, the square remains occupied throughout the game, although it may change sides several times).

2. Only moves which capture pieces are permitted.

3. If no legal move is present, the player loses a turn (and continues to lose turns until a valid move surfaces).

4. Captures are made by line interception, in all 8 possible directions, simultaneously. Remember - only the originally placed piece may capture, and the newly reversed squares are powerless (but open to capture by your opponent), until you regain your turn.

5. You may not pass if a legal move is present (even if the move will do more harm than good).

6. When there are no valid moves for either side (such as when the board is filled), a count is taken, and the side with the largest number of pieces is declared the winner. Note: it is possible, though not common, to win by capturing **all** of the opponent's pieces, resulting in no possible moves even though the board is only partially filled.

LOADING THE PROGRAM

System Requirements: 32K, 1 disk drive.

(TRS-80, Model I and Model III — same procedure)

1. Power up
2. Insert disk (label up and toward you)
3. Press reset
   The program will boot automatically.

Note: The disk must remain in the drive unit during play.

GETTING STARTED


```
ODIN AWAITS YOUR COMMAND



YOUR NAME, PLEASE ?
```
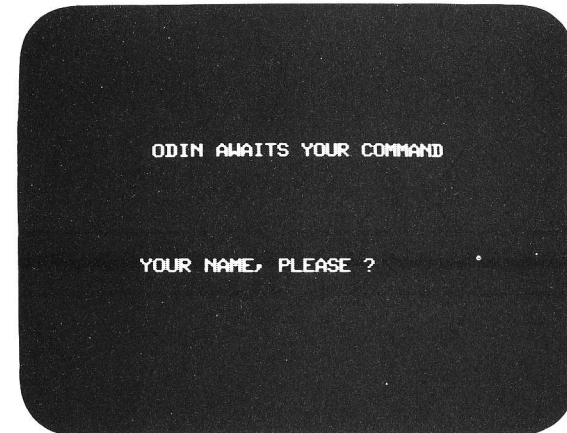
1. In response to the "Your name, please" prompt, you should enter 7 or fewer characters, then push the ENTER key.

2. The next display allows you to select the level of skill for ODIN. Level 1 is the beginning or initiation level, with level A being considered the lowest professional level. ODIN will select his move in a few seconds at levels 1

to 6. At higher levels he will take progressively longer. (Note that the monitor will only ask for levels 1 through 9 and A through F. The special modes "G", "T" or "X" may be entered, but read the section "ODIN'S SKILL LEVELS" first.)

```
            ODIN

        BY PETER W. FREY

    ALPHA-BETA SOFTWARE GROUP


    COPYRIGHT (C) 1981 ODESTA


        SKILL LEVEL (1 TO F)
```

```



        OPENING LIBRARY (Y OR N)
```
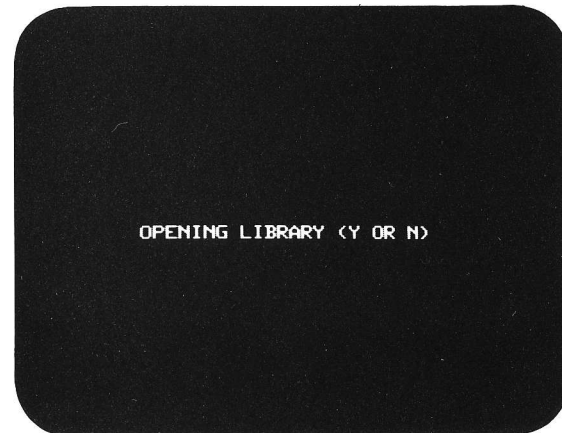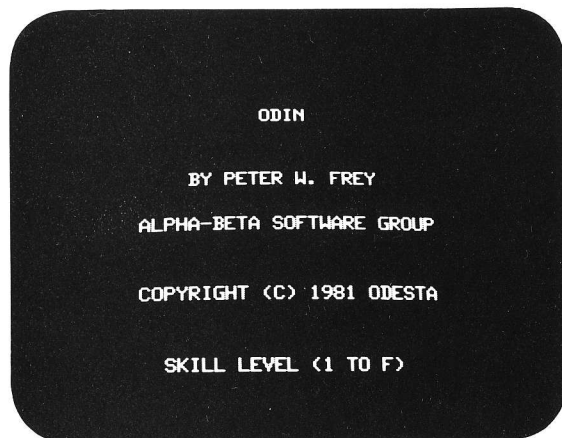
3. If you wish the program to draw on its opening library for the first few moves, enter "Y" for "yes". The moves in the opening library are a selection of plays and responses that have been found to be advantageous. These moves will make ODIN's game stronger. At the

higher skill levels, the use of the library will markedly speed up ODIN's first few moves.

```
        SHOULD ODIN MOVE

          AS SOON AS

          HE IS READY?

          (YES OR NO)
```
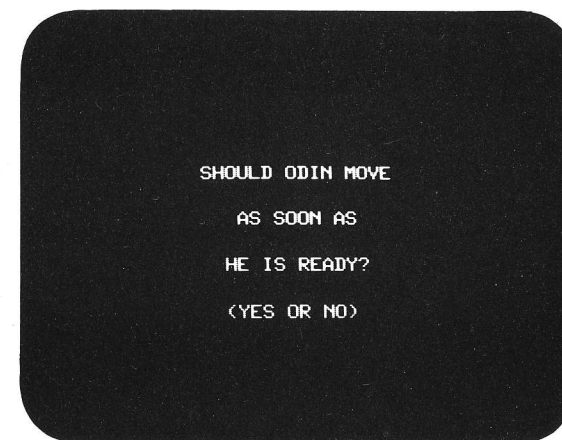
4. "SHOULD ODIN MOVE AS SOON AS HE IS READY?" Here you have the option (if you answer "N" for "no"), to make ODIN delay making his full move until you are ready. Sometimes it is difficult to see exactly where a new piece was placed because several squares may be flashing at once. In this "delay" mode, ODIN will flash the coordinates in the chosen square, and wait for you to press ENTER before "flipping" the captured pieces. For players new to ODIN, we suggest that you respond "Y" for the first few games. This will simplify the play, since ODIN will automatically complete his moves, and might permit a more rapid familiarization with the other program features.

DO YOU WANT TO

GO FIRST (Y OR N)

5. "DO YOU WANT TO GO FIRST?" If you go first, you
will play the black pieces, since black always has the
first move.

FOR INSTRUCTIONS

PUSH "I"

DURING THE GAME

6. For list of game features, push "I" during the game.

ENTERING YOUR MOVES

You can give commands to ODIN anytime that pieces
are not blinking on the display, or the asterisk (that some-
times appears in the lower right hand corner) is not flic-
kering. In the first case a move is being executed, and in
the second case, ODIN is thinking about his move. You
can force Odin to stop thinking and play the best move
found so far by pressing the **break** key.
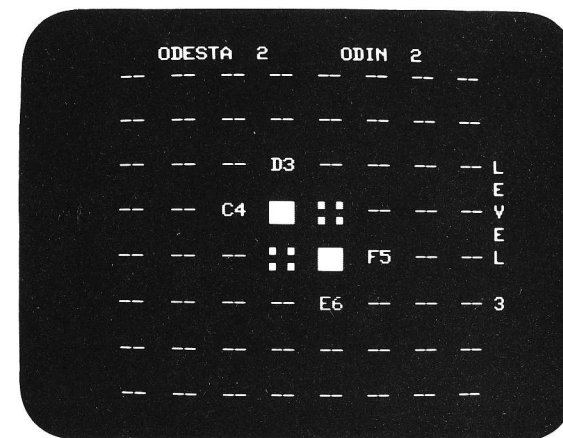
Square designations — first possible moves for black.

When you are ready to move, press the SHIFT key.
The display will show the square designations for all of
the squares into which you can legally play. These letters
and numbers are the standard means for identifying each
individual square of the playing surface. The letters A - H
represent the vertical columns, with the numbers 1-8
specifying each horizontal row (see illustrations at front).

One of the designations will blink on and off. If you wish
to move to that location, press the ENTER key or the
space bar, and your move will be made. If instead you

wish to move to one of the other (non-blinking) squares, enter the appropriate letter-number combination. This will cause the newly designated square to blink on and off. To complete the move, press the ENTER key, as before. If you change your mind before pressing ENTER, simply give the preferred coordinates.

After pressing ENTER, your new piece will be added to the display, and it (along with all pieces captured by the move), will blink several times to show the impact of your move. If you are playing at a low skill level, ODIN will respond with his move almost immediately. At higher levels, the program will take more time.

REMEMBER: press the SHIFT key before attempting to enter a move.

USER FEATURES

```
              ODIN'S COMMANDS
    SHIFT   READY TO MOVE
    A TO H  FOLLOWED BY 1 TO 8·
              MOVE LOCATION OF BLINKER
    ENTER   MAKE MOVE AT BLINKER
    I       INSTRUCTIONS
    L       CHANGE SKILL LEVEL
    M       MOVE (ODIN CHANGES SIDES)
    N       START NEW GAME
    P       PRINT BOARD + RESUME PLAY
    R       REPLAY GAME (SPACE BAR)
    S       SET UP NEW POSITION
    T       TUTOR (PRINT MOVE VALUES)
    V       PRINCIPAL VARIATION
    W       WRITE GAME RECORD
    X       RETRACT PREVIOUS MOVE
```

A variety of special features has been included to help make your playing time pleasant and educational. The features are active only when it is your turn to move. When the asterisk appears on the lower right of the display, or when a move is being made, the keyboard will be unresponsive. At all other times, you can issue commands by pressing any one of the special command keys. At the higher skill levels, where ODIN may be thinking on **your** time as well, you may have to press the SHIFT key in order to enable the command keys. **If you try a command and nothing happens, press SHIFT, and then try the command again.**

Each special command is triggered by entering a single letter code. The command codes and their meanings are as follows:

I   INSTRUCTIONS — This will display the "menu", which shows which keys are responsible for the various commands and features.

L   SKILL LEVEL — This lets you change the level of

expertise at which ODIN is playing at any time during the game. Enter a new value, from 1 to 9, A to F, G, T, or X.

M MOVE (CHANGE SIDES) — This feature allows you to change sides after a game is underway (especially satisfying when losing). With continual use of this command, the computer can be made to play **both** sides for as long as desired. Note that these changes will not be reflected in the game record.

N NEW GAME — At any time you may abort the current game and start a new one. This is an irreversible command, so use it with care. Use it at the end of a game to set up for the next one, or use it to escape from a hopeless situation anywhere in the game.

P PRINT BOARD — A command to restore the playing board to the display. This is used after commands such as "I", which erase the board from view to present other information.

R INSTANT REPLAY — At the end of a game (or even during a game, if you do not plan to complete it), you may request to see the entire game replayed move by move. For each move, hit the SPACE BAR (or keep it depressed for a rapid sequence).
IMPORTANT: After a replay has been completed, ODIN will automatically revert to the new game mode. Therefore, if you want to view or record the game moves as contained in the game record, use the "W" command **before** re-playing the game.

S SET-UP A POSITION — This feature allows the construction of any position or scenario you might desire, with the game proceeding from that point in the normal fashion.
1. To set-up a position, load the program and start

it as usual. Of the early prompts, the only one of special significance is the skill level prompt. If you wish a detailed analysis of a position, and don't mind waiting for a considerable period, select level "G" or "X". If you don't have several hours, select a lower skill level.

2. After the program has been loaded or during a game, press the SHIFT key, followed by the "S" key. The instructions for entering the positions will then be given. You will also be asked which side (black or white) ODIN should play. Each square of the board will then be visited in turn, and the alpha-numeric designation for that square will flash on and off.

3. For each square, press either the "B" key for a black piece, the "W" key for a white piece, or the SPACE BAR for an empty square.

4. If you enter the wrong value, use the left arrow key to back-up and change one or more square designations.

5. When the position is complete (all the squares must be designated, one way or another), you will be asked to specify who is to move first (black or white). The game will then be activated. From this point on, everything will proceed just like a regular game.

The use of this feature will permit, for instance, a player to leave in the middle of a game (after carefully noting the board positions), and to then return and resume play without having to keep the computer running during this time. It also provides for the analysis of game problems, such as those published regularly in the OTHELLO QUARTERLY magazine, and is useful for "postal" tournaments.
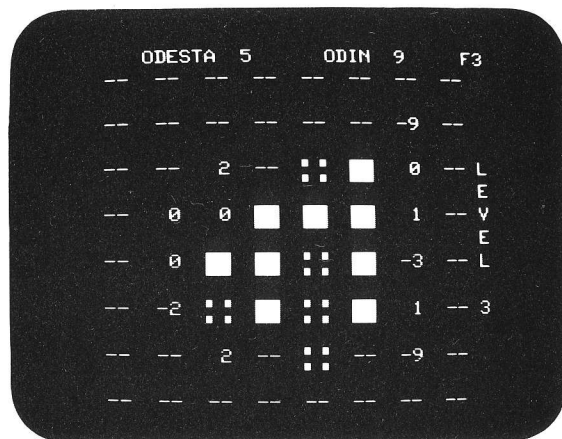
T   TUTOR MODE — If you press the "T" key when it is your turn to move, a number will appear on each of the squares to which you can legally move. When you are ready to resume play, push the "P" key.

Positive numbers denote good moves, negative numbers imply poor moves. The larger the number (in absolute terms), the better (+) or worse (−) the move is for you.

One should be aware, however, that these numbers are based on ODIN's evaluation of the immediate situation, and do not reflect the strategic considerations formed with a look-ahead search. They will provide for a reasonably balanced game against the computer on the first few levels, but will fall further behind at the higher skill levels. With this consideration in mind, the TUTOR MODE should be very helpful to the novice in learning what constitutes a good move for an immediate board position, but will be less valuable for the advanced player. Also, during the endgame, these values may not be helpful, since a look-ahead search is required for accurate assessment.
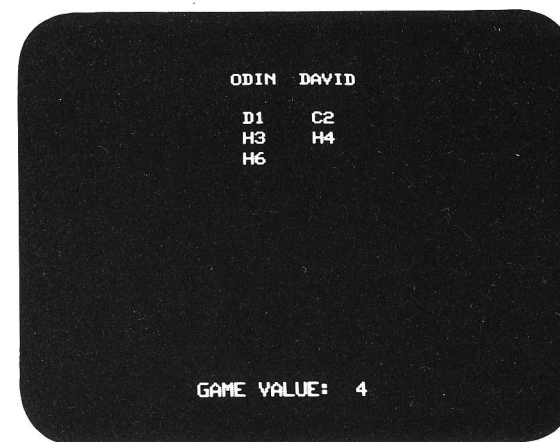
V   PRINCIPAL VARIATION — This feature, especially of interest to the more advanced player, provides detailed information about ODIN's planning process. It is only available at skill level 5 or higher.

When it is your turn to move, push the "V" key, and ODIN will display his move, the reply he thinks is best for you, what he expects to make as a counter-reply, and so on, for the number of moves equal to the depth of the look-ahead search. This is called the principal variation.

In addition to the move notations, a game value will be printed at the bottom of the display, indicating ODIN's view of who is winning. Positive numbers indicate a game favorable to ODIN. Negative numbers mean he thinks you are winning. When the endgame module is in effect, the game value actually reflects ODIN's prediction of the final piece differential.

To resume play after inspecting the principal variation, push the "P" key. If you have used the SET-UP command to analyze a game problem, you should use the "shift" command followed by the "V" command as soon as ODIN completes his analysis of the game problem.

1	F5	F6	17	H4	G2
2	E6	F4	18	C1	B1
3	E3	C5	19	C6	H6
4	C4	D3	20	H1	B2
5	C3	F2	21	A1	F8
6	F3	D7	22	G8	B4
7	B5	E2	23	A4	A6
8	G6	G5	24	B3	A5
9	H5	G4	25	B6	A2
10	F1	E1	26	A3	H2
11	D2	D6	27	A7	C7
12	G3	G1	28	H7	G7
13	C8	F7	29	B8	B7
14	E7	D8	30	A8	P
15	E8	D1	31	H8	
16	C2	H3			

W WRITE GAME RECORD — When you use the "W" command (any time during or after a game), a complete game record will be presented, using the standard notation. A pass by either player is denoted by the letter "P". To resume play, or to return to the command mode, press the "P" key.

X TAKE BACK A MOVE — If you wish to erase your previous move (and ODIN's reply, as well), use the "X" command. The display will instantly change back to the previous position, and your last play will have vanished. You can then enter another move and resume play. At higher skill levels, you may have to push the SHIFT key before using the "X" command. There are limitations on the use of this command, as follows:

1. You can only go back one full move per play (you can't use this command two or more times in succession).
2. The command is not available when you are in the opening library, or during the first few moves of the game.
3. **The command cannot be used immediately after you have used the "M" (change sides) command.**

ODIN'S SKILL LEVELS

It is possible to adjust ODIN's level of play from that of a beginning amateur, to that of championship players. At tournament setting, ODIN plays competitively with the world champion. The various skill levels are determined in a complex way by manipulating the depth of the look-ahead search, and the time for activating the endgame module. In addition to setting the skill level, the user can independently activate or disable the opening library.

The lowest skill level (level 1), is produced by using a simple square-priority strategy. The squares are ordered from best to worst, based only on their board location, and a move is made by scanning this list from top to bottom and selecting the first square to which a legal move can be made. This strategy was discussed by Peter Frey in an article in BYTE (July, 1980, p. 56). It provides surprisingly strong competition for the beginner, but is easily defeated by an experienced player. It has no look-ahead capability, and is especially weak in the endgame.

Skill level 2 applies this same strategy during the main part of the game, and then triggers the endgame module when there are 3 or fewer empty squares. The endgame module produces perfect endgame play, and can be a bit intimidating when triggered when there are still many empty squares (only on higher levels).

Skill levels 3 to 9, A to F, and "G", are determined by progressively increasing the depth of the middle game search, and the number of empty squares which trigger the endgame module. The values used to set these skill levels are presented in the table. The table also provides estimates of the average time you can expect each of the move calculations to take. Individual moves will vary greatly about these average values. In order to verify a given depth of search, the "V" command can be used to inspect the principal variation. The number of moves given is equal to the depth of search.

Two special skill levels, "G" and "X" are designed for use in solving game problems.

At levels "G" & "X", ODIN selects a move by doing a very deep search. The middle game search is set for a depth of either 8 ply (G) or 10 ply (X), and the endgame triggers when there are 17 (G) or 18 (X) empty squares. At these levels, ODIN can take hours to select a single move.

To analyze a position, load the program as usual, and select level "G" or "X" during the start-up sequence. Use the set-up command ("S"), to enter the position you wish to study. Specify ODIN as the color whose turn it is to move, and then sit back and read a book, watch T.V. (or mow the lawn), while ODIN grinds away. When the asterisk in the lower right hand corner disappears, press the SHIFT key, then the "V" key, and ODIN will present a detailed breakdown of his analysis. In the middle game, this analysis will be helpful, but not necessarily best. In the endgame, this analysis will present perfect play for both sides.

The tournament level is designed to produce the strongest level of play for ODIN when the game has to be played within the time restrictions of official tournament play. (According to the rules specified by the U.S. Othello Association, each player may take up to 25 minutes to complete his or her moves.) **With a 3x (three times) hardware speed-up modification, level "T" will play tournament style. Otherwise, level B may be used for similar play, time-wise.**

At tournament level, the opening library should be activated. This will save time and lead to stronger moves. After leaving the library, ODIN will initially do a 5 ply search. During the middle game, it will switch to 6 ply. Just before the endgame starts, a 7 ply search will be used. The endgame is set to trigger with 13 or 14 empty squares, depending on the game situation. The trigger at 14 is used when the game is close or ODIN is behind.
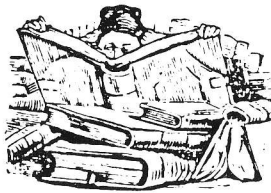
APPENDIX

REVERSI AND GO BANG.

BY

" BERKELEY."

Authorized by Lewis Waterman.

WITH NUMEROUS ILLUSTRATIONS.

NEW YORK:
FREDERICK A. STOKES COMPANY.
MDCCCXC.

The earliest comprehensive treatise published on the strategy of Reversi (1890). The game was apparently first described in the "Queen" newspaper in the spring of 1888, and in a handbook authorized by the inventor (Waterman), in the same year.

A BIT OF BACKGROUND

Many board games originated as a reflection of the real world, and their popularity lies in the ability of the players to manipulate armies, empires, and strategic forces — without risking more than their pride.

ODIN plays the modern variation of a game which has engrossed and challenged players for many years. The early history of this pastime is clouded in obscurity, but points to a game called Annexation. (International law describes annexation as the act by which a state adds territory to its dominions). Known in parts of Europe at least as far back as the 1700's, the game followed the same general principles as its modern counterparts. An official set of rules was lacking, however, and it is fairly certain the board size varied. Annexation and its various descendants are classed as war games, with the playing pieces traditionally referred to as "men".

The rules for Annexation were modified around 1890, when the game was "re-invented" by Lewis Waterman, who claimed all proprietary rights to the game. He gave the game, for the first time, a clear set of rules, fixed the board size to the present standard, and, for ownership and marketing purposes, gave it a new name — "Reversi". References to the game invariably use the Reversi name, with mention of its earlier history being rare.

Reversi, as originally published by the London firm of Jaques & Son, was very popular in England at the close of the Victorian era. The game ranged up and down in popularity over the years, and by the 1970's had generally declined in familiarity. Then, from the Far East, came yet another re-birth (cloaked in a new name).

A Japanese chemical engineer, Goro Hasejawa, seems to be the father of the modern and most commonly known version. It is sold under the tradename "Othello" by the Tsukuda Company in Japan, and by CBS Toys, Inc. (Gabriel Inc.), in the United States and Canada. Othello, as currently marketed world wide, uses a variation of the

rules Hasejawa established in 1974. The game has become a great success, with more than 20 million sets sold in Japan, and over 5 million sets already sold in the newer U.S. market.

Some of the differences between Reversi and its offspring "Othello" are significant. In Reversi, the two players take turns placing each disk of the initial four disks in the center four squares, and each player is also limited to a maximum of 32 disks. Othello does away with the initial placement routine in favor of a fixed, standard placement, and allows unlimited playing pieces for each side.

The process of refinement continues through the United States Othello Association, which publishes a comprehensive set of rules and guidelines for use in officially recognized tournament play.

All things considered, the procedural innovations have tended to streamline the game, adding to its exciting, concise nature of play. At the same time, the different names tied to these alterations have, perhaps, contributed to an identity problem. The beauty of the game in its modern incarnation is that the rules are easily learned, and yet truly skillful play develops only after considerable practice. Each player's fortunes may change rapidly, and the winner is seldom known until the last few pieces are placed. It is a compelling game of logic and strategic planning, and the relative speed of play adds to its addictive properties. Unlike chess or "Go", a thoughtful game can be completed within 20 or 30 minutes. The phenomenal increase in the number of players in the last few years is testimony to the game's inherent fascination.

PLAYING SKILLFULLY
Some Strategic Considerations
by Peter Frey

Despite the fact that Annexation/Reversi/Othello has been played for several hundred years in many different countries, there remains some doubt concerning which playing strategies are most effective. There are, however, a number of ideas which appear to have nearly universal acceptance. The advice which follows tends to emphasize this common ground.

One of the most basic ideas about the game is that corner squares are very desirable. The reasoning behind this idea is not complicated. The four corner squares are the only locations on the playing area which can never be reversed. Once a corner has been captured, it will remain as the property of the initial owner for the rest of the game. The corners therefore provide permanent outposts on a playing area which otherwise has the property of quicksand in terms of ownership rights.

A related idea is that it is good to play next to a corner after the corner has been captured. Pieces "backed-up" to ones own corner piece are also permanent. When a corner has been captured, the successful party should attempt to make moves adjacent to that corner while his or her opponent should strive to direct play away from that corner.

If corners are valuable, then it follows that playing on a square next to an empty corner is very dangerous. The reasoning in this case is that your opponent can never go to a corner square if you have no pieces adjacent to that corner. If you do play next to an empty corner, it is very likely that your opponent will eventually gain control of the corner. Most good players avoid playing next to an empty corner during the early stages of the game. This is especially true of the square next to the corner on the diagonal.

Although some players believe that it is advantageous to gain access to and control of the edge

CORNER SQUARES

squares, this idea is not universally accepted. Recent tournament play demonstrates a tendency by the top players to avoid moves to edge squares during the early part of the game. If a player gets many pieces on the edge during the early part of the game, there is a tendency for these pieces to cause later moves to flip many pieces. If the playing area becomes dominated by one set of pieces, this is often a disadvantage for the side with most of the pieces. Having a large number of pieces often restricts your future move options and forces you to make a bad move. When moves are made to an empty edge, there seems to be a slight preference for the squares located two away from the corner instead of squares which are three away from the corner. One should never play next to the corner on the edge when the edge is otherwise empty.

One cannot overemphasize the importance of having many move options. If you have many pieces and your opponent has very few, he or she may be able to select moves which eventually force you to play adjacent to a corner for lack of any better moves. The number of pieces for each player is only a rough index of the number of moves for each side. A more reliable consideration has to do with the relative position of the pieces. In general, one should avoid as much as possible having ones pieces on the "outside" of the game.

During the early stages of the game, it is common for players to select moves which decrease their opponent's future move options while increasing their own options. Generally this means making moves which flip only one or two pieces. When multiple pieces are flipped, it is best if they are interior pieces surrounded on all sides by other pieces.

During every game, each player is faced with the decision of whether to capture pieces on the edge and thereby gain a row of pieces on the edge or to give the opponent the option of capturing the edge. There are two rules of thumb which are useful for these decisions.

A drastic example of the concept of mobility.

Black has been spotted 38 pieces (none in the corners, though). Black is destined to lose.

5 plays later

1) Black 39 – White 1
The first move for white is to strike downward, to D8.

2) White has established a beachhead on the lower row, but the real power still comes from the excellent, (unblocked), center positions.

3) Black 3 White 61
White has completely devastated the opponent.

	Black	White
19		D8
20	E8	B6
21	A6	G6
22	H6	F8
23	F7	B8
24	B7	A8
25	A7	A1
26	pass	B2
27	pass	B1
28	pass	G7
29	G8	G2
30	G1	H5
31	pass	H8
32	pass	H7
33	pass	H2
34	pass	H1

Game Record

EDGES

The first has to do with the number of edges which you control. It is better to control one or two edges than to control no edges or three or four edges. It can be a serious problem if you control all the edges or if you have no pieces at all on the edge. A second important consideration has to do with the configuration of your pieces on the edge. It is better to have an even number of pieces in a row on the edge than an odd number of pieces. Five pieces in a row can be a major liability when the adjacent corners are still empty.

SAFE MOVES

In the late middle game when the contest becomes tense, there are several important goals for which each player should strive. Each person should try when possible to reserve one or more safe moves. A safe move is one which does not immediately endanger a corner. Moves which can be reserved are ones which are open to you but not available to your opponent. When possible, these moves should be postponed as long as possible. In simple terms, you are trying to save for a rainy day. As the game approaches its climax, one of the players will run out of safe moves and will be forced to give up a corner. If you have saved several safe moves, it is likely to be your opponent who runs out of safe moves first.

DIAGONALS

A second important idea at this stage of the game is to control one or both of the main diagonals. Sometimes a player can create a safe move for himself or herself by playing on the diagonal square next to an empty corner (normally a very bad move) **if** the player controls the diagonal (i.e. the opponent has no pieces on the diagonal). Even though the player has a piece in a very dangerous position, the opponent cannot immediately move to the corner and may be forced to make a move which gives up one of the other corners.

TEMPO

A third idea which can be helpful in the late stages of the game is the notion of tempo. This term comes from the game of chess and is related to which player has the move. Often in Othello, and especially in the early endgame, it is important to minimize the number of forced

TEMPO

moves you have to make. This concept is important when you are in a position where you are forced to be the first one to offer a corner. When there is an odd number of empty squares in the corner area (most often the four square corner area), you will usually be able to make both the first and last moves into this section of the board. Consequently, your opponent will be forced to make the first move adjacent to another corner and you will have the opportunity to win that corner. In this way, you will have an opportunity to gain the initiative. When you play into a corner with an even number of empty squares, your opponent is usually the one to have the last move and therefore you will be forced eventually to offer him or her another corner. In general, when you are in a difficult position, it can be advantageous to give up a corner to your opponent at an opportune time in order to change the fortunes of the game. If your timing is right, you can gain the initiative and battle on to win the game.

ENDGAME

Endgame play requires precise calculation and in this respect closely resembles the game of chess. It is very common in the endgame for antipositional moves to be more advantageous than positional moves. For example, a player can often maximize his or her piece count by giving the opponent the corner and playing adjacent to the corner instead. The corner move at the very end of the game may flip fewer pieces than a non-corner move. The player should carefully count the number of pieces which are permanently flipped by each move and select the move which maximizes the final disk count. There is no substitute for precise analysis at this stage of the game. In close games, the player who calculates more precisely in the endgame will win.

Skill Level	Depth of Middle-Game Search	(Approx.) Average Time (Sec.) Required to Move	Number of Empty Squares To Trigger Endgame	Average Time (Sec.) Required for First Endgame Move
3	1	1	3	1
4	1	1	5	1
5	2	2	5	1
6	2	2	7	3
7	3	5	7	3
8	3	5	9	10
9	4	15	9	10
A	4	15	11	50
B	5	45	11	50
C	5	45	13	400
D	6	150	13	400
E	6	150	15	3000 (50 min.)
F	7	500	15	3000
G	8	1600	17	20000 (5.5 hrs.)
X	10	16000	18	60000 (16.6 Hrs.)

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