8. APPENDIX

If being selective is an act of manicuring, I plead guilty to doing so with this appendix, as I did by choosing the position of Diagram 3.

It contains the complete listing of the game between the 1993 Micro World Champion HIARCS and NIMZO-Guernica, Micro WC Munich, 1993. Each move is followed by NIMZO's computation time in seconds. These times include operator time. Moves characterized by NIMZO as *easy* are in **bold** type. Also the moves 16. Bf2, 17. Bd3 and 18. Qxd4 hint that HIARCS uses some kind of simple-move technique. Strange is 45. fxe4: HIARCS spent about 6 minutes on the only way to recapture the piece. The programs have different styles of playing, therefore the rate of correct guesses is unusually low. Both played their first 11 moves from their opening books.

According to Hyatt (1984), it is wise to spend more time on the first moves than on those in the endgame. I think this is erroneous. NIMZO, by design, uses in the endgame about the same time per move as in the middle game.

1. d4 Nf6 2. c4 e6 3. Nc3 Bb4 4. Qc2 0-0 5. a3 Bxc3+ 6. Qxc3 b6 7. Bg5 Bb7 8. f3 h6 9. Bh4 d5 10. e3 Nbd7 11. Bd3 Rc8 12. Ne2 235 **c5** 124 13. cxd5 207 **exd5** 74 14. 0-0 273 Re8 147 15. Bb5 106 g5 294 16. Bf2 50 a6 290 17. Bd3 103 cxd4 286 18. Qxd4 15 Nc5 144 19. Rac1 188 Bc6 221 20. Bc2 105 **Bb5** 106 21. Rce1 438 **Ne6** 120 22. Qd2 288 d4 286 23. exd4 133 Nf4 609 24. Nxf4 16 **Bxf1** 106 25. Rxf1 36 **gxf4** 128 26. Bd3 177 Nd5 7 27. Bxa6 136 Rc7 7 28. Rc1 819 Rxc1+ 281 29. Qxc1 332 Ne3 7 30. Qc6 504 Re6 276 31. Qc3 643 Nd1 7 32. Qc8 381 **Qxc8** 116 33. Bxc8 231 Re2 291 34. Bh4 218 **Rxb2** 43 35. Bf6 149 Ra2 291 36. Be5 115 **Rxa3** 145 37. Bxf4 142 **Kg7** 137 38. Bb7 267 Ra4 289 39. Bc6 187 Rc4 214 40. Bd5 41 **Rb4** 60 41. Be4 49 f6 224 42. d5 30 Rc4 308 43. Kf1 51 Nc3 203 44. Be3 23 **Nxe4** 137 45. fxe4 352 **b5** 137 46. d6 841 Kf7 273 47. Ke2 14 Rxe4 260 48. Kf3 215 **Rh4** 89 49. Kg3 Rc4 257 50. Bxh6 43 **Ke6** 50 51. Bg7 391 b4 258 52. d7 325 **Rd4** 123 53. Bh6 34 **b3** 106 0-1.

LITERATURE RECEIVED

EIN KORREKTES PROGRAMM FÜR DAS ENDSPIEL KÖNIG UND BAUER GEGEN KÖNIG UND BAUER

Institutsbericht Nr. 36, February 1994

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We paraphrase the abstract:
A correct program for the endgame KPKP has been developed using the rule method (Barth, W. and Barth, S., 1991, 1992). This method yields for every position an interval guaranteed to contain the correct evaluation. Though after a short time the program may give only a wide-range interval as a result, e.g. [drawn, won] failing to define the result of the game, it *will* deliver a point interval, e.g., [drawn, drawn], after sufficient time. The program has been validated by the method described in the paper cited, i.e., it has proved that its results are correct for all KPKP positions.

Experience shows that only easy rules, well-known to every skilful chess-player, had to be transferred into algorithmic form to get a program that finds the final result in a short time. One interesting and surprising rule has been inspired by Reti's famous problem. The behaviour of the program has been tested by solving this and other problems and by analysing some positions discussed in the literature.

References

Barth, W. and Barth, S. (1991). Programme für korrekte Schachendspiele und deren Validierung. Institutsbericht Nr. 34, Institut für Computergraphik, Technische Universität Wien.

Barth, W. and Barth, S. (1992). Validating a Range of Endgame Programs. *ICCA Journal*, Vol. 15, No. 3, pp. 132-139.

ARTICLES PUBLISHED ELSEWHERE

THE MULTI-PLAYER VERSION OF MINIMAX DISPLAYS GAME-TREE PATHOLOGY

D. Mutchler (1993). The multi-player version of minimax displays game-tree pathology (Research Note), *Artificial Intelligence*, Vol. 64, pp. 323-336.

We reproduce the abstract:
"It is widely believed that by searching deeper in the game tree, the decision maker is more likely to make a better decision. Dana Nau and others have discovered pathology theorems that show the opposite: searching deeper in the game tree causes the quality of the ultimate decision to become worse, not better. The models for these theorems assume that the search procedure is minimax and the games are two-player zero-sum. This report extends Nau's pathology theorem to multi-player game trees searched with *maxn*, the multi-player version of minimax. Thus two-player zero-sum game trees and multi-player trees are shown to have an important feature in common."

PROOF-NUMBER SEARCH

L.V. Allis, M. van der Meulen, and H.J. van den Herik (1994). Proof-number search. *Artificial Intelligence*, Vol. 66, pp. 91-124.

We reproduce the abstract:
"Proof-number search (pn-search) is designed for finding the game-theoretical value in game trees. It is based on ideas derived from conspiracy-number search and its variants, such as applied cn-search and αβ-cn search. While in cn-search the purpose is to continue searching until it is unlikely that the minimax value of the root will *change*, pn-search aims at *proving* the true value of the root. Therefore, pn-search does not consider interim minimax values.

Pn-search selects the next node to be expanded using two criteria: the potential range of subtree values and the number of nodes which must conspire to prove or disprove that range of potential values. These two criteria enable pn-search to treat efficiently game trees with a non-uniform branching factor.

It is shown that in non-uniform trees pn-search outperforms other types of search, such as α-β iterative deepening search, even when enhanced with transposition tables, move ordering for the full principal variation, etc. Pn-search has been used to establish the game-theoretical values of Connect-Four, Qubic, and Go-Moku. There pn-search was able to find a forced win for the player to move first. The experiments described here are in the domain of Awari, a game which has not yet been solved. The experiments are repeatable for other games with a non-uniform branching factor.

This article describes the underlying principles of pn-search, presents an appropriate implementation, and provides an analysis of its strengths and weaknesses."