But Does It *Actually* Work?

Sadler and Doknjas on improving by studying with modern engines

BY **IM JOHN WATSON**

THE WORLD OF CHESS ENgines took a dramatic turn in 2017 when AlphaZero, with just a few hours of self-training, became the strongest chess playing entity on the planet. Soon *Game Changer*, a 2018 book about AlphaZero by GM Matthew Sadler and WIM Natasha Regan, was an award-winning bestseller. And in time AlphaZero's self-evaluating AI approach was incorporated into other engines, resulting in continuous advances in strength to this day.

In the Epilogue to *Game Changer*, the authors state:

> Traditional chess engines like Stockfish or Houdini are tremendously strong in unravelling complex tactics in a fraction of the time it would take without their help.
>
> However it is rare to be able to distil general lessons about chess from their calculation-heavy style of play. In contrast, the sense of purpose and direction in the way AlphaZero plays is palpable. This explains why AlphaZero's games are such a fertile and intuitive learning ground for human chess players.

Sadler's latest work, *The Silicon Road to Chess Improvement*, promises to expand upon that last thought by showing how humans can improve their games and understanding by using the latest chess engines. He begins with a very useful chapter on the basics of engine searches and evaluation (particularly the self-learned evaluation of the neural network engines), and the nature and strengths of top engines like AlphaZero, Stockfish Classical, Stockfish NNUE, Leela Zero, AllieStein, Stoofvlees, Komodo, and a few others.

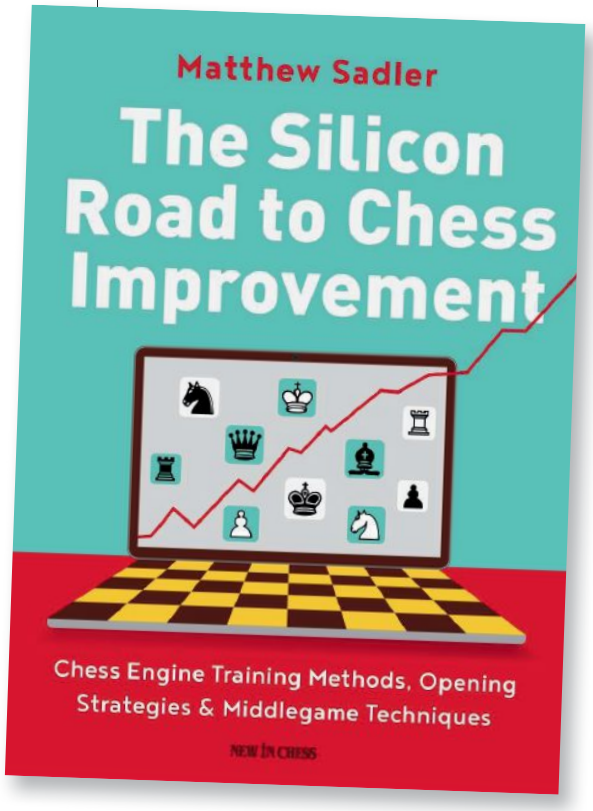
To grossly oversimplify, the older-style engines (like Stockfish Classical, with what he calls 'hand-crafted evaluations') have continuously improved and are generally superior in calculating outrageously deep and ingenious tactics. Nevertheless, the neural network engines like Leela Zero with self-learnt evaluations can play a more profound and effective strategic ('positional') game, which tends to outperform the calculating monsters. While all of these engines are (literally) superhuman in strength, Stockfish 15, a hybrid engine incorporating a neural network, is currently the strongest of the lot.

Arguably the most relevant chapter in *The Silicon Road* for those looking to improve their game is called "Training with Engines." Sadler lays out seven ways of using engines with explanations and detailed examples:

- Training approach #1: Playing rapid games (for example 15 minutes + 10 seconds increment) against Stockfish
- Training approach #2: Playing against Leela Zero restricted to a one-node search.
- Training approach #3: Playing out positions against an engine at a rapid time control (for example 15 minutes + 10 seconds increment)
- Training approach #4: Playing 'correspondence chess' against your engine
- Training approach #5: Running engine matches from key opening positions and summarizing the results
- Training approach #6: Letting your engines analyze an opening position for x hours (deep analysis)
- Training approach #7: Periodic checking of your analysis with a live engine

The titles are self-explanatory, and he gives examples of his own training games in each mode. I feel that all these approaches will be useful, but I can't judge whether they are superior to human online play or other modes of study, or even whether one would gain any particular insight into the way the engine makes those superior evaluations. (More on this concern later.)

For me, training approach #2 is particularly interesting, because in some sense, it separates 'strategy' from calculation. Re-



markably, Leela at a one-node search depth (using pure evaluation to choose a move, with no calculation) was able to score over 20% against GM Sadler in a 101-game rapid play match … despite not calculating!

If you could find a good way to describe what 'ideas' lie behind the neural network engine's ability to positionally outplay the hand-crafted engines (which it does regularly), you'd think those qualities might stand out more clearly in this one-node situation. Therein lies the rub: trying to describe in words how a human would have to think to 'understand' what Stockfish NNUE 'knows' about a position that Stockfish Classical doesn't may be an impossible task. If you go over Sadler's astonishingly detailed notes to engine games, you see that such brilliant evaluation depends upon many tiny details, the alteration of any of which would change the assessment. The general guidelines and tips he gives cannot encompass such niceties.

This leads us to the general question of whether engines provide a promising path to improvement. It's not clear to me that Sadler himself feels that he has actually become stronger (in terms of being able to achieve better results) by training with engines, or by absorbing general strategic lessons from them. Nor, to be fair, does he claim this. But he obviously appreciates the brilliance of engine play, and he says that certain factors of modern engine play have become more important for him to consider than he previously understood.

Among these notable factors, he mentions: piece mobility, whole board play, attacking on different wings, rook-pawn advances, slow moves, and many methods of play such as 'exchanging active pieces to leave the opponent with passive ones,' 'developing major pieces by giving away the pawn(s) in front of them,' and 'invading through the channel the opponent opened.' These are instructive sections of the book, and easy to relate to.

On a practical level, Sadler notes that he is (after writing *The Silicon Road*) more aware of the factors listed above, and he believes he has a better feel for maneuvers that enhance their effectiveness. For all of this, I can't help but suspect that incorporating these feelings into making actual moves is another matter, possibly only achievable by players with an already sophisticated chess understanding.

Here's a typical example from the chapter 'Queen versus pieces,' which typifies the depth and precision of modern opening preparation with engine assistance:

CATALAN OPENING (E01)
Stockfish Classical
Alliestein
TCEC Season 18 "Top of the Top," 2020

1. g3 d5 2. Nf3 c5 3. Bg2 Nf6 4. 0-0 e6 5. d4 cxd4 6. Nxd4 e5 7. Nf3 Nc6 8. c4 d4
Here we reach a position that can arise via a number of move orders, most notably from the Symmetrical English Opening or the Catalan. This position has been hotly contested going all the way back to the 1940s, and from move 12 through the final move of the game, Sadler's notes prepare the reader thoroughly to play a theoretically important line.

9. e3 Be7 10. exd4 exd4 11. Bf4 0-0 12. Ne5 Qb6
The main line. Now White has played 13. Qb3 most often, but in the past few years his next move, sacrificing a pawn, has become the main one:

13. Re1 Qxb2 14. Nd2 Nxe5 15. Rb1
Sadler's method throughout the book is to set up engine games to test alternatives. Here he has Stoofvlees playing White against Stockfish Classical with 15. Bxe5 Bb4! 16. Re2 Bg4 17. Nf3 Qc3 18. Bxd4 Qxc4 19. h3 Bxf3 20. Rc2 Qxa2 21. Bxf3 Qe6 22. Bxb7, soon leading to a draw.

15. … Qxa2!!
This already anticipates the loss of the queen and Black's brilliant 20th move below. Earlier games with 15. … Qa3 16. Bxe5 favored White.

16. Ra1 Bg4!
Sadler sets up engine games with 16. … Qb2 and 16. … Qxa1, both resulting in wins for White.

17. f3
A slight but crucial weakening, There's another engine game with 17. Rxa2 here, which is interesting but no better.

17. … Qb2 18. Rxe5
After 18. fxg4, 18. … Nexg4 (*18. … Ng6!?*) 19. Rxe7 d3! threatens … Qb2-d4+: 20. Nb3 Rfe8 21. Rxe8+ Rxe8 22. Bd2! (*22. Qxd3?? Qf2+ 23. Kh1 Qxf4!*) 22. … Re2 23. Bf3 Rxd2 24. Qxd2 Qxb3 results in equality.

18. … Be6 19. Rb5 Qc3 20. Rb3

The queen is trapped, and it's hard to imagine full compensation, but Black's engine mind has anticipated this:

20. … b5!!
20. … Rfd8 21 Bf1 b5!! transposes.

21. Bf1
White tries to improve his pieces' positions before taking the queen. It doesn't make much difference.

21. … Rfd8 22. Qb1 a5! 23. Rxc3 dxc3 24. Ne4 b4

Black has only a rook and two pawns for the queen, but is counting upon the connected passers. In many lines, the weakness created by 17. f3 gives him play against White's king.

25. Bd3
Threatening to exchange on f6 and win the h-pawn.

25. … a4!
Ignoring material. Time is of the essence.

26. Ng5

Less effective here is 26. Nxf6+ gxf6 27. Bxh7+ Kg7, when Black threatens to advance the pawns, e.g., 28. Bc2 b3 29. Bxb3 Bc5+! 30. Kg2 axb3 31. Rxa8 Rxa8 32. Qxb3 Ra1! and the bishops and rooks create threats: 33. g4 Bd4 34. h4 Rg1+ 35. Kh2 Rf1 36. h5 Rxf3 37. h6+ Kh7 38. Qb1+ f5 39. gxf5 Rf2+ 40. Kg3 c2 41. Qb8 Bxc4 42. Qd6 Rxf4! 43. Qxf4 Bb2 44. Qxc4 c1=Q 45. Qxf7+ Kh8 46. Qf8+ with equality.

26. ... b3! 27. Bxh7+ Kh8 28. Nxe6 fxe6 29. Bc2 b2! 30. Ra2
After the weaker 30. Rxa4 Rxa4 31. Bxa4 Ra8 32. Bc2 Ra1 White has to be careful not to allow ... Nf6-d7-c5-b3-d2!.

30. ... a3

What a position! White has made progress on the kingside, but the disastrous rook on a2 justifies Black's play. Sadler spends more than a column of prose adding up the pros and cons on each side. For what it's worth, the latest development version of Stockfish evaluates this as +0.66 for White at depth 52, while Leela assesses it at +0.44 at depth 26.

31. g4 Bc5+ 32. Kh1 Rac8
A typical engine move — even Sadler admits that he doesn't 'fully understand the reason for it!'

33. Qe1 e5! 34. Bg5
If 34. Bxe5 Rd2!.

34. ... Kg8 35. h3
Even this late in the game, Sadler arranges two more engine contests with 35. Kg2, both leading to equality.

35. ... e4! 36. Bxf6 gxf6 37. Qxe4
37. Qxc3 Rd1+! 38. Kg2 Rcd8 also draws.

37. ... Rc7 38. f4 Rd2 39. Qg6+ Rg7 40. Qe8+ Bf8 41. Qe6+ Rf7! 42. Bg6
Now it's a queen for just a lone bishop!

42. ... Rdd7 43. g5
The position is equal after 43. Bxf7+ Rxf7 44. Qf5 (*44. Qe4?? f5! 45. gxf5 Re7 46. Qb1 c2 47. Qxc2 Re1+ 48. Kh2 b1=Q* and Black wins) 44. ... Rb7.

43. ... fxg5 44. Kh2
One last engine game with 44. fxg5 c2!? (*44. ... Rde7 45. Bxf7+ Rxf7 46. Qg6+ Rg7* also draws) 45. Bxc2 Rd6 46. Qe2 Re7 and it's drawn.

44. ... gxf4 45. h4 Rd2+ 46. Kh3 Rdd7 47. c5 Bxc5 48. Bxf7+ Rxf7 49. Qg4+ Kh8 50. Qh5+ Kg8 51. Qg5+ Kh8 52. Qh5+ Kg8 53. Qg5+ Kh8, draw.
An utterly brilliant game, but one wonders precisely how the inspiration evoked by such moves could translate into better play over-the-board, or on-the-screen.

One of Sadler's particular interests is in using modern engines to examine key opening tabiya, and many examples in the book turn into painstaking opening investigations. Since these openings tend to have some theory that extends into the endgame, a whole gamut of position types gets tested.

BLACK TO MOVE

If you'd like to know how to handle both sides of the above position after **1. d4 Nf6 2. c4 g6 3. Nc3 Bg7 4. e4 d6 5. Nf3 0-0 6. Be2 e5 7. 0-0 Nbd7 8. Qc2 c6 9. d5**, for example, a single Leela Zero – Stockfish NNUE game includes 16 embedded engine games analyzing separate alternatives just through move 15! Sadler adds considerable commentary trying to explain in words what's going on. And, curiously, after 39 moves of astonishingly complex play involving both positional and tactical piece sacrifices, Sadler mentions that a different engine game between Stockfish NNUE and Komodo reached exactly the same position, and ended with a wild sequence leading to perpetual check! Obviously the reader isn't supposed to memorize the game from start to finish, but this kind of investigation is very much along the lines of how the world's elite players are preparing these days.

Another book which investigates the nature and impact of neural network engines is FM Joshua Doknjas' *The AI Revolution in Chess*. Like Sadler, Doknjas organizes his book around well-annotated games, but he doesn't set up engine-versus-engine matches. Rather he annotates recent games (mainly human-versus-human, between super GMs), using both neural network (AI) and classical engines to explain how the new engines have influenced the way the game is being played today.

Doknjas emphasizes opening theory even more than Sadler, and his first four chapters (199 pages of the book) are detailed examinations of the Grünfeld ("arguably the opening that has been impacted the most by modern engines"), the Catalan, the Najdorf, and a few 'AI-inspired' openings like 1. d4 Nf6 2. c4 g6 3. h4.

This last example is particularly interesting. Modern games with the Grünfeld have featured (h2-)h4-h5-h6 repeatedly at even the top levels, particularly in the Exchange Variation line **1. d4 Nf6 2. c4 g6 3. Nc3 d5 4. cxd5 Nxd5 5. e4 Nxc3 6. bxc3 Bg7 7. Bc4** (but also with 7. Nf3); after both sides develop in standard fashion over the next six to eight moves, White plays h2-h4 more-or-less out of the blue.

The advance of this pawn to h6 (which is arguably the main difference between the engine treatment and previous grandmaster practice) is to either shut in or suffocate Black's dark-squared bishop and/or to take away squares from the king and create tactical opportunities. It's interesting that the same engines that influenced White towards the h4-h5-h6 scheme have provided Black with effective counter-strategies. From both Doknjas' analysis and recent over-the-board and correspondence games, we see that White's ideas that initially led to success are running into effective defenses.

In the Catalan, White has tried a wide variety of pawn sacrifices, some of which have a kind of long-term compensation that engines are so much better at seeing than humans. Anyone who has followed Catalan theory over the years will recognize how much this staid old opening has been spiced up and expanded by dynamic engine ideas.

In discussing the Najdorf, Doknjas notes that "the older engines struggle against the newer ones in closed, strategic middlegames because concrete calculation is less effective in such positions," and that "the newer engines have the remarkable ability to bring long-term strategic ideas into the sharpest positions." From the examples — even in highly tactical lines — the AI engine will

very often beat a classical engine which is superior in calculation.

The rest of the book deals mainly with middlegame ideas such as pawn sacrifices, closed positions, and material imbalances. As with similar sections of Sadler's work, the examples are excellent but it's not clear that a human player can translate the strategic generalities into practical success. Doknjas continues to use games with highly theoretical contemporary openings to make his points, which is a nice bonus for students.

As someone who keeps up with French Defense theory (I write a monthly column with the latest games for *ChessPublishing.com*), I was curious whether these monsters had any breakthroughs which might advance theory or introduce novel strategies. Sadler's book has a chapter called "French Structures," and has nine games with the French Defense.

In contrast to other openings he deals with, there are few, if any, games in important theoretical lines, and we don't get to see how a super-engine might handle any of the currently successful variations for Black. I didn't feel I learned much about the French from Sadler, although I did find one fine example instructive and enlightening:

FRENCH DEFENSE, WINAWER VARIATION (C18)

LCZero
Ethereal
TCEC Season 19, 2020

1. d4 e6 2. e4 d5 3. Nc3 Bb4 4. e5 c5 5. a3 Bxc3+ 6. bxc3 Ne7 7. Nf3 Nbc6
Active alternatives are 7. ... Bd7 (intending ... Bd7-a4) 8. a4 Qa5 and 7. ... Qa5, while the flexible 7. ... h6 has been played with success over the past few years.

8. Be2 Qc7
Rare and somewhat passive. Most frequently played is 8. ... Qa5.

9. 0-0 0-0?!
Black commits to the kingside, which can be dangerous. Here 9. ... Bd7 retains more options.

10. Rb1!
Almost unknown at the time of this game, and remarkably effective. 10. a4 and 10. Re1 have been the most common moves here, both favorable for White but not as convincing.

10. ... h6
Sadler gives convincing alternative engine games that show how poor Black's setup is:

a) 10. ... cxd4 11. cxd4 f6 12. exf6 Rxf6 13. Bg5 Rf7 14. Re1 Bd7 15. Bh4 Nf5 16. Bg3 Nxg3 17. hxg3 Rf6 18. Bd3 Raf8 19. c3 (*19. Rb2 h6 20. c3 Be8 21. Nh2* with a tremendous advantage) 19. ... b6 20. Rb2 Na5 21. Rbe2 Qxc3 22. Ne5 Qc7 23. Ng4 R6f7 24. Qb1 and White had a winning position in Stockfish NNUE – Komodo Classical, 2020.

b) 10. ... f6 11. exf6 Rxf6 12. dxc5! e5 13. c4 d4 14. Bd3 Bf5 15. Ng5 Raf8 16. Ne4 with a decisive advantage in Stockfish NNUE – Stockfish Classical, 2020.

11. g4!
A wonderful move. I've been a fan of g2-g4 and h2-h4 moves for decades, but it goes against all my instincts to play 11. g2-g4 right after the slow 8. Be2 and 9. 0-0 (the latter move preventing White's rook from supporting the pawn advance from g1 or h1). Surely (says the fallible human) when Black plays ... f7-f6, the breakdown of White's center and his weaknesses on the f-file will ruin his attacking chances?

11. ... Bd7
And yet 11. ... f6 12. exf6 Rxf6 13. g5 hxg5 14. Bxg5 is terrifically strong for White. According to Sadler, Stockfish NNUE defended the Black position successfully with 14. ... Rg6 15. Bd3 Nf5 in an engine match, but when it got the chance to be White, the sequence 16. Kh1 cxd4 17. Bxf5 exf5 18. cxd4 turned out to be winning: 18. ... Qf7 19. Rg1 b6 20. Qd3 f4 21. Nh4 Re6 22. Rg2 Bd7 23. Rbg1 in Stockfish NNUE — Leela Zero, 2020.

12. Kh1! a6 13. Bd3 Na7 14. Nh4 c4!?
The alternative 14. ... Bb5! gets rid of one attacker, but 15. f4 Bxd3 16. cxd3 cxd4 17. cxd4 is extremely awkward: 17. ... Ng6 18. Ng2! f5 19. a4 Nc6 20. Ba3 fxg4 21. Qxg4 Qf7 22. Ne3 Nxd4 23. Bxf8 Rxf8 24. Rb6 looked very strong in Stockfish NNUE – Stockfish Classical, 2020.

15. Be2 g5

Sadler arranges two other games here with 15. ... Ng6 and 15. ... Ba4, both ending in disaster for Black.

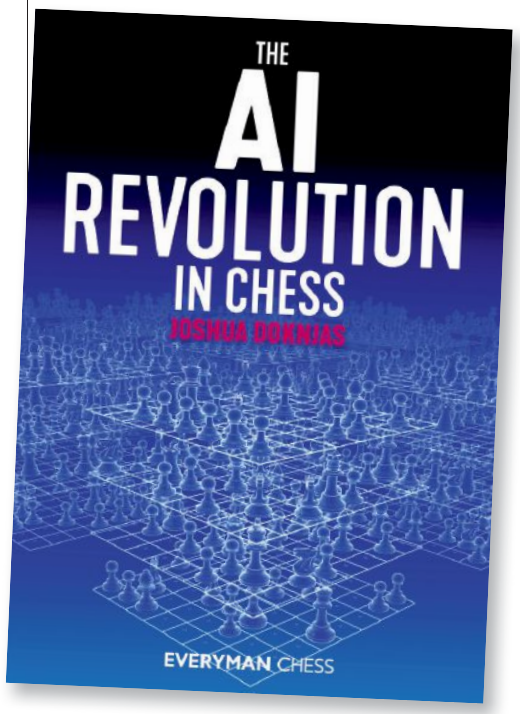
16. Qe1! Ba4
Here 16. ... gxh4? 17. Bxh6 followed by f2-f4 and Qe1xh4 ends the game right away.

17. f4! Bxc2 18. Rb2 Be4+ 19. Bf3 Bd3 20. fxg5! Bxf1 21. Qxf1 Ng6 22. Qh3
22. Nf5! exf5 23. gxf5 also wins.

22. ... Nc6 23. gxh6 Qd8 24. g5 Nce7 25. Nxg6 fxg6
Or 25. ... Nxg6 26. Qg4 followed by h2-h4-h5 wins easily.

26. Qxe6+ Kh8 27. Bg4 b5 28. Kg2 Qc8 29. Qxc8 Nxc8 30. Kg3 Rf1 31. Bf4 Kh7 32. e6
The bishops and passed pawn decide.

32. ... Ra7 33. h4 Ne7 34. Bd6 Rg1+ 35. Kf4 Rf1+ 36. Ke5 Nf5 37. Bc5 Ra8 38. Bxf5 gxf5 39. e7 Rf3 40. Kf6 Re3, Black resigned.



Doknjas has some more theoretically relevant examples in the French, including this one:

FRENCH DEFENSE, WINAWER VARIATION (C18)

LCZero
Stockfish Classical
TCEC Season 19, 2020

1. e4 e6 2. d4 d5 3. Nc3 Bb4 4. e5 c5 5. a3 Bxc3+ 6. bxc3 Ne7 7. h4 Qc7 8. h5 h6 9. Rb1!

An example of the influence of engines. After 50 years of practice with this variation, this move (the first engine choice today) was unknown. In the past two years it has become White's clear favorite.

9. ... b6 10. Qg4 cxd4

Here 10. ... Rg8 11. Bb5+ Kf8 12. Bd3 Ba6 was tested in a couple of high-profile Vachier-Lagrave – Nepomniachtchi games in 2020, analysed separately by Doknjas. Engines seem to prefer the exchange.

11. Qxg7 Rg8 12. Qxh6 Qxe5+ 13. Ne2 dxc3

There are many variants of this type of position in Winawer theory. White's bishops and h-pawn are balanced by Black's strong center and activity. At first sight this might seem easier for the first player to play in practice, but with engines we find that White, in order to even try for a small advantage, apparently has to go into the following sequence, and although there's doubtless more to be investigated, equality seems the outcome:

14. Bf4 Qf5 15. Nd4

After 15. Nxc3, best is 15. ... Ba6! 16. Nb5! Bxb5 17. Bxb5+ Nd7 with equality, e.g., 18. Kf1 (*18. Be3 Qxc2 19. Rc1 Qb2 20. Bxd7+ Kxd7 21. Qf4 e5 22. Qxf7 Rxg2 23. h6 Rag8 24. Rc7+* forces a draw) 18. ... Qg4 19. g3 Qf3 20. Rh3 Nf5 21. Qf6 Ne3+ 22. Ke1 Nxc2+ 23. Kd2 Qxf2+ 24. Kd3 Ne1+ 25. Rxe1 Qxe1 26. Bxd7+ Kxd7 27. Qxf7+ Kc6 28. Qc7+ Kb5 29. Qd7+ Ka6 30. Qa4+ Kb7 31. Qd7+.

15. ... Qe4+ 16. Be3 Ba6 17. f3 Qe5 18. g4! Qg3+

Here 18. ... Bxf1 19. Kxf1 Nbc6 is also playable, and eventually drew in one correspondence game.

19. Bf2 Qe5+ 20. Qe3 Qxe3+ 21. Bxe3 Bxf1 22. Kxf1 Kd7

The alternative 22. ... e5 23. Nb5 Kd7 24. Nxc3 f6 25. h6 Nbc6 26. h7 Rh8 27. Rd1 Ke6 is similar.

23. h6 e5 24. Nb5 f6 25. Rd1 Nbc6 26. Nxc3 Ke6

27. Ne2

The position is balanced after 27. Rh5 Rh8 28. f4 exf4 (*28. ... Rag8 29. Nxd5 Rxg4 30. f5+ Kf7 31. Nxe7 Kxe7* with equality) 29. Bxf4 Rag8 30. g5 fxg5 31. Bxg5 Rf8+ 32. Kg2 Rf5.

27. ... Rh8

White has a slight edge after 27. ... Rg6 28. Kf2 Rh8 29. Rh5.

28. Kf2 Rac8

If 28. ... Kf7 29. g5 d4 30. Bc1 fxg5 31. Bxg5 Nf5 32. f4 Rag8 33. Rdg1 e4 is equal.

29. c3 Rcg8 30. Rh5 Na5 31. Rg1 Rh7 32. a4 Nc4 33. Bc1 Kf7 34. Rgh1 Nd6 35. Rd1 Ke6 36. Re1 Kf7 37. Rf1, draw.

Both of these books are full of wonderful games with stunning strategies that seem to come from another planet. This in itself makes them enjoyable and rewarding. Both authors' annotations are instructive but also show an enthusiastic appreciation of the engines' ingenuity.

On a more philosophic level, the alien nature of computer play inevitably raises difficult questions about whether engines can be reasonably said to have 'ideas' or 'intuitions.' More importantly, it remains to be shown whether and how humans can utilize and benefit from such ideas. Sadler answers this latter question with an enthusiastic 'yes,' and Doknjas is optimistic if more cautious.

I have to admit that the most impressive examples of strategic thinking in these books seem indescribable to me and out of the grasp of human reasoning. The moves simply work because dozens of minor factors conspire together. For example, an engine sacrifices material for extremely long-term compensation because it can work out the consequences of various counter-sacrifices or attempts at simplification. A human, subject to calculational imperfection, would imagine those potential pitfalls stretching well ahead into the future and conclude that the probability of success is too low to make the sacrifice practical. What the engine is doing not only can't be put into words, but is essentially too complex to be understood by us.

So yes, these books convince me that engine study can lead to improvement, but generally in fairly narrow and specific contexts. First, by finding exact orders, well-timed maneuvers, and successful plans in the opening, as is practiced by every leading player in the world. More generally, in discovering typical maneuvers in certain structures and better evaluation of contrasting strategies — for example, certain pawn sacrifices or flank attacks.

Once you move beyond this sort of specific knowledge, however, I think it becomes fruitless to try to 'think like an engine.' Sometimes you may well have no idea why the engine is pointing you in a certain direction, at which point using your own chess judgment can be a good way to get back to the real world.

I would argue that a more modest but meaningful way to benefit from studying engine games — and one endorsed by both authors — would be to refine your sense of the factors that an engine seems to value in particular kinds of positions, for example, mobility, space, or centralization. In that sense, studying with engines isn't so different from studying games collections or even your own games. The nice part is that you have a genius by your side to keep your mind open and surprise you with new ideas.

Doknjas, Joshua. The AI Revolution in Chess. *Everyman Chess, 2002. ISBN 9781781945988, 336 pages. (Available from* uscfsales.com, *product code B0550EM. $28.95.)*

Sadler, Matthew. The Silicon Road to Chess Improvement. *New in Chess, 2022. ISBN 9789056919832, 496pp. (Available from* uscfsales.com, *product code B0262NIC. $29.95.)*